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ANTIFEEDANT EFFICACY OF GREEN SYNTHESIZED ZINC OXIDE NANOPARTICLES AGAINST THE LARVAE OF *Papilio demoleus* L.

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ABSTRACT

Pongamia pinnata aqueous leaf extracts (PALE) and *P.pinnata* synthesized Zinc Oxide nanoparticles synthesized (Pp-ZnONPs) efficacy as antifeedants against the 4th instar larvae of Citrus butterfly, *Papilio demoleus* L. was evaluated in this study conducted between July 2022 and November 2022. GC-MS analysis of PALE confirmed several prominent bioactive compounds to be present in the sample. Scanning Electron Microscope (SEM) results of Pp-ZnONPs confirmed the spherical shape of nanoparticles with an average size of 57.18 nm. In the antifeedant bioassay, the no-choice leaf disc method was employed to assess the antifeedant activity (AFA) at different concentrations of PALE and Pp-ZnONPs solutions separately. The leaf area fed by the larvae was measured by the graph sheet method after 24 and 48 hours of the treatment. The AFA of the test compounds gave dose-dependent results. 70.28% and 64.10% of the highest AFA were obtained with 250 ppm of PALE after 24 and 48 hours of treatment, respectively. For the same periods, 84.38% and 73.92% AFA was observed, respectively with Pp-ZnONPs. The findings showed that both PALE and Pp-ZnONPs have the potential to be used as antifeedants against the 4th instar larvae of *P. demoleus.*

Key words: Citrus butterfly larvae, Feeding inhibition, Green synthesized ZnONPs, Nano insecticides, and *Pongamia pinnata* leaf extracts

INTRODUCTION

India is the second largest producer of Fruits and Vegetables globally (NHB, 2020-21). In India, Citrus is the third most important fruit crop after banana and mango (NHB, 2017). Larvae of the Lime butterfly (*Papilio demoleus*) are voracious feeders, with older instars being the most damaging. Heavy infestation leads to the complete defoliation of young citrus orchards. Upto 40% of global crop production is lost due to pests annually costing $220 billion loss to the global economy, of which $70 billion is due to invasive insects (FAO, 2021). The larvae of *P. demoleus* cause upto 30% yield loss (Pawandeep *et al*., 2020) in citrus orchards. Pesticides are a major tool in controlling insect pests of agricultural and health importance (Diego Valbuena *et al.,* 2021). Approximately, 2 million tonnes of pesticides are utilized annually worldwide (Anket Sharma *et al*., 2019).

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Indiscriminative usage of pesticides has negative effects such as environmental pollution, loss of biodiversity and human health issues ranging from nerve damage to cancers and the development of insecticide resistance by pests (Siegwart *et al.,* 2015).

Secondary metabolites such as Alkaloids, Flavonoids, Terpenoids, Phenols and saponins are well known for their pesticidal properties and are considered biopesticides. Antifeedants are one type of biopesticide that prevent feeding by the pests and make them die due to starvation. Green synthesized nanoparticles are the new ray of hope in replacing synthetic pesticides. Various scientists have used different plant extracts such as *Eucalyptus globulus* (Shahid *et al.,* 2019), *Cayratia pedata* (Jayachandran *et al.,* 2021), *Garcinia cambogia (*Varsha Jayakar *et al.,* 2021), *Calotropis gigantea (*Chaudhuri and Malodia*,* 2017), *Eichhornia crassipes* (Vanathi *et al.,* 2014), *Passiflora caerulea* (Santhosh kumar *et al.,* 2017) *Costus igneus* (Vinotha *et al.,* 2019) to synthesize ZnONPs.

P. pinnata plant extracts were used to synthesize silver nanoparticles by Reddya Naik *et al.* (2014). Zinc Oxide Nanoparticles (ZnONPs) were synthesized using *P. pinnata* plant extracts by Sundrarajan *et al*. (2015), Malaikozhundan and Vinodhini (2018) and Senthilrasan *et al.* (2022). The green synthesized ZnONPs have been reported to exhibit antibacterial, antioxidant, anticancer and pesticidal properties. However, the effect of ZnONPs on Lepidopteran insect control has not been completely documented.

This study was intended to assess the antifeedant activity (AFA) of *P. pinnata* aqueous leaf extracts (PALE) and *P. pinnata* leaf synthesized ZnONPs (Pp-ZnONPs) against the 4th instar larvae of *P. demoleus* under laboratory conditions.

MATERIALS AND METHODS

Test insect culture

This study was conducted between July and November, 2022. Eggs and early larval instars of *P. demoleus* were collected from sweet orange (*Citrus sinensis*) orchards located in PA pally village of the Nalgonda district of Telangana State, India. After disinfecting the eggs in the laboratory, they were dried and allowed to hatch. Along with them the field collected larvae also were reared in the laboratory on *Citrus sinensis* leaves by providing 25± 20 ^{0}C temperature, 5–11-h light-dark photoperiod and 75±5% relative humidity. From the reared larvae, the fourth instar larvae were used for the antifeedant bioassays.

Pongamia pinnata plant parts collection

The healthy leaves of the *P. pinnata* were collected from the Osmania University campus, washed under running tap water first and then with distilled water and shade dried for 15 days. The fully dried leaves were powdered using an electrical blender and stored in airtight sealed polythene bags until usage.

Pongamia pinnata plant parts extraction

50 g of the leaf powder of *P. pinnata* was added to 200 ml of distilled water and soaked for five days with frequent shaking. Later the solution was filtered with Whatman filter paper No. 1 and the extracts were dried using a rotary evaporator, packed in air-tight containers and stored in the refrigerator until further use.

Synthesis of ZnO nanomaterials

Freshly prepared leaf extracts were used to synthesize Pp-ZnONPs by making some

modifications to the method followed by Malaikozhundan and Vinodhini (2018). 20 mL of 0.02 M zinc nitrate hexahydrate solution was added to 50 mL of double distilled water and placed on a magnetic stirrer for 10 minutes. Later 250 mL of *P. pinnata* aqueous leaf extract and 2.0 M NaOH were added till the solution's pH reaches 12 and placed on the magnetic stirrer for two hours. The yellowish precipitate formed was separated by centrifuging at 5000 rpm for 10 min and washed three times with distilled water and ethanol. The paste so obtained was calcinated at 4000 C for three hours and later ground in a mortar to get the Pp-ZnONPs.

Test compounds characterization: To find out the bioactive molecules of the PALE sample, GC-MS analysis was done by GCMS-QP2010 PLUS (Shimadzu, Japan). To determine the particle size and surface morphology of the Pp- ZnONPs, they were examined using a field emission scanning electron microscope (FE-SEM; JXA-8200, JEOL).

Preparation of test solutions: Ten ml of Tween 80 was added to one gram of PALE and Pp-ZnONPs separately and ultrasonicated for five minutes to make homogeneous solutions. Later, 990 mL of double distilled water was added to each of the solutions to make a 1000 ppm stock solution. Five different concentrations (250 ppm, 200, 150, 100 and 50 ppm of PALE and 25 ppm, 20, 15, 10 and 5 ppm of Pp-ZnONPs) were prepared with distilled water by dilution method. The control solutions were prepared using the same solvents in the same ratios excluding the solutes.

Antifeedant Bioassay

Antifeedant bioassays were conducted between July and October 2022 in the entomology laboratory, Department of Zoology, Osmania University, Hyderabad. To assess the antifeedant activity (AFA) of the test solutions, leaf disc and no-choice methods were followed. Fresh *C. sinensis* leaf discs of 30 sq. cm diameter were punched and dipped in prepared solutions of different concentrations. Control leaf discs were dipped in the control solution. After drying the leaf discs, they were placed in separate Petri dishes. Wet tissue papers were placed in each petri dish. Later a single 4th instar larva of *P. demoleus* was introduced into each of the Petri dishes and allowed to feed for 48 hours. For each concentration, five larvae were tested in five separate petri dishes. The experiment was repeated five times. The leaf areas consumed by the larvae were measured using graph paper, after 24 h and 48 h of the treatment. Antifeedant Activity (AFA) was calculated by using the following formula:

AFA = T% - C%/100- C% * 100

Where: AFA = Antifeedant Activity;

T% = % of leaf area protected in Treated leaf disc and

C% = % of leaf area protected in Control leaf disc

Statistical analysis

The recorded experimental data was subjected to one-way analysis of variance (ANOVA). SPSS software version 29.0 (64-bit) was used for the purpose. The results were expressed as Mean ± SD. The level of significance was set at $p<0.05$. Tukey Kramer's post-hoc test was conducted to find the significant differences among the tested concentrations of PALE and Pp-ZnONPs.

RESULTS AND DISCUSSION

GC-MS analysis

GC-MS report of PALE (Figure 1) confirmed the presence of 100 Phytochemicals in the tested sample. Of them, Cholesta-4,6 Diene-3one, Glycine-N-penta-decafluoro-octanoyl-hexadecyl ester, Naphthalene-1,2,3,4-tetrahydro-1-phenyl and 1-Amino-4-bromoanthraquinone-2-carboxaldehyde were identified to be the principle secondary metabolites.

Characterization of ZnO NPs

SEM image (Figure 2) confirmed the spherical shape of the Pp-ZnONPs. The average size of the Pp-ZnONPs was found to be 57.18 nm. SEM image has shown individual ZnO nanoparticles as well as a number of aggregates.

Antifeedant bioassay

The results of the AFA bioassay with PALE and Pp-ZnONPs are presented (Table 1). Mean leaf areas protected by PALE treatment were 16.71 ± 0.67, 19.51 ± 0.38, 21.17 ± 0.61, 23.14 ± 0.59 and 25.03 ± 0.91 sq. cm. at 50, 100, 150, 200 and 250 ppm concentrations after 24 h, respectively, compared to control treatment (13.29 ± 0.65 sq. cm). At the same concentrations, 13.21 ± 0.54, 16.94 ± 0.61, 18.68 ± 0.88, 21.39 ± 0.56 and 23.13 ± 0.61 sq.cm. mean leaf areas were protected, respectively, after 48 h, while in control treatment 10.87 ± 0.78 sq. cm leaf area was protected.

In the experiment conducted with Pp-ZnONPs treatment, the mean leaf areas protected were 20.25 ± 0.51, 23.05 ± 0.55, 24.60 ± 0.25, 26.11 ± 0.51 and 27.39 ± 0.45 sq. cm. after 24 Hrs at 5, 10, 15, 20 and 25 ppm concentrations, respectively. 17.82 ± 0.51, 19.91 ± 0.53, 20.78 ± 0.74, 22.95 ± 0.56 and 25.01 ± 0.59 sq.cm leaf areas were protected after 48 hrs at the same concentrations, respectively. The mean leaf areas protected in control plates were 13.29 ± 0.65 and 10.87 ± 0.78 after 24 h and 48 h, respectively.

Table 2 shows the AFA percentages of the tested concentrations of PALE and Pp-ZnONPs. The AFA increased as the test concentrations increased. More than 50% AFA was exhibited by PALE at 200 ppm (58.96%) and at 250 ppm (70.28%) after 24 h. After 48 hours also, 200 ppm and 250 ppm conc. of PALE showed more than 50% AFA (54.97% and 64.10%). Pp-ZnONPs treatment exhibited more than 50% AFA on 14th instar larvae of *P. demoleus* at 15, 20 and 25 ppm (67.71%, 76.71% and84.38%, respectively) after 24 hrs of the treatment. After 48 h, the observed AFA values were 51.80%, 63.17% and 73.92%, respectively at the same concentrations.

As per the ANOVA results, all the tested concentrations results were significant at the 5% level of significance. The results of the Tukey - HSD (Honest Significance Difference) post-hoc test indicated that all the tested concentrations results are significantly different from each other.

P. pinnata extracts were proven to be good antifeedants against many pests. They showed better AFA than *Ceiba pentandra* against *H. armigera* (Lakshmanan *et al.,* 2017). Oils of *P. pinnata* were better antifeedants than *Azadirachta indica, Sesamum inidicum* against the *Spodoptera litura* (Wankhede *et al.,* 2020*).* Several phytochemicals were tested for their AFA against the larvae of *P. demoleus.* Deepika and Poonam (2017) revealed that 1%

Table 1. Mean ± SD of leaf areas protected by PALE and Pp-ZnONPs against the 4th instar larvae of *P. demoleus*

S.No.	Extract	Concentration (ppm)	Sample Size (N)	Mean ± SD (sq. cm.) After 24 hrs.	Mean ± SD (sq. cm.) After 48 hrs.
1	PALE	Control	25	13.29 ± 0.65*	10.87 ± 0.78*
		50	25	16.71 ± 0.67*	13.21 ± 0.54*
		100	25	19.51 ± 0.38*	16.94 ± 0.61*
		150	25	21.17 ± 0.61*	18.68 ± 0.88*
		200	25	23.14 ± 0.59*	21.39 ± 0.56*
		250	25	25.03 ± 0.91*	23.13 ± 0.61*
2	Pp-ZnONPs	Control	25	13.29 ± 0.65*	10.87 ± 0.78*
		5	25	20.25 ± 0.51*	17.82 ± 0.51*
		10	25	23.05 ± 0.55*	19.91 ± 0.53*
		15	25	24.60 ± 0.25*	20.78 ± 0.74*
		20	25	26.11 ± 0.51*	22.95 ± 0.56*
		25	25	27.39 ± 0.45*	25.01 ± 0.59*

Mean ± SD values are significant at P<0.05; *All values are significantly different as per Tukey's – HSD post-hoc test

Table 2. AFA (antifeedant activity) percentages exhibited by PALE and Pp-ZnONPs against the 4th instar larvae of *P. demoleus*

S. No.	Extract	duration	50 ppm	100 ppm	150 ppm	200 ppm	250 ppm
1	PALE	24 Hrs.	20.17*	37.21*	47.16*	58.96*	70.28*
		48 Hrs.	12.21*	31.70*	40.80*	54.97*	64.10*
S. No.	**Extract**	**duration**	**5 ppm**	**10 ppm**	**15 ppm**	**20 ppm**	**25 ppm**
2	Pp-ZnONPs	24 Hrs.	41.65*	58.40*	67.71*	76.71*	84.38*
		48 Hrs.	36.34*	47.23*	51.80*	63.17*	73.92*

AFA values are significant at P<0.05; *All values are significantly different as per Tukey's -HSD post-hoc test

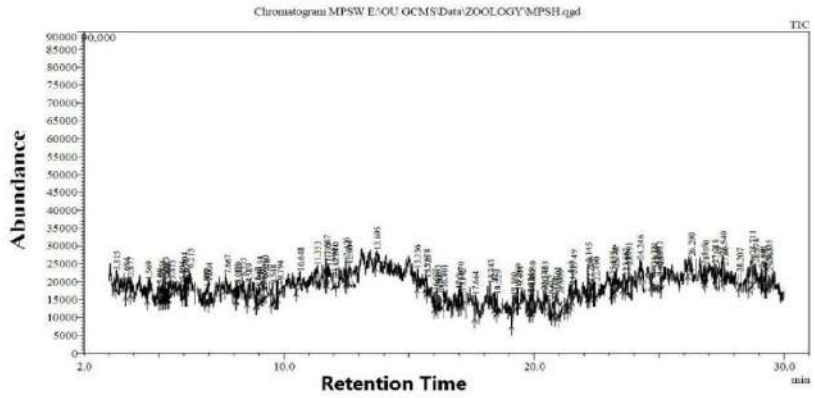

Figure 1. GCMS spectrum of *P. pinnata* Aq. leaf extract

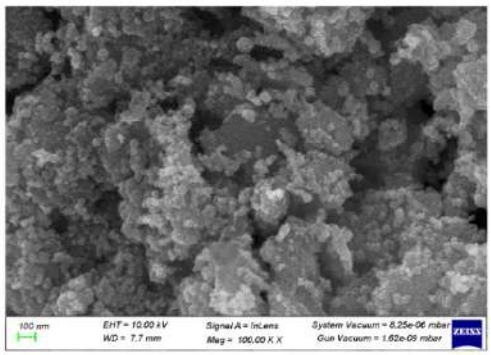

Figure. 2. SEM micrograph of ZnO nanoparticles synthesized from the leaf extracts of *P. pinnata.*

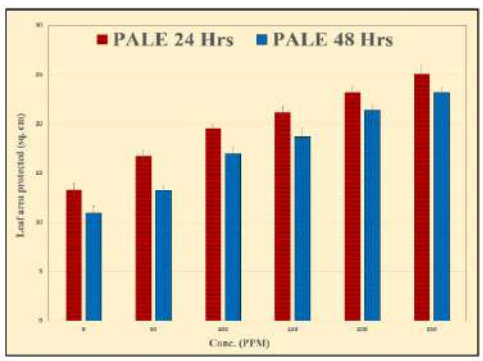

Figure 4. Mean leaf areas protected by ZnONPs synthesized from *P. pinnata* leaf extracts against the 4th instar larvae of *P. demoleus*

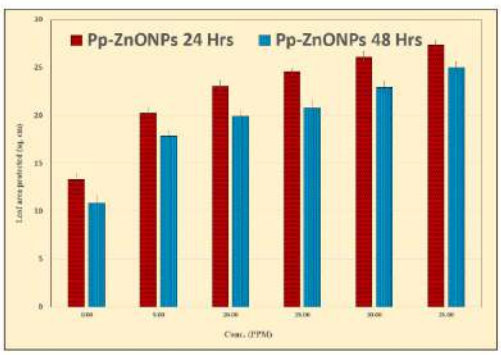

Figure 3. Mean leaf areas protected by *P. pinnata* Aq. Leaf Extract (PALE) against the 4th instar larvae of *P. demoleus*

concentrations of Lemon grass- Chirharit and Lemon grass- Krishna essential oils were most effective as feeding deterrents. Forskolin exhibited AFA of 66.01% and 60.89% with 200 ppm against 4th instar larvae of P. demoleus after 24 h and 48 h of treatment, respectively *(*Vattikonda *et al*., 2014). Vattikonda and Sangam (2016) reported that Azadirachtin exhibited 86.28% and 70.43% of AFA after 24 h and 48 h with 200 ppm, respectively. Similarly, Andrographolide also gave the same results as 83.60% and 80.05% AFA with 200 ppm concentration after 24 h and 48 h, respectively (Vattikonda, 2015). Rahman *et al.* (2022) observed high antifeedant activity of 98.01% with copper oxide nanoparticles against the 4th instar larvae of *S. litura.* In another study, Arunthirumeni *et al.* (2022) synthesized Selenium nanoparticles using *Trichoderma* extracts and found them to be effective antifeedants against *S. litura* larvae at 100 ìg/ml after 48 h of treatment.

In this study, PALE was identified to possess several esters, phenols and sterols as bioactive compounds. These phytochemicals reacted with the zinc ions and reduced them to ZnONPs. Both PALE and Pp-ZnONPs exhibited concentration-dependent results. Figures 3 and 4 exhibit the Mean leaf areas protected by PALE and Pp-ZnONPs after 24 h and 48 h of the treatment. It is evident that Pp-ZnONPs performed better than PALE by preventing the feeding by the larvae at much lower concentrations. The same trend was observed in AFA percentages also (Table 2). At the highest tested concentration, PALE exhibited 70.28% and 64.10% AFA, whereas, Pp-ZnONPs exhibited 84.38% and 73.92% AFA after 24 h and 48 h, respectively. It may be inferred that the bioactive compounds present in PALE and nano-sized Pp-ZnONPs are responsible for the Antifeedant efficacy shown by them.

Insect pests find their host plants through the olfactory signals and physical features of the plants. Gustatory sensilla located on mouthparts help the insect pests accept or reject the food sources. Antifeedants act on the antifeedant receptor sensory cells of the insect pests and prevent feeding or slow down further feeding at low concentrations. Some antifeedants such as azadirachtin, block the feeding stimulant receptors of the pest and thus prevent them from receiving feeding stimulants. Careful electrophysiological studies are required to determine the mechanism of action of the antifeedants (Purrington, 2017). In this study, the bioactive molecules present in PALE and Pp-ZnONPs might have interacted with the gustatory sensilla of the insect pest and prevented feeding by the insect pest, either by binding with antifeedant sensory receptors or by blocking the feeding stimulant receptors. To know which specific phytochemicals are responsible for this AFA and by what mechanism they exert their AFA, further studies are required.

CONCLUSIONS

ZnONPs were synthesized from the leaf extracts of *P. pinnata.* Several esters, phenols and sterols were identified in PALE. These phytochemicals present in PALE reduced Zinc ions and thus helped to form Pp-ZnONPs. Both-PALE and Pp-ZnONPs have proved to exhibit an efficient AFA against the larvae of *P. demoleus.* Comparatively, Pp-ZnONPs were more effective than PALE. Pp-ZnONPs were also proved to be a good biopesticidal agent against many other pests. Hence, they may be used to control the

larvae of P. demoleus. Furthermore to understand the physiological and molecular mechanisms of AFA shown by PALE and Pp-ZnONPs further studies are required.

REFERENCES

Anket Sharma, Vinod Kumar, Babar Shahzad, Mohsin Tanveer, Gagan Preet Singh Sidhu, Neha Handa, Sukhmeen Kaur Kohli, Poonam Yadav, Aditi Shreeya Bali, Ripu Daman Parihar, Owaisi Iqbal Dar, Kirpal Singh, Shivam Jasrotia, Palak Bakshi, M. Ramakrishnan, Sandeep Kumar, Renu Bhardwaj and Ashwani Kumar Thukral. 2019. Worldwide pesticide usage and its impacts on ecosystem. SN Applied Sciences. 1:1446. DOI: https://doi.org/10.1007/s42452-019-1485-1

Arunthirumeni, M., Veerammal, V and Shivakumar, M.S. 2022. Biocontrol efficacy of mycosynthesized selenium nanoparticle using *Trichoderma* species on insect pest *Spodoptera litura*. Journal of Cluster Science. 33, 1645–1653. Dol: https://doi.org/10.1007/s10876-021-02095-4

Chaudhuri, S.K and Malodia, L. 2017. Biosynthesis of zinc oxide nanoparticles using leaf extract of *Calotropis gigantea*: characterization and its evaluation on tree seedling growth in nursery stage. Applied Nanoscience (7): 501–512. https://doi.org/10.1007/s13204-017-0586-7

Deepika C and Poonam S., 2017. Feeding inhibitory activity of different medicinal plant oils against *Papilio demoleus* L. Journal of Entomology and Zoology studies. 5(1): 631-635.

Diego Valbuena, Marcela Cely-Santos and Diana Obreg´on. 2021. Agrochemical pesticide production, trade and hazard: Narrowing the information gap in Colombia. Journal of Environmental Management. 286 (2021): 112141.

FAO, 2021. Scientific review on the impact of climate change on plant pests - A global challenge to prevent and mitigate plant pest risks in agriculture, forestry and ecosystems. Retrieved from the website (https://www.fao.org/documents/card/en/c/cb4769en) on 29.1.2023.

Jayachandran, A., Aswathy, T.R and Nair, A.S., 2021. Green synthesis and characterization of zinc oxide nanoparticles using *Cayratia pedata* leaf extract. Biochemistry and Biophysics Reports, 26, p.100995. Doi:10.1016/j.bbrep.2021.100995

Lakshmanan, S., Gokulakrishnan, J., Baranitharan, M and Thushimenan, S. 2017. Antifeedant, larvicidal and oviposition detergent activity of *Pongamia pinnata* and *Ceiba pentandra* against pod borer larvae of *Helicoverpa armigera* (Noctuidae: Lepidoptera). International Journal of Zoology and Applied Biosciences. 2(4): 185-189.

Malaikozhundan, B and Vinodhini, J. 2018. Nanopesticidal effects of *Pongamia pinnata* leaf extract coated zinc oxide nanoparticle against the Pulse beetle, *Callosobruchus maculatus*. Materials Today Communications. 14: 106–115. Dol: 10.1016/j.mtcomm.2017.12.015

NHB; 2017. National Horticulture Board - Annual Report-2016-17: Retrieved from the website (https://nhb.gov.in/statistics/State_Level/2017-18-(Final).pdf) on 29.1.2023.

NHB; 2021. National Horticulture Board- Annual Report-2020-21: Retrieved from the website (https://nhb.gov.in/pdf/AR-2020-21.pdf) on 29.1.2023.

Pawandeep, Khushwinder Singh and Anita Singh. 2020. Management of *Papilio demoleus* L. using insecticides on Kinnow nursery plants at Talwandi Sabo, Punjab. Journal of Pharmacognosy and Phytochemistry. 9 (4): 692-695.

Purrington, C. B. 2017. Antifeedant substances in plants. Encyclopedia of Applied Plant Sciences. pp. 364–367. Doi:10.1016/b978-0-12-394807-6.00068-x

Rahman, Afroja, Sarayut Pittarate, Vivekanandhan Perumal, Julius Rajula, Malee Thungrabeab, Supamit Mekchay and Patcharin Krutmuang. 2022. Larvicidal and antifeedant effects of copper nano-pesticides against *Spodoptera frugiperda* (J.E. Smith) and its immunological response. Insects. 13 (11): 1030. DoI: https://doi.org/10.3390/insects13111

Reddya Naik, B., Swarna Gowreeswara, G., Yuvo Singh, Satyavathi, R., Dharavath, S.S and Ramachandra Reddy, P. 2014. Bio-Synthesis of silver nanoparticles from leaf extract of *Pongamia pinnata* as an effective larvicide on dengue vector *Aedes albopictus* (Skuse) (Diptera: Culicidae). Advances in Entomology. (2): 93-101.

Santhosh Kumar, J., Kumar, S. V and Rajeshkumar, S. 2017. Synthesis of zinc oxide nanoparticles using plant leaf extract against urinary tract infection pathogen. Resource-Efficient Technologies. 3(4): 459–465. Doi:10.1016/j.reffit.2017.05.001

Senthilarasan K., Raguraman, V., Senthilmurugan, V and Sowmiya, D. 2022. Green synthesis and characterization of Zinc Oxide nanoparticles from the leaf extract of *Pongamia Pinnata*. International Research Journal of Multidisciplinary Scope (IRJMS). 3(2): 35-40. DoI: 10.47857/irjms.2022.v03i02.076

Shahid S., Fatima, U., Sajjad, R and Khan, S.A. 2019. Bioinspired nanotheranostic agent: Zinc Oxide; Green synthesis and biomedical potential. Digest Journal of Nanomaterials and Biostructures. 14 (4): 1023-1031.

Siegwart, M., Graillot, B., Blachere Lopez, C., Besse, S., Bardin, M., Nicot, P. C and Lopez-Ferber, M. 2015. Resistance to bio-insecticides or how to enhance their sustainability: A review. Frontiers in Plant Science. 6. Doi:10.3389/fpls.2015.00381

Sundrarajan, M., Ambika, S and Bharathi, K. 2015. Plant-extract mediated synthesis of ZnO nanoparticles using *Pongamia pinnata* and their activity against pathogenic bacteria. Advanced Powder Technology. 26(5): 1294–1299. Doi:10.1016/j.apt.2015.07.001

Vanathi, P., Rajiv, P., Narendhran, S., Rajeshwari, S., Rahman, P. K. S. M and Venckatesh, R. 2014. Biosynthesis and characterization of phyto mediated zinc oxide nanoparticles:

A green chemistry approach. Materials Letters. 134: 13–15. Doi:10.1016/j.matlet.2014.07.029

Varsha Jayakar, Vinayak Lokapur, Nityasree B. R., Raju Krishna Chalannavar, Lyned D. Lasrado and Manjula Shantaram. 2021. Optimization and green synthesis of Zinc Oxide nanoparticle using *Garcinia cambogia* leaf and evaluation of their antioxidant and anticancer property in kidney cancer (A498) cell lines. Biomedicine. 41(2): 206-222. DoI: https://doi.org/10.51248/.v41i2.785

Vattikonda S.R., Amanchi N.R and Sangam S.R. 2014. Antifeedant activity of forskolin, an extract of *Coleus forskohlii*, against *Papilio demoleus* L. (Lepidoptera: Papilionidae) larvae. European Journal of Experimental Biology. 4(1): 237-241.

Vattikonda, S.R. 2015. Effect of andrographolide on feeding behaviour of *Papilio demoleus* L. (Lepidoptera: Papilionidae) larvae. Asian Journal of Bio Science. 10 (1): 65-70. DoI: 10.15740/HAS/AJBS/10.1/65-70

Vattikonda S.R and Sangam S.R. 2016. Assessment of the antifeedant potential of azadirachtin. A plant product of *Azadirachta indica* against *Papilio demoleus* L. (Lepidoptera: Papilionidae) larvae. Journal of Entomology and Zoology Studies. 4(5): 956-959.

Vinotha, V., Iswarya, A., Thaya, R., Govindarajan, M., Alharbi, N. S., Kadaikunnan, S and Vaseeharan, B. 2019. Synthesis of ZnO nanoparticles using insulin-rich leaf extract: Anti-diabetic, antibiofilm and anti-oxidant properties. Journal of Photochemistry and Photobiology. B: Biology: 111541. DoI:10.1016/j.jphotobiol.2019.111541

Wankhede M.S., Kulkarni, U.S and Thakare, V.S. 2020. Evaluation of AFA of some herbal oils against *Spodoptera litura* (Fab.) under laboratory conditions. Journal of Entomology and Zoology Studies. 8(1): 1140-1142.

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DoI: https://doi.org/10.58537/jorangrau.2023.51.2.02

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MORPHOLOGICAL AND MOLECULAR CHARACTERIZATION OF *Ustilaginoidea virens* TIRUPATI ISOLATE CAUSING FALSE SMUT IN RICE (*Oryza sativa L.)*

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ABSTRACT

Rice false smut disease, an emerging threat to rice cultivation worldwide due to its detrimental effects on both grain yield and quality. The study was conducted on characterization of rice false smut fungus viz., *U. virens* Tirupati isolate in the year 2020-21. It has white coloured fluffy, compact and leathery mycelium with slight undulations and orange or yellowish chlamydospores. The *U.virens* Tirupati isolate was molecular characterized by sequencing ITS amplicon of 439 bp (GenBank accession number ON987217.1). The phylogenetic analysis revealed that *U. virens* Tirupati isolate was different from other strains such as MAFF 240994, strain iJS62, strain UV-8b, strain P1, *Ustilaginoidea usambarensis* and it formed a separate cluster with *Ustilaginoidea virens* sy1.

Keywords: RFS, NCBI, ITS, *Ustilaginoidea virens*

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal crop and widely cultivated food crop in the world. Among various biotic stresses affecting rice production, the rice false smut (RFS) disease caused by *Ustilaginoidea virens* is responsible for significant grain yield losses and quality reduction due to production of dark smut balls (Rush *et al*., 2000). It is a vital devastating disease-causing yield loss from 1.01 to 10.91 per cent and also reducing the chaff percentage and 1000-grain weight (Atia, 2004). About 44 percent yield loss was reported in India (Singh and Pophaly, 2010). In India, the disease has been observed in severe form since 2001 in major rice-growing states (Saha *et al*., 2020).

RFS is previously considered as a minor disease of sporadic occurrence (Cooke, 1878) but is now reached to a status of epidemic and major disease in all rice-growing areas across the world (Singh and Pophaly, 2010). The disease has expanded rapidly worldwide because of the large-scale planting of high-yielding rice varieties and the overuse of nitrogen fertilizers in the past decades (Zhou *et al*., 2008).

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The sexual (ascospores) and asexual (chlamydospores) spores of *U. Virens* can infect rice spikelets (Tanaka *et al*., 2008). Sclerotia produce ascospores, which are the primary source of infection in rice plants, whereas secondary infection may come from air-borne chlamydospores (Ashizawa *et al.*, 2010). The pathogen colonizes inner organs like stamens with mycelia at the late booting stage and in infected plants mature head is replaced by velvety smut balls which are globose and yellowish green. When the smut balls burst open, powdery dark green spores are released (Atia, 2004).

U. virens conidia can also infect rice roots and coleoptiles at seedling stages but the hyphae cannot extend into stems to cause systemic infection. *U. virens* hyphae can epiphytically grow onto the inner surface of leaf sheath and proliferate asymptotically along with the developing rice panicle. Such asymptotic colonization may increase the chance to infect developing rice spikelets at the late booting stage. Therefore *U. virens* may survive for a long period via epiphytotic growth on rice and other weed plants and starts infection directly or through producing conidia where rice panicles are available.

Although the disease has been very well studied in other states of India, very scanty and sporadic information is available in the Andhra Pradesh. Since *U. virens* is a very slow-growing fungus, it is difficult to isolate it in its pure form. It often gets contaminated by the fast-growing saprophytes during isolation and incubation. The availability of genome sequence in the databases is useful to design the markers for identification of *U. virens* pathogen at the molecular level. The study was undertaken to fill up this research gap and to update our existing knowledge on the false smut pathogen in the Andhra region.

MATERIALS AND METHODS

Sample collection

The infected rice panicles of the most susceptible rice genotype BPT- 5204 with typical false smut balls were collected from wetland farm of S. V. Agricultural College, Tirupati during 2020-2021.

Isolation conditions and methods

The *U. virens* pathogen was isolated from infected rice panicles as per the procedure of Ladhalakshmi *et al*. (2012). Collected smut ball samples were used for isolating the pathogen.The smut balls collected were thoroughly washed with running tap water and transferred to a sterilized glass vial.

Then, these smut balls were surface sterilized with 0.1% mercuric chloride for one minute and subsequently washed two times with sterile distilled water. The smut balls were then dried between two sterilized filter papers. Using a sterilized inoculation loop, the smut ball was disturbed and the smear of chlamydospores was streaked onto Petri dishes containing Potato Sucrose Agar (PSA) medium under complete aseptic conditions. To check the bacterial contamination, the medium was added with streptomycin (100 ppm). The petri dishes were incubated in an incubator at 25 ± 20 ^{0}C for two weeks for obtaining fungal growth.

Since it is a slow-growing fungus, the culture was often contaminated during incubation with fast-growing saprophytes, so the modified hyphal tip method was used for sub-culturing of the fungus in slants or Petri plates in order to get the

pure culture of the fungus. A single, well-isolated colony of the fungus (arising from a single spore) was picked up using a sterilized needle and transferred to the fresh PSB and maintained as a pure culture on a PSA medium at 4 °C. The culture was periodically transferred to fresh media during the study. For DNA extraction the fungal culture was grown in potato sucrose broth at 27±2 °C. All the work of isolation and transfer of fungal inoculum were carried out in laminar air flow to avoid contamination.

Isolation of DNA

A pure culture of *U. virens* mycelia was inoculated in Potato Sucrose Broth (PSB) and incubated at 28 °C for 2 weeks in a rotary incubator shaker at 125 rpm. The mycelium was harvested by filtration and dried under sterile conditions. The genomic DNA from the mycelium of *U. virens* was isolated by using the Cetyl trimethyl ammonium bromide (CTAB) method according to Wu *et al*. (2001) with minor modifications. Approximately 100 mg of the mycelial mat was grounded to a fine powder using liquid Nitrogen and transferred to 2 ml microcentrifuge tube. To this, 1 ml of CTAB extraction buffer was added and mixed thoroughly by vortex and incubated in a water bath maintained at 65 °C for 45 min. The contents were mixed intermittently and centrifuged at 13,000 rpm for 15 min at room temperature. The supernatant was collected into a fresh eppendorf tube and an equal volume of chloroform and isoamyl alcohol (24:1) was added and the contents were mixed gently and centrifuged at 10,000 rpm for 15 minutes at room temperature. The aqueous phase was transferred to an eppendorf tube and extracted again with chloroform and isoamyl alcohol (24:1). The supernatant was collected into a fresh 1.5 ml eppendorf tube and nucleic acids (both DNA and RNA) were precipitated with 0.6 volume of ice-cold isopropanol, 0.1 volume of 3M sodium acetate and incubated overnight at -200 C. The precipitate was centrifuged at 13000 rpm for 15 minutes at 40 °C and the pellet was washed twice with 70% ethanol to remove the organic wastes and salts present along with the precipitate and centrifuged at 13000 rpm for 20 min at 40 °C. The supernatant was discarded and the pellet was air-dried and dissolved in 50 µl of TE buffer. 5ìl RNase A (20 mg/mL) was added to DNA samples, mixed and incubated at 37 °C for 1 h. DNA was recovered and air dried as described above. DNA was reconstituted in TE buffer for further use for PCR amplification. The quality of genomic DNA was tested by using 0.8% agarose gel and the total genomic DNA obtained was quantified by measuring the absorbance at 260 nm using a nanodrop spectrophotometer (Nanodrop, ND-1000, USA).

Designing *U. Virens* specific primers to the ITS Region for species characterization

The ITS region genome sequence of *U. virens* was retrieved from NCBI (https://www.ncbi.nlm.nih.gov/). Specific primers were designed by using the Primer 3 software (https://primer3.ut.ee/). The software gave out a primer set comprising of Uv ITS primers given in Table 1. The primers were synthesized from sigma Aldrich, Bangalore.

Internal transcribed spacer (ITS) region analysis

The ITS region of rDNA was amplified using PCR conditions with specific primers UV ITS FP and UV ITS RP. PCR amplifications were carried out in 0.2ml eppendorf tubes with a 25µl reaction

Table 1. Uv ITS primers

Primer Name	Sequence
UV ITS FP	CAACAACGGATCTCTTGGTTCT
UV ITS RP	GCCAGAAGCATCCTCTACAAAT

mixture which consists of 2.5µl of 10X Taq buffer, 2.0µl of 25mM MgCl2, 2.5µl of primer (10 picomoles/µl), 1.0 µl of 10mM dNTP mix, 0.4µl of Taq polymerase enzyme (conc. 5U µl-1) and 14.6il of sterile PCR water (Genei, Bangalore) and 2µl (100ng) of DNA sample. Annealing temperature was 590 C. Tubes were covered properly by their cap and placed in a programmable thermal cycler (Eppendorf, Germany) for the reaction to take place as given below. The cycle parameters were included and initial denaturation at 96 °C for 5 min, followed by 30 cycles consisting of denaturing at 96 °C for 30 seconds, annealing at 59 °C for 30 seconds, and extension at 72 °C for 30 seconds and a final extension for 10 min at 72 °C.

Gel Electrophoresis for PCR products

The PCR product with 4 replications were checked with 3% of agarose gel. It is prepared with 1X TBE buffer of pH 8.0 was used to separate the PCR samples. For visualization of the amplicons, 4% of ethidium bromide was added to 100ml agarose gel. The PCR samples were prepared for loading by mixing with 2 ìl of loading dye. The electrophoresis was performed at 100V for 45-60 minutes in 1X TBE buffer. The gel image was captured in Gel Doc™ XR+ Gel Documentation System (Biorad).

Purification of PCR products, sequencing and analysis

The amplified PCR product of ITS regions was purified through gel elution using a gel extraction kit (QIAGEN gel extraction kit). The purified DNA from ITS-PCR was given for sequencing to Medauxin, Bangalore. The obtained nucleotide sequences were later subjected to BLAST analysis (https://blast.ncbi.nlm.nih.gov/Blast.cgi).The sequences were submitted to GenBank at NCBI database and accession number was assigned by NCBI. The ITS Sequencing was done to confirm the identity of the isolated fungus present in the Tirupati region on a molecular basis.

RESULTS AND DISCUSSION

Cultural characteristics and morphological characterization of *U. virens* Tirupati isolate

U. virens inoculated on PSA media proliferated to a small tiny white to creamy white coloured colony in three days and spread in circular form and the diameter increased gradually (Fig.1). The white coloured fluffy mycelium was formed within 15 days post inoculation with slight undulations. The mycelium is compact and leathery in nature. Chlamydospores were formed at the centre and margins of the colony, which appeared orange or yellowish and later turn to greenish colour. The typical chlamydospore germination and white fluffy mycelium on potato sucrose agar (PSA) was similar to that of the previous reports (Ladhalakshmi *et al*., 2012). Lin *et al*. (2018) reported the colony morphology was milky white and olive green with fluffy mycelium, flat or slightly convex surfaces, compact and leathery. The

a) 3 days after inoculation **b) 7 days after inoculation** **c) 15 days after inoculation**

Fig. 1. Morphology of RFS grown *in vitro* at 3, 7 and 15 days after inoculation on PSA medium

morphological identity growth habits of the pathogen were similar to that of previous reports of *U. virens*.

A single well-established colony from a chlamydospore was picked up by using a sterilized needle and transferred into PSB for mass multiplication of the pure culture (Fig 2). Owing to slow growth of *U. virens* and prone to frequent contamination by saprophytes, only a few reports were available on the isolation and culture media suitable for maintenance (Banasode *et al*., 2020; Baite and Sharma, 2015). Isolation using PSA has been described by many authors (Haiyong *et al*., 2015; Zhang *et al*., 2003). Mass multiplication of *U. virens* in PSB was described by Rani *et al.* (2015).

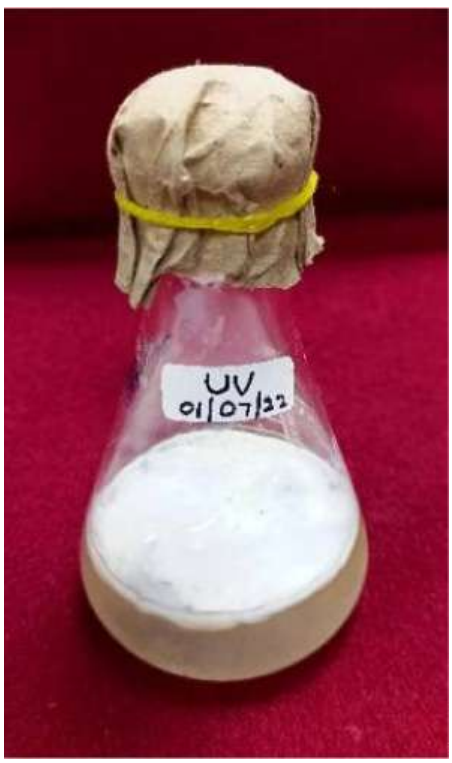

Fig 2. Culture of RFS in potato sucrose broth after 15 days of inoculation

Under the compound microscope, the conidial spores appeared round and globose in shape. Baite *et al*. (2014) reported the spores were warty in nature and globose to spherical. Kim (2007) documented that conidia were 3-5 µm, warty and round to elliptical. Under the inverted fluorescent microscope, the mycelium is septate and hyaline (Fig 3). Similar findings were reported by Ladhalakshmi *et al*. (2012).

Molecular characterization of *U. Virens* Tirupati isolate

The Molecular characterization of the *U. virens* Tirupati isolate was carried out by amplification of ITS region with *U. virens* species

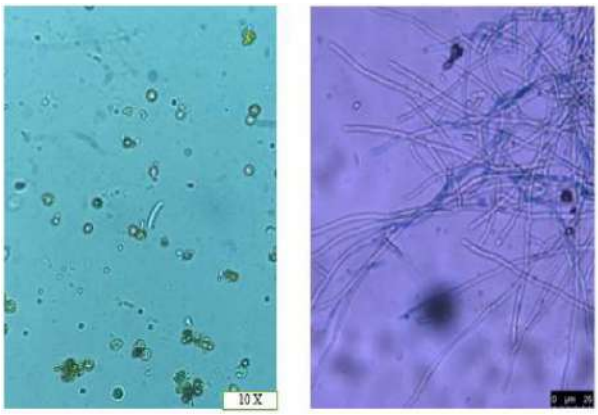

Fig. 3. Characteristics of false smut spores and mycelium under microscope.

specific primers which amplified a PCR product of 439 bp (Fig. 4).

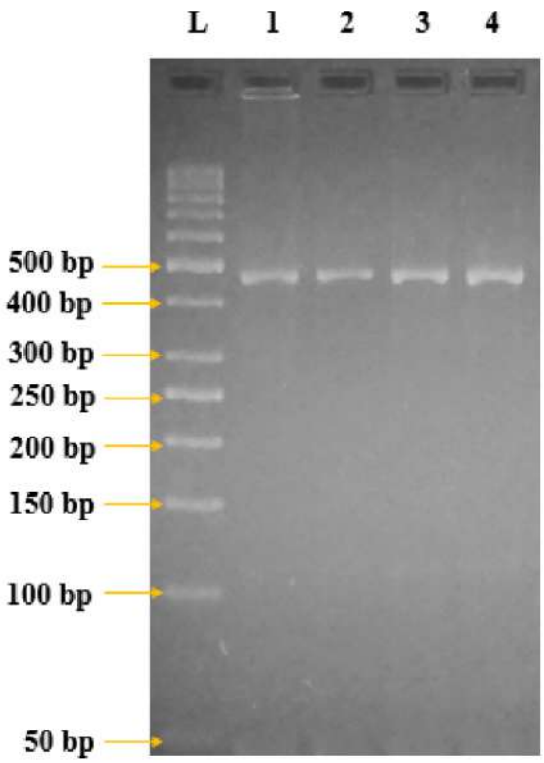

Fig. 4. Resolved amplicon product in 3% agarose stained with ethidium bromide showing amplicon obtained from reacting DNA extracted from *U. virens* Tirupati isolates in UV ITS PCR reaction

Lane: L, 50 bp ladder; lane 1,2,3,4 - Tirupati UV isolate.

The high-quality single DNA fragment was gel eluted and purified with QIAGEN gel extraction kit. The gel purified PCR products were sequenced at Medauxin, Bangalore, India. The good quality sequence of 439 bp long stretch of ITS region was obtained (Fig. 5).

This sequence was compared with the available NCBI database employing Basic Local Alignment Search Tool (BLAST) for taxonomic species identification (Fig 6). The BLAST analysis against all the available nucleotide sequences in NCBI (compared with nucleotide collection nr/nt) identified as *Ustilaginoidea virens* with a maximum score of 789. When the aligned sequence is subjected to BLAST analysis with *U.virens* genome it covered 98 per cent query coverage and matched 81.72 percent with the *U. virens* strains like *Ustilaginoidea virens* MAFF 240994, *Ustilaginoidea virens* strain IJS62, strain UV-8b, strain P1 and other strains of *U. virens* sequences available in the NCBI database (Table 2). Followed by blast analysis the sequence data of *U. virens* was submitted to GenBank of NCBI with accession number ON987217.1 (Fig. 7).

Culture characteristics and morphological characterization through microscopic studies complementing with molecular tools are very promising in identifying species (Hollingsworth, 2007). During the past 15-20 years, molecular identification through DNA barcoding of fungi has become an integrated and essential part of fungal ecology research (Begerow, 2010). DNA barcoding is a technique that uses a short DNA sequence from a standardised region of an organism's genome to identify the pathogen. The internal transcribed spacer (ITS), a non-coding

AACGGGCCGGGGGGACANATTTCATATTTGAGCTGTTGCCGCTTCACTCCCCGTTAC
TGGGGCAATCCCTGTTGGTTTCTTTTCCCCCGCTTATTGATATGCTTAAGTTCAGCGG
GTATTCCTACCTGATCCGAGGTCAACTCTAAAAAAGTTGGGCGTTTTACGGCGTGAC
CCCCCCCCCCCTCCGGGGCGAGGGGTGTGCTACTACCCAGGGGAGGCTGCGGCGGG
GTCCCCACTGCATTTCGGGGGCGGCTGGTGTGCCCCCCCCCCAACACCGAGGCCCCC
GGGGGGGGCTCAAGGGTTAAAATGACCCTCAAACAGGCATGCCCGCCAAAATGCTG
GCGGGCCCAATGTGCGTTCAAAAATTCGATGATTCACTGAATTCTGCAATTCACTTTA
TTTATCGCTTTTCGCTGCGTTCTTCTTTTTTGCCAAAACCA

Fig. 5. Sequence of 439 bp long stretch ITS region of *U. virens* Tirupati isolate

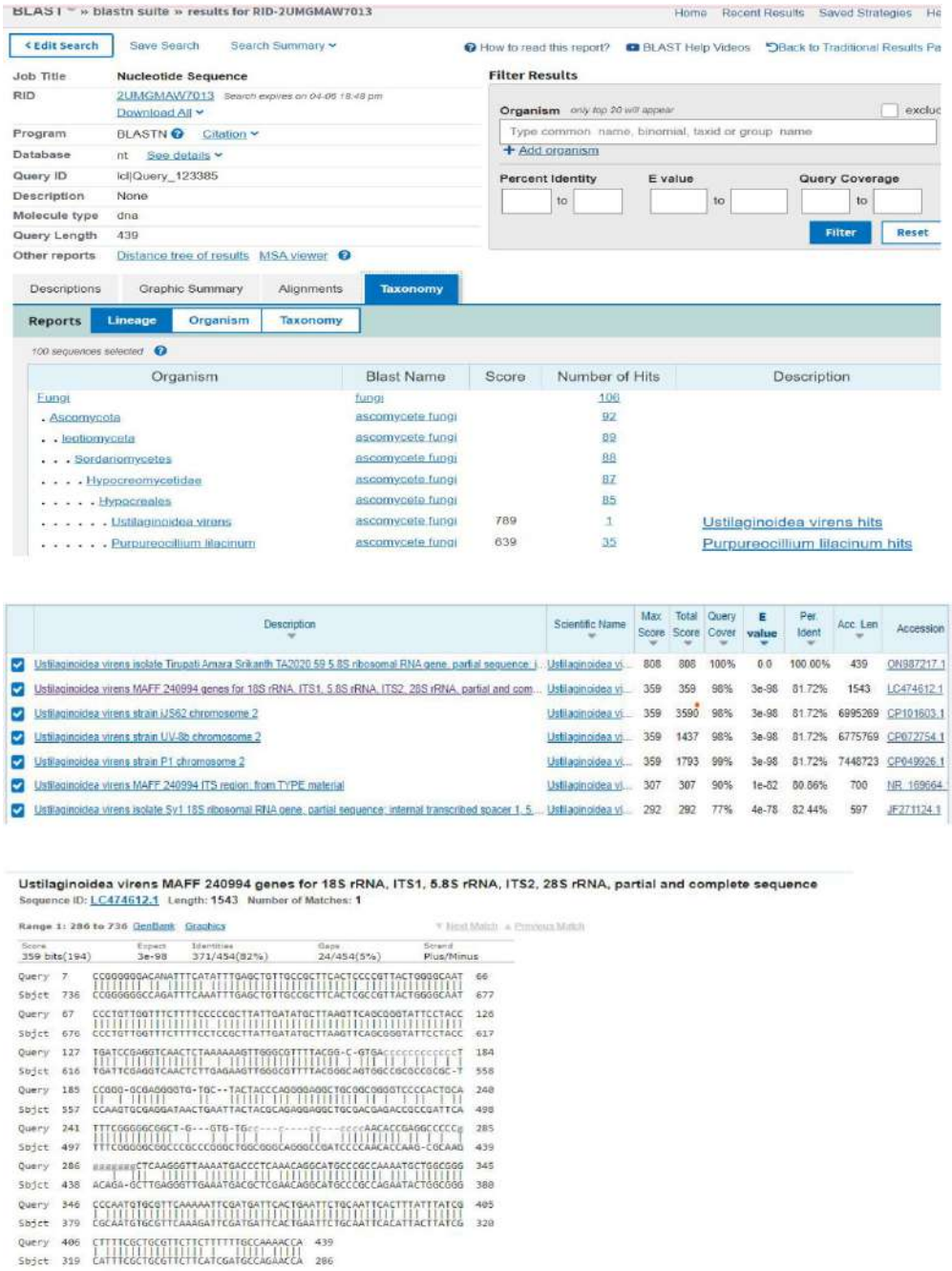

Fig. 6. Blast search result of *U.virens* Tirupati isolate

Table 2. Fungal identification based on NCBI-BLAST search (for UV ITS region)

Isolate	Source	Nucleotide length (nt)	Species identified as	Query coverage (%)	Maximum identity (%)
UV Tirupati isolate	Wetland Farm, S.V.Ag. College, Tirupati	439 bp	*Ustilaginoidea virens*	98%	81.72

region of the ribosomal cistron in the nuclear genome, which harboured a highly variable sequences of great importance in distinguishing fungal species was adopted as the standard barcode for fungi (Schocha *et al*., 2012). Here, the primers designed to ITS region of *RFS* successfully amplified a PCR product of 439 bp. The sequence data of *U. virens* was submitted to GenBank of NCBI with accession number ON987217.1. The importance of DNA barcoding for species identification lies in its ability to accurately identify species (Centre for Biodiversity Genomics, University of Guelph, 2021) which in turn helps in monitoring and effective management of pathogens like RFS.

Phylogenetic analysis of *U. virens* Tirupati isolate

Different strains of *U. virens* viz., *Ustilaginoidea virens* MAFF 240994, strain iJS62, strain UV-8b, strain P1, strain Sy1, *Ustilaginoidea usambarensis* were selected and ITS region sequences were retrieved from the NCBI gene bank for Phylogenetic analysis. Phylogenetic analysis was carried out using the MEGA version 11 tool (https://www.megasoftware.net/) and a dendrogram was generated using neighbour joining method. The phylogenetic analysis revealed that the *U. virens* Tirupati isolate is distinct from all others strains like MAFF 240994, strain iJS62, strain UV-8b,strain P1, *Ustilaginoidea*

Ustilaginoidea virens isolate Tirupati Amara Srikanth TA2020 59 5.8S ribosomal RNA gene, partial sequence; internal transcribed spacer 2, complete sequence; and large subunit ribosomal RNA gene, partial sequence

GenBank: ON987217.1

GenBank Graphics

>ON987217.1 Ustilaginoidea virens isolate Tirupati Amara Srikanth TA2020 59 5.8S ribosomal RNA gene, partial sequence; internal transcribed spacer 2, complete sequence; and large subunit ribosomal RNA gene, partial sequence

TGGTTTTGGCAAAAAAGAAGAACGCAGCGAAAAGCGATAAATAAAGTGAATTGCAGAATTCAGTGAATCA
TCGAATTTTTGAACGCACATTGGGCCCGCCAGCATTTTGGCGGGCATGCCTGTTTGAGGGTCATTTTAAC
CCTTGAGCCCCCCCCGGGGGCCTCGGTGTTGGGGGGGGGCACACCAGCCGCCCCCGAAATGCAGTGGGGA
CCCCGCCGCAGCCTCCCCTGGGTAGTAGCACACCCCTCGCCCCGGAGGGGGGGGGGGGTCACGCCGTAAA
ACGCCCAACTTTTTTAGAGTTGACCTCGGATCAGGTAGGAATACCCGCTGAACTTAAGCATATCAATAAG
CGGGGGAAAAGAAACCAACAGGGATTGCCCCAGTAACGGGGAGTGAAGCGGCAACAGCTCAAATATGAAA
TNTGTCCCCCCGGCCCGTT

Fig. 7. The specific Tirupati isolate ITS sequence submitted to NCBI (Accession number: ON987217.1)

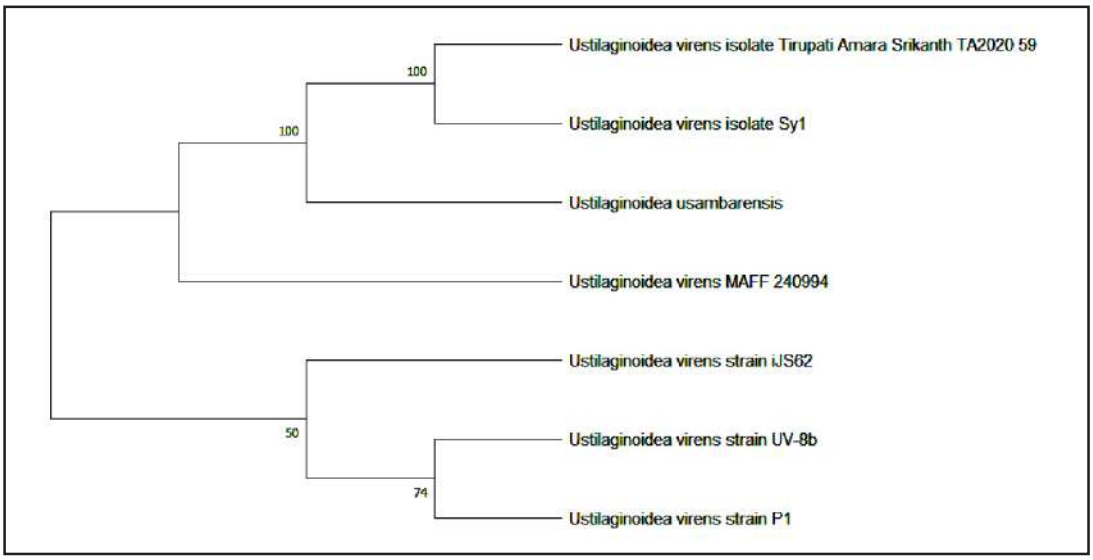

Fig. 8. Phylogenetic analysis of seven *Ustilaginoidea virens* isolates with MEGA 11 software

usambarensis as it formed a separate cluster with *Ustilaginoidea virens* sy1 (Fig. 7). The dendrogram topology and clade was reconfirmed using both the neighbour joining and maximum likelihood methods also. Shivamurthy (2017) carried out the phylogenetic analysis of 15 isolates of *U. virens* by using UPGMA-NJ online software. The dendrogram constructed from the pooled data clearly showed two major clusters A and B. At 75 percent similarity co-efficient, isolates clearly grouped into five clusters.

CONCLUSIONS

The researcher isolated the pure culture of *U. virens* Tirupati isolate and characterized the fungal organism for morphological features and molecular level with ITS region. The Phylogenetic analysis revealed that it is different from the other isolates and it formed a separate cluster with *Ustilaginoidea virens* sy1.

REFERENCES

Ashizawa, T., Takahashi, M., Moriwaki, J and Hirayae, K. 2010. Quantification of the rice false smut pathogen *Ustilaginoidea virens* from soil in Japan using real-time PCR. European Journal of Plant Pathology. 128 :221-232.

Atia, M. M. M. 2004. Rice false smut (*Ustilaginoidea virens*) in Egypt. Journal of Plant Diseases and Protection. 111: 71-82.

Baite, M. S and Sharma, R. 2015. Isolation technique and culture conditions of false smut pathogen (*Ustilaginoidea virens*) on rice. Indian Phytopathology.68(1): 50-55.

Baite, M.S., Sharma, R.K., Devi, T.P., Sharma, Prathiba and Kamil, Deeba. 2014. Morphological and molecular characterization of *Ustilaginoidea virens* isolates causing false smut of rice in India. Indian Phytopathology. 67(3): 222-227.

Banasode, M and Hosagoudar, G.N. 2020. Studies on cultural and morphological characteristics of *Ustilaginoidea virens* (Cooke) in hilly and coastal zones of Karnataka. International Journal of Agriculture Sciences. 12: 9715-9718.

Begerow, D., Nilsson, H., Unterseher, M and Maier, W. 2010. Current state and perspectives of fungal DNA barcoding and rapid identification procedures. Applied Microbiology and Biotechnology. 87: 99-108.

Centre for Biodiversity Genomics, University of Guelph. 2021. The Global Taxonomy Initiative 2020: A Step-by-Step Guide for DNA Barcoding. Technical Series No. 94. Secretariat of the Convention on Biological Diversity, Montreal. pp. 66.

Cooke, M. C. 1878. Some extra European fungi. Grevillea. 7:13-15.

Haiyong, H., Wongkaew, S., Jie, Y., Xuehui, Y., Xiaojun, C., Shiping, W., Qigqun, T.,Lishuang, W., Sompong, M and Buensanteai, N. 2015. Biology and artificial inoculation of *Ustilaginoidea virens* (Cooke) Takahashi in rice. African Journal of Microbiology Research. 9(11): 821-830.

Hollingsworth, P.M. 2007. DNA barcoding: potential users. Genomics, Society, and Policy. 3(2):44-47.

Kim, K. W and Park, E. W. 2007. Ultrastructure of spined conidia and hyphae of the rice false smut fungus *Ustilaginoidea virens*. The International Research and Review Journal for Microscopy 38(6): 626-631.

Ladhalakshmi, D., Laha, G., Singh, R., Karthikeyan, A., Mangrauthia, S., Sundaram, R., Thukkaiyannan, P and Viraktamath, B. 2012. Isolation and characterization of *Ustilaginoidea virens* and survey of false smut disease of rice in India. Phytoparasitic. 40(2): 171-176.

Lin, X., Bian, Y., Mou, R., Cao, Z., Cao, Z., Zhu, Z and Chen, M. 2018. Isolation, identification, and characterization of *Ustilaginoidea virens* from rice false smut balls with high ustilotoxin production potential. Journal of Basic Microbiology. 58(8):670-678.

Rani, R.I.T.U., Sharma, V.K., Lore, J.S and Pannu, P.P.S. 2015. Cultural studies on *Ustilaginoidea virens*, the incitant of false smut of rice (*Oryza sativa*). Indian Journal of Agricultural Sciences. 85: 28-31.

Rush, M.C., Shahjahan, A.K.M., Jones, J.P and Groth, D.E. 2000. Outbreak of false smut of rice in Louisiana. Plant Disease. 84(1): 100-100.

Saha, M., Chakraborty, A and Bhattacharya, K. 2020. Aerobiology, epidemiology and disease forecasting of false smut disease of rice in West Bengal state, India. Aerobiologia. 36:299-304.

Schocha, C.L., Seifertb, K.A., Huhndorfc, S., Robertd, V., Spougea, J.L., Levesqueb, C.A., Chenb, W and Consortiuma, F.B., 2012. Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. PNAS. 109(16): 6241-6246.

Shivamurthy, P. 2017. Studies on false smut of rice caused *Ustilaginoidea virens* (Cke.) Tkh (Doctoral dissertation, M.Sc. Thesis submitted to University of Agricultural Sciences , Raichur, Karnataka, India.

Singh, A.K and Pophaly, D.J. 2010. An unusual rice false smut epidemic reported in Raigarh District, Chhattisgarh, India. International Rice Research Notes. 35:1-3.

Tanaka, E., Ashizawa, T., Sonoda, R and Tanaka, C. 2008. *Villosiclava virens* gen. nov., comb. nov., the teleomorph of *Ustilaginoidea virens*, the causal agent of rice false smut. Mycotaxon. 106(1): 491-501.

Wu, Z.H., Wang, T.H., Huang, W And Qu Y.B. 2001. A simplified method for chromosome DNA preparation from filamentous Fungi. Mycosystema. 20: 575-577.

Zhang, J., Chen, Z., Zhang, B., Liu, Y and Lu, F. 2003. Study on morphology of *Ustilaginoidea virens*. Acta Phytopathologica Sinica. 33(6): 517-523.

Zhou, Y.L., Pan, Y.J., Xie, X.W., Zhu, L.H., Xu, J.L., Wang, S and Li, Z.K. 2008. Genetic diversity of rice false smut fungus, *Ustilaginoidea virens* and its pronounced differentiation of populations in North China. Journal of Phytopathology. 156(9): 559-564.

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SEASONAL INCIDENCE OF MAJOR INSECT PESTS OF GROUNDNUT AND THEIR NATURAL ENEMIES IN RELATION TO METEOROLOGICAL PARAMETERS

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ABSTRACT

Seasonal incidence of major insect pests in groundnut was studied during *kharif* 2015-16 with the variety, Kadiri-6 (K6). The results indicated that the population of groundnut leaf miner (*Aproaerema modicella*) reached peak in the first week of September with a mean larval incidence of 0.8 plant-1 and the larval population of tobacco caterpillar (*Spodopter alitura)* was more abundant on the crop during second week of October with a mean incidence of 9.3 plant-1. Aphid (*Aphis craccivora*) touched the peak in the first week of September with a mean population of 8.8 aphids top 2 cm shoot-1; whereas, leaf hopper(*Empoasca kerri*) attained the peak in the second week of September with a mean population of 10.6 three leaves^{-1} plant^{-1}. Maximum activity of thrips, *Scirtothrips dorsalis* (Hood) was recorded in the second week of October with a mean of 4.8 terminal^{-1}. Leaf miner, leafhopper and aphids showed positive correlation with rainfall (r= 0.120, 0.158 and 0.121, respectively). In case of larval (r= -0.075) and adult (r= -0.103) populations of *S. litura,* adult catch of *H. armigera* (r= -0.299) and thrips (r= -0.105) negative correlation were observed with rainfall. Larval and adult populations of *S. litura* and thrips showed positive correlation to both minimum (r=0.196, 0.159, 0.179) and maximum temperature (r=0.067, 0.266, 0.095, respectively). However, leaf miner, leafhopper, aphid populations and *H. armigera* adult catch showed negative correlation for maximum temperature (r= -0.008, -0.250, -0.014 and -0.148) and positive correlation with minimum temperature (r= 0.084, 0.663, 0.646 and 0.127, respectively). With respect to relative humidity, all the pest populations have showed negative correlation, however, leaf hopper and aphids only recorded significance at 5% with morning RH (r= -0.680 and -0.583). Peak activity of predators were recorded a week after the pest populations attained their peak.The populations of three predators'*viz*., coccinellids, spiders and syrphid fly maggots were positively correlated with all the pest populations.

Keywords: Groundnut, Insect pests, Natural enemies,Seasonal incidence,Weather

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leguminous plant that is widely cultivated in the tropics and subtropics between 40 °N and 40 °S latitudes. It is valued for its high-oil content and edible seeds. It is the fourth most important

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source of edible oil and a third most important source of vegetable protein in the world. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity. Globally, India ranks first in groundnut area under cultivation with 55.72 lakh ha and is the second largest producer in the world with 102 lakh tonnes and productivity of 1831 kg per hectare in 2020-21 (agricoop.nic.in). In *kharif* 2021-22, groundnut production was 101.1 lakh tonnes in an area of 48.64 lakh hectares (agricoop.nic.in). Groundnut is cultivated in one or more (*kharif*, *rabi* and summer) seasons, but nearly 90% of acreage and production comes from *kharif* crop (June-October). In Andhra Pradesh, groundnut is cultivated in an area of 8.25 lakh hectares with a production of 5.15 lakh tones and productivity of 625 kg/ ha, contributing 5.03% to India groundnut production (www.des.ap.gov.in) for the year 2021-22.

In Andhra Pradesh, eight species of insect pests are considered to be economically important as reported by Radhika (2013). They are leaf miner,*Aproaerema modicella* (Deventer), tobacco caterpillar,*Spodoptera litura*(Fabricius), gram caterpillar, *Helicoverpa armigera* (Hubner), thrips,*Scirtothrips dorsalis* (Hood), *Frakliniella scultzei* (Trybom),*Thrips palmi*(Kamy), leafhopper, *Empoasca kerri*(Pruthi) and aphid, *Aphis craccivora*(Koch). The changed environmental conditions increases the activity of thrips and defoliators and reaches peak during flowering and pod formation stage and causes heavy crop losses (Naresh *et al*., 2017). To safeguard the crop, farmers are opting for synthetic insecticides and at times are going for repetition of sprays which are neither judicious nor timely. Weather parameters play an important role on the population dynamics and distribution of groundnut pests and also yield loss in groundnut (Naresh *et al*., 2018). Hence, research is designed a need to study the relation of weather parameters on the incidence of different insect pests and their natural bio-control agents at different phenological crop growth stages. The study was conducted to know the seasonal incidence of major insect pests and their natural enemies on groundnut and to study the influence of abiotic factors on the major insect pests of groundnut and their natural enemies.

MATERIALS AND METHODS

The field trial was conducted with groundnut variety, Kadiri-6 (K-6) at the Agricultural Research Station, Darsi, Prakasam district of Andhra Pradesh to study the seasonal incidence and influence of various weather parameters on the incidence of groundnut major pests during *kharif* 2015-16. The trial was laid out in a plot size of 25 m x 25 m area with planting distance of 30 cm × 10 cm during fourth week of July by following normal agronomic practices developed by ANGRAU without any plant protection measures.

Ten plants were selected randomly in a quadrate of 1 m x 1 m of the experimental plot and they were tagged for recording the observations on insect pests and their predators at three days interval and presented Meteorological Standard Week (MSW) wise starting from 15 Days After Sowing (DAS) to harvesting of the crop. Incidence of *A. modicella* and *S. litura* was assessed in terms of larvae present on ten marked plants of each quadrate in the experimental plot and data on percent foliar damage was recorded by counting the number of damaged leaves and total number of leaves

per plant. The population of thrips was recorded by counting the number of thrips present in unopened tender leaves (terminals) of tagged ten plants in each quadrate using 10X magnification lens and population of leaf hoppers by visual observations on top three leaves of each of the ten randomly tagged plants of each quadrate in the experimental plot without disturbing the plant. Aphid population was recorded on top 2 cm shoot length of tagged ten plants in each quadrate. The population of natural enemies' *viz.,* lady bird beetle, spiders and maggots of syrphid flies were also recorded on the same tagged ten plants at each quadrate. There were three quadrates in the experimental plot and for each species of insect pest and predator, observations recorded on 30 plants were considered. The pheromone trap data of lepidopteran defoliators'*viz., S.litura* and *H. armigera* were also recorded. Weather parameters were recorded on daily basis from meteorological station and compiled to standard week wise for analyzing the data.The data was statistically analyzed by correlation analysis between weather parameters and insect pests as well as natural enemies.

RESULT AND DISCUSSION

Incidence of A. modicella

During *kharif* 2015, the larval incidence of leaf miner was observed from 35th to 45th MSW with peak incidence was recorded during 36th MSW (0.8 larvae plant-1) and 40th MSW (0.7 larvae plant-1) representing first week of September and October months, respectively and thereafter the incidence of leaf miner was declined gradually (Table 2). These results are supported by the findings of Basha Hussain *et al.* (2012) who indicated that highest leaf miner larval incidence was recorded during September (15.40 larvae plant$^{-1)}$ on groundnut crop. The peak larval incidence was also coincided with highest per cent foliar damage of *A. modicella*. The field incidence of leaf miner in terms of foliar damage was ranged from 1.02 to 6.53 percent on K-6 variety of groundnut. Foliar damage was high during the 40th MSW (6.53%) and 41st MSW (5.3%) of 2015. The results are in accordance with the results of Pazhanisamy and Hariprasad (2014) who reported that *A.modicella* was noticed from 33rd to 42nd standard week (10.5% to 92%) during the *Kharif* season of 2010 and 33rd to 44th standard week (22% to 86.5%) during *kharif*, 2011.

Incidence of S. litura

The maximum larval population was appeared in 41st MSW (9.3 larvae plant-1) and 40th MSW (6.7 larvae plant-1) during *Kharif,* 2014 and thereafter larval population was declined. The foliar damage of *S. litura* was noticed from 35th to 45th MSW which was ranged from 8.2 to 54.9% and it was coincided with larval infestation of *S. litura* on groundnut (Table 2). The incidence of *S.litura* in terms of male moth catch was started in the 36th MSW. Peak trap catch was observed in 41st MSW (13.5 males trap-1 week-1). Later on, the moth catch was declined to 3.5 moths trap-1 week-1during 45th MSW (Fig 1).

Incidence of H.armigera

The *H. armigera* trap catch was low during the entire period of study. The moth catch was in the range of 1.3 to 3.9 moths trap-1.The initial trap catches (1.3 moths trap-1) was started in the month of August in 35th MSW. Slight increase in moth catch was observed during 39th (2.6

trap-1) and 41st MSW (4.3 trap^{-1}) and thereon no catch was observed. Again, a catch of 2.3 and 1.6 moths trap-1was observed during 44 th and 45th MSWs, respectively (Fig. 1).

Incidence of thrips

Scirtothrips dorsalis Hood was the predominant species found on the terminal bud leaves. They fed on young unopened bud leaves and caused dull yellowish-green patches on upper surface and darkbrown necrotic patches on lower leaf surface as well as curling of leaves. Thrips commenced from 15 DAS and continued up to 105 DAS and declined later. Thrips became higher numbers during first week of October (40th MSW) to third week of October (42nd MSW) with the peak average number of 4.8 thrips terminal bud leaves-1 during 41st MSW. The dry spell for 27 days from 39th MSW (25/09/14) to 42nd MSW (22/10/14) might have influenced the higher thrips incidence. The rainfall received during 43rd MSW decreased the thrips population (2.6 terminal bud leaves-1) and declined later to 0.9 thrips top bud leaves-1 during 45th MSW (Table 2). The results are in accordance with Kandakoor *et al*. (2012) and Radhika (2013) who also observed higher thrips population in wetter end of the season compared to drought stress days.

Incidence of leafhoppers

Leafhopper *Empoasca kerri* was the predominant species during the study period.The data presented in Table 2 indicated that the leafhopper incidence was commenced in the second week of August (33rd MSW) with a mean population of 2.3 hoppers three leaves-1 plant-1 and were found in large numbers (8.8 to 10.6 hoppers three leaves^{-1} plant^{-1}) during September month (36 to 39 MSWs) in vegetative phase and reached its peak in the second (10.6 hoppers three leaves^{-1} plant$^{-1)}$ and fourth weeks of September (10.1 hoppers three leaves^{-1} plant $^{-1)}$. Both nymphs and adults suck the sap from the leaves and petioles. A heavy infestation on young plants caused stunting and leaf tips turned yellow with atypical 'v-shape' marking. Thereafter, the population declined and reached minimum levels of 1.1 hoppers three leaves^{-1} plant^{-1} during 45th MSW (2nd week of November). Similar observations have been reported by Kandakoor *et al*. (2012) and Yadav *et al*. (2012) where in *E. motti* was the most abundant on top three leaves of tender groundnut plants during August and September months. Sunil Gocher and Sarfraz Ahmad (2019) observed higher incidence of leafhopper, *E. kerri* in groundnut during vegetative stage.

Incidence of aphids

The aphids (*Aphis craccivora* Koch) were present up to 75 days after sowing of crop only with a high population prevailed during vegetative growth stage. Aphids preferred to attack the terminal twigs and tender parts resulting in curling of leaves and stunted growth, also sooty mold was seen to the little extent, but not in severe form. The incidence was commenced three week after sowing in the third week of August (34th MSW) with a mean population of 2.8 aphid stop 2 cm shoot-1 and swiftly reached to peak in the first week of September (36th MSW) with 8.8 aphid stop 2 cm shoot-1. Thereafter, the population started declining up to 41st MSW where only a trace population of aphid (0.7 aphids top 2 cm shoot-1) was observed (Table 2). This study results were in line with the observations of Tarun Kumar Nayak *et al*. (2019), Sunil Gocher and Sarfraz

Ahmad (2019). The results were in partial conformity with that of Kandakoor *et al.* (2012) who reported that the incidence of aphid on groundnut remains throughout the crop period with peak population in the fourth week and first week of September, respectively.

Incidence of natural enemies

The populations of Lady bird beetle (*Coccinella septempunctata* L.) and spiders were appeared in the second week of August (33rd MSW) and increased with the increase in pest population which were maximum in the fourth week of September (39th MSW) *i.e*. 3.2 and 6.0 plant^{-1}, respectively. Whereas, the population of Syrphid fly maggots was appeared a week later in the 34th MSW and found maximum in the second week of September (37th MSW) with 1.9 maggots plant-1 (Table 2). The peak populations of predators were observed next week of the peak population of sucking pests and defoliators. Similar results have also been observed by Sunil Gocher and Sarfraz Ahmad (2019), wherein, the population of predators was appeared in the first week of August and reached to maximum in the third week of September.

Influence of weather parameters on insect pests of groundnut

A. modicella

The influence of weather parameters on the incidence of groundnut leaf miner recorded positive correlation with minimum temperature (r = 0.084), rainfall (r = 0.120) and negative correlation with other weather parameters (Table 3). These results were in conformity with the findings of Radhika (2013), Hanamant Gadad *et al.* (2013) and Pazhanisamy and Hariprasad (2014) proving the positive and negative association of minimum temperature and morning Relative Humidity with larval population of groundnut leaf miner, respectively.

S. litura

The correlation studies of number of tobacco caterpillar larvae with different weather parameters showed a positive correlation with minimum temperature (r = 0.196) and maximum temperature (r = 0.067), while remaining weather parameters were found to be negatively correlated with tobacco caterpillar. Similarly, minimum temperature (r =0.159) and maximum temperature (r =0.266) were positively correlated with *S. litura*trap catch and the morning RH (r =-0.049), evening RH (r =-0,238) and rainfall (r =-0.103) showed negative correlation (Table 3). The correlation studies showed that the incidence of tobacco caterpillar was affected only by temperature, which indicated that the fall in temperature increasing the population of tobacco caterpillar. The findings agreed with Arpit Kumar Mishra *et.al.* (2021) who reported that larval population of tobacco caterpillar showed significant positive correlation with minimum temperature (r = 0.533) and average temperature (r =0.571). Radhika (2013) also observed a significant positive association between male moth catches of *S. litura* and maximum and minimum temperatures.

H. armigera

Pheromone trap catches of *H. armigera* showed a positive correlation with minimum temperature (r=0.127). These results were in conformity with the findings of Radhika (2013).

Thrips

Thrips population on terminals exhibited a positive correlation with minimum temperature

(r=0.179) and maximum temperature (r=0.095). While other weather parameters showed negative association (Table 3). The incidence of *S. dorsalis* was commenced in the second week of August and touched its peak in the second week of October. In this investigation it was found that temperaturefavours multiplication of the thrips, while rainfall and relative humidity hadadverse effect on population buildup of thrips.These findings are in agreement with Tarun Kumar Nayak *et al.* (2019) who reported that the population of thrips exhibited a significant positive association with minimum temperature (r = 0.681) and mean temperature (0.606). Kandakoor *et al.* (2012) also reported that thrips showed positive correlation to maximum (r=0.277) and minimum temperature (r=0.087). Thus, temperature had a major role of influence on thrips populations.

Leafhopper

The correlation analysis depicted a significant positive correlation between mean population of leafhopper and minimum temperature (r =0.663) and rainfall (r =0.158) whereas, morning relative humidity was found to be significant and negatively correlated (r = - 0.680). Thus, the ambient temperature favored to increase the leafhopper population. The findings of present investigation are in close conformit y with the finding of Yadav *et al.* (2012), Nigude*et al.*(2018), Tarun Kumar Nayak *et.al.* (2019),Sunil Gocher and Sarfraz Ahmad(2019).

Aphids

The infestation of aphid on groundnut crop showed significant positive correlation (r = 0.646) with minimum temperature and significant negative correlation with morning relative humidity (r = -0.583), while non-significant negative correlation with maximum temperature (r = -0.014), evening relative humidity (r = -0.192) and non-significant positive correlation with rainfall (r = 121) were observed (Table 3). These results were corroborating with Choudhary (2015) and Ahir *et al.* (2017) who reported that aphid population had non-significant negative correlation with maximum temperature, while positively correlated with rainfall. Kandakoor *et al.* (2012) also observed that the aphid population had non-significant negative correlation with maximum temperature (r= -0.211) and positive correlation with minimum temperature (r= 0.165). Sunil Gocher and Sarfraz Ahmad (2019) revealed that the aphid population on groundnut showed significant negative correlation (r = -0.742) with maximum temperature and positive correlation with minimum temperature (r = 0.474) and rainfall (r = 0.399) supported this study findings.

Natural enemies

The population of the three predators, coccinellids, spiders and syrphid fly maggots were positively and significantly correlated with leafhopper population (r= 0.932, r= 0.810 and r= 0.788, respectively). The data of correlation (Table 3) also showed that coccinellids and spiders had significant positive correlation with the larvae of *S. litura* (r=0.649 and r=0.554), while coccinellids had significant positive correlation with Aphids (r=0.507). However, Syrphid fly maggots had significant positive correlation with Aphid population (r= 0.934). Similar results were observed by Bhede *et al.* (2018) and Sunil Gocher and Sarfraz Ahmad (2019) who reported that population of ladybird beetle and maggot of syrphid fly showed significant positive correlation with aphid population.

Table 1. Meteorological parameters recorded at ARS, Darsi during *kharif*, 2015

S.No.	Stand. week	Rainfall (mm)	Min. Temp. (oC)	Max. Temp. (oC)	RH (%) 8.00 AM	RH (%) 2.00 PM
1	33	1.42	26.6	36.2	74.7	47.1
2	34	1.10	25.6	32.4	78.1	63.3
3	35	0.0	26.3	33.3	74.2	55.2
4	36	0.14	27.3	34.2	65.3	47.3
5	37	5.4	26.7	31.4	64.3	48.7
6	38	6.34	26.2	28.4	63.0	42.7
7	39	0.0	25.6	23.7	64.3	42.9
8	40	0.0	25.4	34.6	69.0	42.3
9	41	0.0	26.9	35.1	79.1	53.6
10	42	0.0	24.7	31.5	69.7	40.2
11	43	9.05	23.2	29.5	95.0	72.4
12	44	0.0	22.5	30.7	83.3	65.1
13	45	0.0	23.1	30.0	71.4	42.4

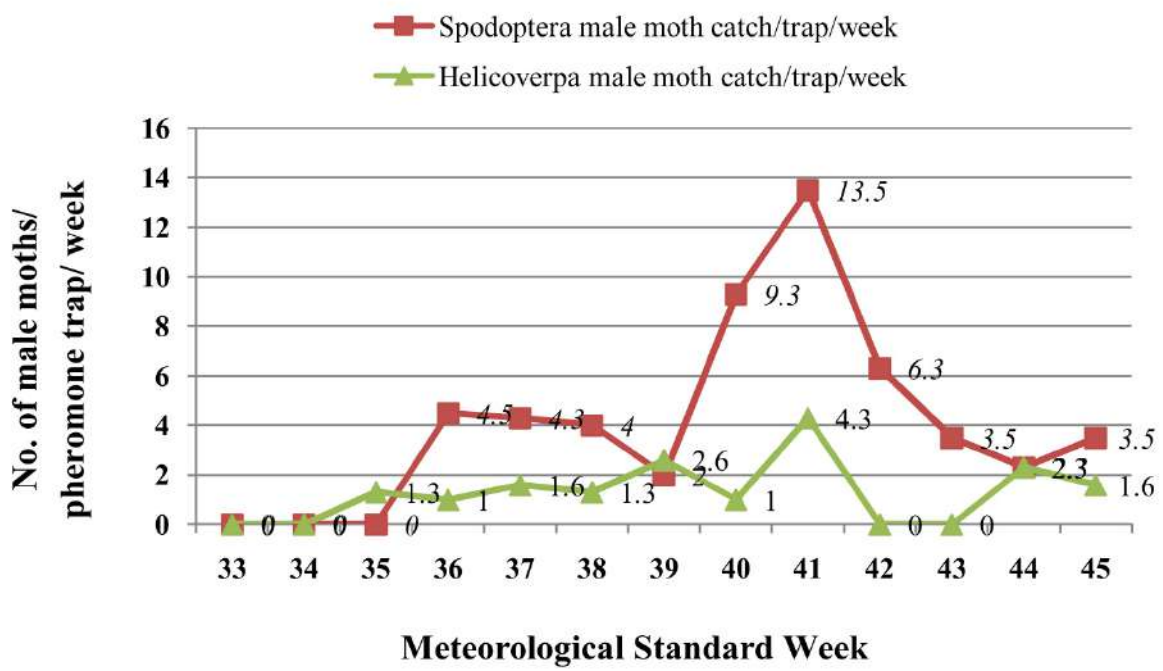

Fig 1. Seasonal pheromone trap catches of *S. litura* and *H. armigera* on groundnut during *kharif*, 2015

Table 2.Seasonal incidence of insect pests and their natural enemies in groundnut during *kharif*, 2015

Days after sowing (DAS)	Standared. week	Leaf miner larvae /plant	*S.litura* larvae /plant	%foliar damage by leaf miner	% foliar damage by *S. litura*	Thrips population/terminals	Leaf hopper /3 leaves /plant	Aphids / top 2 cm shoot	Spiders /plant	Cocci-nellids /plant	Maggot of Syrphid spp. / plant
15	33	0.0	0.0	0.0	0.0	0.8	2.3	0.0	0.5	0.2	0.0
22	34	0.0	0.0	0.0	0.0	1.3	3.3	2.8	0.9	0.3	0.9
30	35	0.4	2.0	1.0	8.2	1.4	4.3	5.1	1.7	1.2	1.3
37	36	0.8	3.3	2.5	12.2	2.5	8.8	8.8	1.6	1.8	1.5
45	37	0.5	3.1	2.0	11.6	2.0	10.6	6.4	2.5	2.6	1.9
52	38	0.6	4.1	1.5	10.4	1.9	9.4	5.7	5.2	2.8	1.3
60	39	0.3	4.6	3.9	18.7	2.7	10.1	2.9	6.0	3.2	0.8
67	40	0.7	6.7	6.5	34.9	3.1	6.8	1.3	3.7	2.7	0.7
75	41	0.5	9.3	5.3	34.1	4.8	6.7	0.7	2.9	2.1	0.4
82	42	0.5	3.4	4.2	42.7	4.7	3.8	0.0	1.4	1.2	0.1
90	43	0.5	3.3	3.4	39.9	2.6	2.6	0.0	0.9	0.6	0.0
97	44	0.3	2.3	1.9	44.0	1.4	1.5	0.0	0.4	0.0	0.0
105	45	0.5	2.3	1.5	54.9	0.9	1.1	0.0	0.0	0.0	0.0
	Mean	0.4	3.4	2.6	24.0	2.3	5.1	2.6	2.1	1.4	0.7
	S.E±	0.06	0.7	0.5	5.1	0.4	0.9	0.8	0.5	0.3	0.2

Table 3. Correlation coefficients between weather parameters and insect pestsand natural enemy incidence in Groundnut during *kharif,* 2015

Insect Pest	Rainfall (mm)	Min. Temp. (°C)	Max. Temp. (°C)	Morning RH (%)	Evening RH (%)	Coccinellids	Spiders	Maggot of Syrphid flies
Larvae of *A. modicella*	0.120	0.084	-0.008	-0.306	-0.320	0.492	0.283	0.312
Larvae of *S. litura*	-0.075	0.196	0.067	-0.107	-0.222	0.649*	0.554*	0.043
Thrips	-0.105	0.179	0.095	-0.026	-0.194	0.459	0.335	-0.084
Leafhopper	0.158	0.663*	-0.250	-0.680*	-0.436	0.932*	0.810*	0.788*
Aphid	0.121	0.646*	-0.014	-0.583*	-0.192	0.507*	0.344	0.934*
Trap catch of *S. litura*	-0.103	0.159	0.266	-0.049	-0.238	—	—	—
Trap catch of *H. armigera*	-0.299	0.127	-0.148	-0.118	-0.084	—	—	—

*Significant at 5% level

CONCLUSIONS

The study revealed that peak activity of groundnut leaf miner, leafhoppers and aphids was recorded during 1st and 2nd weeks of September during pre-flowering to flowering stage when plants were 37-45 days old. Peak activity of *S. litura* and thrips was noticed during 2nd week of October during pre-maturity stage when plants were 75 days old. Rainfall had positive correlation with leaf miner, leafhopper and aphid populations, while it showed negative correlation with thrips and *S. litura*. Minimum temperature showed positive correlation with all the pest populations, whereas, maximum temperature showed positive relationship with thrips and *S. litura.* On the contrary, relative humidity had negative association with pest populations infesting groundnut. The results further revealed a positive correlation between insect pests and predator populations.

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REFERENCES

Ahir, K.C., Saini, A., Rana, B.S and Dangi, N.L. 2017. Population dynamics of sucking pests in relation to weather parameter in groundnut *Arachis hypogaea* L. Journal of Entomology and Zoology Studies. 5 (2): 960-963.

Arpit Kumar Mishra, Archana Kerketta, Awasthi, A.K., Chaure, N. K and Shukla, R. K. 2021. Seasonal incidence of tobacco caterpillar (*Spodoptera litura* Fab.) on groundnut (*Arachis hypogea* L.) and it's correlation with different abiotic factors. Journal of Pharmacognosy and Phytochemistry. 10(2): 1456-1459.

Basha Hussain, Somasekhar and Raju, J. 2012. Seasonal incidence of parasitoid fauna on groundnut leaf miner, *Aproaerema modicella* Deventer. Journal of Life Science. 9(4): 440-442.

Bhede, B.V., Bhosle, B.B and Zanwar, P.R. 2018. Correlation and regression of aphid on cauliflower with abiotic and biotic factors of environment. Journal of Entomological Resarch Society.42 (3): 355-359.

Choudhary, H.S. 2015. Studies on the incidence and losses caused by the insect pests in groundnut (*Arachis hypogaea* L.) M.Sc. thesis submitted to Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan.

Directorate of Economics and Statistics, 2020 Ministry of Agriculture and Farmers Welfare, New Delhi First Advance Estimates of Production of Food Grains for 2020-21. Retrieved from the website (www.agricoop.nic.in) on 10.02.2023.

Directorate of Economics and Statistics, Government of Andhra Pradesh. 2022. Crop-wise final estimates of Area, yield and production of various principle crops during 2021-22 in Andhra Pradesh. Retrieved from the website (www.des.ap.gov.in) on 10.02.2023.

Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare. 2023. Second Advance Estimates of Production of Oilseeds and Commercial Crops for 2022-23. Retrieved from the website (www.agricoop.nic.in) on 10.02.2023.

HanamantGadad, Mahabaleshwar Hegde and Balikai, R. A. 2013. Seasonal incidence of *Spodoptera litura*and leafminer in *rabi/* summer groundnut. Journal of Experimental Zoology India.16(2):619-622.

Kandakoor, S.B., Khan, H.K., Gowda, G.B., Chakravarthy, A.K., Kumar, C.T.A and Venkataravana, P. 2012. The incidence and abundance of sucking insect pests on groundnut. Current Biotica. 6(3):342-348.

Naresh, T., Ramakrishna Rao, A., Murali Krishna, T., Devaki, K.,KhayumAhammed, S and Sumathi, P. 2017. Seasonal incidence of leaf miner *Aproaerema modicella*on groundnut (*Arachis hypogaea* L.) during *rabi* season. Journal of Entomology and Zoology Studies. 5(6): 92-96.

Naresh, T., Ramakrishna Rao, A., Murali Krishna, T., Devaki, K., KhayumAhammed, S and Sumathi, P. 2018. Seasonal incidence and effect of abiotic factors on population dynamics of thrips on groundnut (*Arachis hypogaea* L.) during *rabi* season. Journal of Pharmacognosy and Phytochemistry. 7(2): 1600-1604.

Nigude, V.K., Patil, S.P., Patil, S.A and Bagade, A.S. 2018. Management of sucking pests of groundnut with newer molecules of insecticides *Arachis hypogaea* L. International Journal of Current

Microbiology and Applied Sciences.7(1): 566-569.

Pazhanisamy, M and Hariprasad, Y. 2014. Seasonal incidence of leaf miner, *Aproaerema modicella* (Deventer) in groundnut ecosystem in Ariyalur district of Tamilnadu, India. Plant Archives. 14(1): 55-58.

Radhika, P. 2013. Influence of weather on the seasonal incidence of insect pests on groundnut in the scarce rainfall zone of Andhra Pradesh. Advance Research Journal of Crop Improvement. 4(2): 123-126.

Sunil Gocher and Sarfraz Ahmad. 2019. Seasonal incidence of major sucking insect pests of groundnut in relation to weather parameters of semi-arid -rtegion of India. International Journal of Current Microbiology and Applied Sciences. 8(08): 1106-1111.

Tarun Kumar Nayak, Sonali Deole, Shaw, S.S and Nandan Mehta. 2019. Seasonal incidence of sucking insect pests infesting groundnut crop at Raipur (Chhattisgarh). Journal of Entomology and Zoology Studies. 7(6): 83-87.

Yadav, P. C., Sharma, U. S., Ameta, O. P and Padiwal, N. K. 2012. Seasonal incidence of major sucking insect pests of Groundnut (*Arachis hypogaea* L.). Indian Journal of Applied Entomology. 26(1): 57–59.

How to cite this article? Suneel Kumar, G.V., Rajesh Chowdary, L and Sarada, O. 2023. Seasonal incidence of major insect pests of groundnut and their natural enemies in relation to meteorological parameters. The Journal of Research ANGRAU. 51(2): 22-32.
DoI: https://doi.org/10.58537/jorangrau.2023.51.2.03

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PERFORMANCE EVALUATION OF GROUNDNUT CROP VARIETY KADIRI LEPAKSHI (K 1812) IN CHITTOOR DISTRICT

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ABSTRACT

The on-farm testing was conducted at Krishi Vigyan Kendra, Kalikiri in the farmer's fields of Chittoor district to assess the performance of Kadiri Lepakshi variety under irrigated and rainfed conditions for yield and profitability of groundnut during *rabi* 2020-21 and *kharif* 2021-22. Technologies assessed in the study comprised of 'Kadiri Lepaskhi' as improved variety and 'Narayani' as farmers practice (local check). Results of two-year data revealed that Kadiri Lepakshi recorded 28.0 and 13.5 percent enhancement in pod yield during *rabi* 2020-21 and *kharif* 2021-22, respectively over farmers practice (12.61 q ha^{-1}). As per the economic analysis, Kadiri Lepakshi and Narayani provided net returns of Rs. 22750 ha^{-1} and Rs.11775 ha^{-1} and BCR of 1.39 and 1.21, respectively. Overall, B:C ratio was found higher in Kadiri Lepakshi over local check variety Narayani.

Keywords: Economics, Groundnut, Kadiri Lepakshi,Yield

INTRODUCTION

Groundnut is the major oilseed crop of India, accounting 25% of the total oilseed production in the country, 22.98 percent of the total oilseed area and 14.52 percent of the total production of oilseeds is from groundnut. It occupies an area of 5.30 million ha with a production of 5.50 million tonnes and productivity of 1040 kg ha^{-1} (https://www.indiastat.com). In Andhra Pradesh, groundnut was grown in an area of 7.48 lakh ha with a production of 4.62 lakh tonnes production and productivity of 618 kg ha^{-1}(http://www.indiastat.com). In Chittoor district, groundnut is one of the major oilseeds crop, ranks first in area and production among the Oilseeds. The crop was cultivated in 123268 ha during *kharif*, 2020-21 and 2124 ha during *rabi*, 2020-21 in Chittoor district (O/o JDA, Chittoor). Groundnut is the 13th most important food crop, 4th important source of vegetable oil and 3rd main source of vegetable protein in the world (Shete *et al*., 2018). Groundnut is known as a self-fertilizing crop, nevertheless, it is very exhaustive crop compared to other legumes because a very little portion of the plant residue is left in the soil after harvest. (Shete *et al*.,2018). Groundnut is cultivated in diverse agro-climatic environments characterized by soils of varying water holding capacity under rainfed as well as irrigated conditions (Priya *et al*., 2016). In

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Table 1. Salient features of KadiriLepakshi (K 1812) and Narayani

S.No.	Variety	Year of release	Pedigree	Duration (days)	Season	Potential yield (q ha-1) *Kharif*	*Rabi*	Shelling Percentage	100 seed weight (g)	Oil content (%)	Special features
1	Kadiri Lepakshi (K 1812)	2020	(ICGV 92069 x ICKV 93184) x ICGV 98300	112 (*Kharif*)	*Kharif* and *Rabi*	35	-	70	40	51	Very high yielding, profuse bearing spanish variety with higher oil and protein ontent. Multiple resistant c for drought, pests and diseases. Stable yields (15-20 q ha-1) even under severe drought.
2	Narayani	2002	JL 24 × Ah3 16/S	100 (*Kharif*), 105 (*Rabi*)	*Kharif* and *Rabi*	20-25	35-45	76.0	42-45	49.0	Early maturing, drought tolerant, highly stable performance in different types of soils and situations. Uniform maturity, suitable for low to medium rainfall areas, high frequency of mature kernels (95%), red testa variety.

western mandals of Chittoor district, farmers are growing varieties which are susceptible to sucking pests, PSND, PBND and drought leading to poor yields.Hence, there was need to introduce new variety in western mandals of Chittoor district which tolerates pests and diseases and produce higher yields even under rainfed conditions. Hence, Kadiri Lepakshi variety (K-1812) released at ARS, Kadiri, ANGRAU was introduced in the district.

MATERIALS AND METHODS

The On-Farm testing was conducted by Krishi Vigyan Kendra, Kalikiri during two consecutive seasons of *Rabi*, 2020-21 and *Kharif*, 2021-22 to assess the performance of Kadiri Lepakshi variety during *Kharif* (Rainfed) and *Rabi* (Irrigated) seasons. Trials were conducted in 2.0 ha area in five farmers' fields during *Rabi*, 2020-21 in Guttapalem, Yellampalli villages of Kalikiri Mandal and MG Kota village of Nimmanapalli Mandal and *Kharif,* 2021-22 in Guttapalem village, Kalikiri Mandal with Kadiri Lepakshi as improved variety (varietal characters presented in Table 1) and Narayani as farmer variety. Improved variety Kadiri Lepakshi was released from ARS, Kadiri and Narayani variety was released from RARS, Tirupati. Soils of the study area are sandy loam in texture, low available nitrogen and phosphorus, high in potassium, deficit in zinc and iron. Monthly rainfall data of the study area is depicted in Table 2. Sowings were done with seed drill during *rabi* 2020-21 in the month of December and during *kharif* 2021-22 in the month of June at 5 cm depth in 30 cm rows. Pre-emergent spray of Pendimethalin @ 1.0 lt acre^{-1} was done within 24 hours after sowing. Each treatment was replicated in five farmers fields. Farmers have applied 20 q FYM acre^{-1}, urea @ 25 kg acre^{-1}, SSP @ 100 kg acre^{-1} and MOP @ 35 kg acre^{-1}. The data recorded on various parameters *viz.,* final plant population, number of pods per plant, 100 fresh pod and seed weight, 100 dry pod and seed weight and yield was analyzed.The average prices of inputs and outputs commodities prevailed during each year were taken for calculating cost of cultivation, gross returns, net returns and benefit-cost ratio.

Table 2. Rainfall data during crop growth period

S.No.	Month	Normal (mm)	Actual (mm)	Deviation (%)
1	December, 2020	70.1	104.1	48.5
2	January, 2021	7.8	34.6	343.6
3	February, 2021	4.3	11.7	172.1
4	March, 2021	7.7	00	-100
5	April, 2021	17.6	0.3	-98.3
6	June, 2021	78.7	111.2	41.3
7	July, 2021	102	223.1	118.9
8	August, 2021	117.4	151.2	28.8
9	September, 2021	141.1	156.1	10.4
10	October, 2021	162.7	199.8	22.8

Table 3. Yield attributes of Kadiri Lepakshi and Narayani

S.No	Year and season	Final plant population (sq.m)		No. of pods per plant		100 fresh pod weight (g)		100 fresh seed weight (g)		100 dry pod weight (g)		100 dry seed weight (g)	
		K 1812	Narayani	K 1812	Narayani	K 1812	Narayani	K 1812	Narayani	K 1812	Narayani	K 1812	Narayani
1	*Rabi*, 2020-21	33.0	31.0	43.0	26.0	185.7	151.6	65.8	71.9	87.2	96.7	41.7	45.4
2	*Kharif*, 2021-22	19.0*	28.0	49.6	25.0	155.7	144.2	51.4	49.8	82.7	94.3	32.7	38.8
	Mean	26.0	29.5	46.3	25.5	170.7	147.9	58.6	60.9	85.0	95.5	37.2	42.1

*5 days after emergence due to wet root rot 40% of the plant population was lost

RESULTS AND DISCUSSION

Yield and yield attributes

Data presented in Table 3 about yield attributes and Table 4 about yield revealed that Kadiri Lepakshi recorded substantially higher pod yield over check variety Narayani during both the seasons of on-farm testing (OFT). Eventhough 40% of the crop was lost during *Kharif*, 2021-22 due to wet root rot, the yield was higher than Narayani in which there was 100% crop. Kadiri Lepakshi recorded 28.0 and 13.5

Table 4. Summary of t-test in comparing yield and B: C ratio in treatment and farmers practice for two seasons (pooled data)

S.No.	Particulars	Treatments	N	Mean	Std.Deviation	t-value	p-value
1	Yield	K 1815	5	15.34	0.65	1.94**	0.0005
		Narayani	5	12.61	0.60		

**Significant at 1% level

Table 5. Yield and economics of Kadiri Lepakshi and Narayani

S.No.	Year and season	Yield (q ha^{-1})		% increase in yield over check	Cost of cultivation (Rs. ha^{-1})		Gross returns (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B:C ratio	
		K 1812	Narayani		K 1812	Narayani	K 1812	Narayani	K 1812	Narayani	K 1812	Narayani
1	*Rabi*, 2020-21	18.08	14.12	28.0	57500.00	57500.00	97500.00	77500.00	40000.00	20000.00	1.69	1.35
2	*Kharif*, 2021-22	12.60	11.10	13.5	57500.00	57500.00	63000.00	61050.00	5500.00	3550.00	1.09	1.06
	Mean	15.34	12.61	20.8	57500.00	57500.00	80250.00	69275.00	22750.00	11775.00	1.39	1.21

percent increase in pod yield over local check variety Narayani during *rabi*, 2020-21 and *kharif*, 2021-22, respectively. On pooled basis, 15.34 q ha^{-1} pod yield was recorded in Kadiri Lepakshi with 20.8 percent yield enhancement over local check (12.61 q ha^{-1}). Significant difference in yield was observed among different varieties (Table 4.) A perusal of data on yield attributes indicated positive influence of Kadiri Lepakshi on no. of pods per plant and fresh pod weight over local check. On pooled basis, Kadiri Lepakshi recorded 46.3 g, 170.7 g, 58.6 g, 85.0 g and 37.2 g of no. of pods per plant, 100 fresh pod weight, 100 fresh seed weight, 100 dry pod weight and 100 dry seed weight, respectively compared to Narayani (25.5 g,147.9 g, 60.9 g, 95.5 g and 42.1 g, respectively). Lower 100 seed weight in Kadiri Lepakshi might be due to dense vegetation as Kadiri Lepkashi variety spreads widely and cover the surface and competes for light, water, space and other resources. Results are similar to the findings of Paul and Dawson (2022) and Chandini *et al*. (2011). It might also be due to more number of pods per plant. Eventhough pod and seed weights were higher for Narayani, due to higher number of pods in Kadiri Lepakshi, yield was higher compared to Narayani. This might be due to higher yield potential of Kadiri Lepakshi. Similar results have been reported by Mohite *et al.* (2017), Naik *et al*. (2018) and Akram *et al.* (2021) in groundnut crop assesment.

Economics

Economic analysis revealed that Kadiri Lepakshi provided higher net returns over local check during both the seasons. This variety fetched average net returns of Rs. 40000 ha^{-1} and Rs. 5500 ha^{-1} during *rabi*, 2020-21 and *kharif*, 2021-22, respectively (Table 5). On pooled basis, Kadiri Lepakshi and Narayani provided net returns of Rs.22750 ha^{-1} and Rs.11775 ha^{-1} and BCR of 1.39 and 1.21, respectively. Overall, B:C ratio was found higher

in Kadiri Lepakshi over local check which indicated that Kadiri Lepakshi might be economically feasible and profitable to farmers. Higher net returns and B:C ratio might be due to higher productivity.

CONCLUSIONS

t-test is carried out to compare three treatments effects on yield. It was inferred that there was significant difference in yield among the two treatments at 5% level ($p<0.05$). Kadiri Lepakshi performed well in both rainfed and irrigated conditions and gave higher yield, net returns and B: C ratio ratio over Narayani. Significant difference in terms of yield (15.34 q ha^{-1} and 12.61 q ha^{-1} yield in Kadiri Lepakshi and Narayani, respectively) was observed in Kadiri Lepakshi compared to Narayani. Kadiri Lepakshi is fetching lower price in the market. Despite of its lower market price farmers are showing interest to grow this variety due to its high yield producing trait.

REFERENCES

Akram, Sk.V., Prasad, P.V.N., Chandrasekhar, K and Subbaiah, P.V. 2021. Yield and economics of groundnut (*Arachis hypogaea* L.) cultivars as affected by levels of Nitrogen. The Andhra Agriculture Journal. 68 (2): 163-167.

Indiastat. 2021. Area, Production and Productivity of Groundnut in India. Retrieved from the website (http:// indiastat.com) on 17.2.2023.

Indiastat. 2021. Area, Production and Productivity of Groundnut in India. Retrieved from website (http:// indiastat.com) on 17.2.2023.

Chandini, Sk., Lakshmi, N.V., Sree Rekha, M and Ravi Babu, M. 2011. Influence of irrigation schedules on yield and nutrient uptake of groundnut varieties. International Journal of Plant and Soil Science. 34 (24): 348-354.

Mohite, U.A., Mohite, A.B and Jadhav, Y.R. 2017. Effect of sowing windows on growth and yield ofgroundnut varieties during *kharif* season. Contemporary Research in India. 7:189-192.

Naik, A.K., Pallavi, N and Sannathimmappa, H.G. 2018. Performance of different spanish-type groundnut varieties suitable under central dry zone of Karnataka, India. International Journal of Current Microbiology and Applied Sciences. 7:1394-1397.

Paul, A and Dawson, J. 2022. Effect of biofertilizers and spacing on growth parameters of groundnut (*Arachis hypogaea* L.). The Pharma Innovation. 11(4): 264-266.

Priya, T., Subramanyam, D and Sumathi, V. 2016. Performance of groundnut (*Arachis hypogaea* L.) cultivars under different plant populations during early *kharif*. Indian Journal of Agricultural Research. pp. 50-51.

Shete, S.S., Bulbule, A.V., Patil, D.S and Pawar, R.B. 2018. Effect of foliar nutrition on growth and uptake of macro and micronutrients of *kharif* groundnut (*Arachis hypogea* L.). International Journal of Current Microbiology and Applied Sciences. 7(10):1193-1200.

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EFFICACY OF ENDOPHYTIC BACTERIA ON PLANT GROWTH PROMOTION AND BIOCONTROL OF *Fusarium* WILT IN TOMATO CROP

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ABSTRACT

Fusarium wilt is a serious disease in tomatoes leading to yield loss. In the study liquid formulations of two endophytic bacteria *viz., Pseudomonas aeruginosa* KM236234 (FR3) and *Bacillus sp.* KC817016 (FR19) were used for evaluating disease control potential and plant growth promotion (PGP) of tomato crops. Cell-free supernatants of both FR3 and FR19 could reduce the radial growth of *Fusarium oxysporum (MTCC10270).* FR3 and FR19 could also able solubilize phosphate and produce IAA at 28 °C and 37 °C. In this study, investigation was done on the effect of two plant growth-promoting (PGP) endophytic bacteria *viz., Pseudomonas aeruginosa*-FR3 and *Bacillus sp.*-FR19 when utilized alone, and in combination with each other on morphology and growth of tomato plants. Inoculation of endophytes significantly increased the plant growth parameters when compared to control. Plant biomass and root biomass 205,189,311%; 200,189,317% were increased in inoculated plants compared to non-treated control plants. The combined use of FR3 and FR19 had a positive impact on tomato morphological parameters and increased shoot biomass. *P. aeruginosa* (FR3) was found to have higher efficacy than *Bacillus spp.* (FR19) for plant growth and development, while the FR19 strain had higher antifungal activity than the FR3 strain.These results suggested that inoculation with *Pseudomonas aeruginosa* (FR3)and *Bacillus sp* (FR19) could be successfully used to enhance tomato biomass. A complete correlation was observed in plant growth parameters with inoculated FR3 and FR19-tested endophytic stains.

Keywords: Anti-fungal activity, Endophytes, Tomato wilt

INTRODUCTION

In recent years the use of microbial inoculants as biofertilizers and biocontrol agents in the agriculture industry has been increasing considerably (Ahmed *et al.,* 2022). Microbial inoculants are favored to reduce environmental pollution caused by chemicals and alsopesticides (Alori and Babalola,2018). Endophytes can also enhance the plant growth-promoting (PGP) traits of crops either by a direct or indirect mechanism (Ahmed *et al.,* 2022)**.** Both the endophytic and rhizosphere microorganisms, including bacteria,

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fungi, actinomycetes *etc*. are reported to exhibit PGP traits such as IAA and ammonia production, phosphate solubilization (Ghosh *et al*., 2016). Endophytic bacteria can produce nutritive metabolites and antibiotics or promote induced systemic resistance (ISR) in plants as a critical defence pathway (Rat *et al.,* 2021).

Tomato (*Solanum lycopersicum* L.) is an important crop cultivated and consumed worldwide as unprocessed fresh fruits as well as in various types of processed products (Brookie *et al*., 2018). India accounts for 55% of the world's total production of tomatoes. It is an annual vegetable crop grown in almost all states of India, such as Andhra Pradesh, Maharashtra, Karnataka, Gujarat, Tamil Nadu, and Orissa. Tomato is an enriched -nutritious fruit due to its large content of vitamins A, C and natural antioxidant agents, which are not present in other crops (Chohan and Perveen, 2015). Compared to other fruits tomato contains higher amounts of lycopene, a type of carotenoid with anti-oxidant properties which is beneficial in reducing the incidence of some chronic diseases (Brookie *et al.,* 2018). The sustainability of tomato-based agriculture is threatened by various biotic and abiotic factors. Various biotic and abiotic factors threaten the sustainability of tomato-based agriculture. Pathogenic microorganisms of the rhizosphere, soil and environment cause many diseases in tomatoes, severely affect yields and cause significant loss (Raaijmakers *et al.,* 2009). *Fusarium oxysporum f. sp. lycopersici* species causes wilt disease in over 150 hosts (Bertoldo *et al.,* 2015). *Fusarium oxysporum f. sp. lycopersici,* mainly cause stem rot, fruit lesions, and leaf blight, also causes damage to the photosynthesis and pigment content, which reduces overall growth and significantly decreases yield. Extensive usage of chemical fungicides to control wilt-causing pathogens become a more significant threat to the environment, humans, and beneficiary insects, (Alori and Babalola, 2018). The study aimed to study the efficacy of endophytic *Pseudomonas aeruginosa* KM236234 (FR3) and *Bacillus sp* KC817016 (FR19) on plant growth promotion and biocontrol of *Fusarium wilt* of tomato.

MATERIALS AND METHODS

Sources of sample collection.

Endophytic bacteria *Bacillus sp*. - KC817016 (FR19) and *Pseudomonas aeruginosa*- (FR3) were isolated from the red fruit of chili (*Capsicum annuum*) and were deposited in NCBI after molecular identification with accession number KC817016 and KM236234, respectively as per the procedure standardized by corresponding author (Amrutha *et al*., 2014). These two purified bacterial strains of endophytic bacteria *Bacillus sp*. - KC817016 (FR19) and *Pseudomonas aeruginosa*- KM236234 (FR3) were maintained on agar media of slants in the Microbiology laboratory, Department of Microbiology, Acharya Nagarjuna University, Guntur, India were used in the experiment and Fusarium *oxysporum (F.O)* (MTCC10270) the pathogenic fungi (Lyophilized cultures) procured from MTCC Chandigarh, India.

Screening of Antifungal activity

Antifungal activity was assayed by dual culture method, bacterial isolate was streaked on sabouraud dextrose agar (SDA) medium at a distance of 3 cm opposite to pathogenic fungi and measured antifungal activity after seven days of incubation at room temperature. The value of inhibition was measured using the formula:

Inhibition (%) = [1-($\frac{a}{b}$)] x 100

a: Distance between fungi in the centre of Petri dish to endophytic isolate.

b: Distance between fungi in the centre of the Petri dish to blank is without endophyte.

Growth optimization studies of endophytic bacteria

Effect of temperature on endophytic bacterial growth

Growth optimization of endophytic bacteria were analysed at different temperatures (5 °C, 25 °C, 35 °C, 45 °C, 60 °C) by incubating for 48 hours and O.D. was recorded at 600 nm using spectrophotometer.

Effect of pH on endophytic bacterial growth

Growth optimization was analyzed at different pH ranges from 4, 5, 6, 7, 8, 9, 10, 11, and 12 in a nutrient broth medium. After 48 h at room temperature, the O.D. of the culture broth read 600nmusingaspectrophotometer.

Effect of carbon source on endophytic bacterial growth

Growth optimization characteristics of bacteria were analyzed in a minimal broth medium at nine different carbon sources (starch, sucrose, fructose, mannitol, dextrose, lactose, glucose, glycerol, and maltose). 100µl of bacterial culture was added to 10 ml of minimal brothmedium containing 1% of carbon source. O.D. of broth was read at 600 nm after 48 h of incubation.

Effect of nitrogen source on endophytic bacterial growth

The growth optimization characteristics of endophytic bacteria were analysed in minimal broth medium at different nitrogen sources, including peptone, beef extract, yeast extract, tryptone, urea, ammonium sulfate, and ammonium chloride sodium nitrate and potassium nitrate. 100 µl of bacterial culture was added to 10ml of minimal broth medium containing 0.5% of nitrogen source. O.D. of broth was read at 600 nm after 48 h of incubation.

Compatibility among bacterial strains

The FR3 and FR19, and FR3+FR19 were tested for their compatibility with each other. The NA medium determined compatibility for FR3 and FR19 and FR3+FR19 strains. The bacterial strains were streaked vertically to each other. The plates were incubated at room temperature (28 ± 2 °C) for 72 h and observed for the inhibition zone. The absence of an inhibition zone indicated compatibility with respective bacterial strains, and an inhibition zone indicates incompatibility.

Qualitative screening of plant growth promotion (PGP) traits

Indole-3-acetic acid (IAA)

Bacteria were grown in nutrient broth supplemented with L-tryptophan (1µg ml^{-1}) for 72 h and centrifuged at 10,000 g for 10 min, 2 ml of Salkowski reagent (1 ml of 0.5 M $FeCl_3$ in 50 ml of 35% $HClO_4$) was added to 1 ml of culture filtrate and allowed to react for 30 min at 28± 2 °C. The development of pink colour indicates the presence of IAA.

Phosphate solubilization

The solubilization of tri calcium phosphate was detected on Pikovskaya's agar. Bacterial isolate was streaked on the surface of Pikovskaya agar medium, and activity was

estimated at room temperature after 1 to 5 days of incubation. Development of the clear zone around the bacterial colony was a positive test for phosphate solubilization.

Ammonia production

Production of ammonia was tested in peptone water. The freshly grown culture was inoculated in 10 ml peptone water and incubated for 48-72 h at 36 ± 2 °C. Nessler's reagent (0.5 ml) was added. The development of brown to yellow colour was a positive test for ammonia production.

Experimental site and design

The pot experiment study was conducted at the Department of Microbiology Acharya Nagarjuna University, Guntur, [16°22'45.23"N, 80°31'51.13"E, elevation:22.2 Meters (72.83 feet)], India, during *rabi* season 2020-2021 in a complete randomized block design with four treatments and replicated thrice. Tomato variety cv. Royal seed was purchased from the local market and sown in pots (size 10 cm x15 cm in height and diameter) containing 25 kg of sterile soil alluvial soil andthinned to two plants per pot after seven days. The average annual rainfall 872 mm at the experimental site and the mean temperature varied between 36.9 °C (during September) and 11.7 °C (during January).

Treatment and plant growth promotion

Three experimental sets, *i.e*., treatment conditions, were used for tomatocrops: Bacterial suspension -FR3, FR19, and FR3+FR19, and uninoculated control. FR3, FR19, and FR3+FR19 were grown in nutrient broth (N.B.) medium for two days at 28 °C to get a population of 2.2×10^9 CFU ml^{-1}. A bacterial suspension of 10 ml was given to the soil region. In the control set, the uninoculated nutrient broth was controlled. The spraying was done at the seedling stage in the rhizosphere region, the second was given after 15 days in the soil and rhizosphere regions, and the last spray was given after one month of the first spray in the soil. After the sufficient growth (4^{th} week) of the plants, morphological, growth, and development parameters of each experimental set were recorded and compared.

Treatment and suppression of pathogen aggressiveness growth

Three experimental sets, *i.e.,* treatment conditions, were used for each pot: FR3 +F. O, FR19+F.O, and FR3+FR19+F.O treated, and uninoculated control. FR3+F.O, FR19+F.O, and FR3+FR19+F.O were grown separately in optimized broth medium for two days at 28 °C to grow the inoculum (2.2×10^9 CFU ml^{-1}), and the inoculum was given to the potted soil. The uninoculated nutrient broth was used as a control, and growth parameters were recorded for ten weeks

Statistical analysis

The data was statistically analysed by MS-Excel land version 16.0 whenever required; multiple mean comparisions were performed using (Dunnett's Multiple Comparision Test) and posthoc test using Graph Pad Prism. Statistical significance was $p< 0.05$ and $p<0.0001$. R software version 4.0 was used for correlation analysis

RESULTS AND DISCUSSION

Compatibility and antifungal activity

Pure cultures of *Pseudomonas aeruginosa* (FR3) and *Bacillus sp.* (FR19) and FR3+FR19

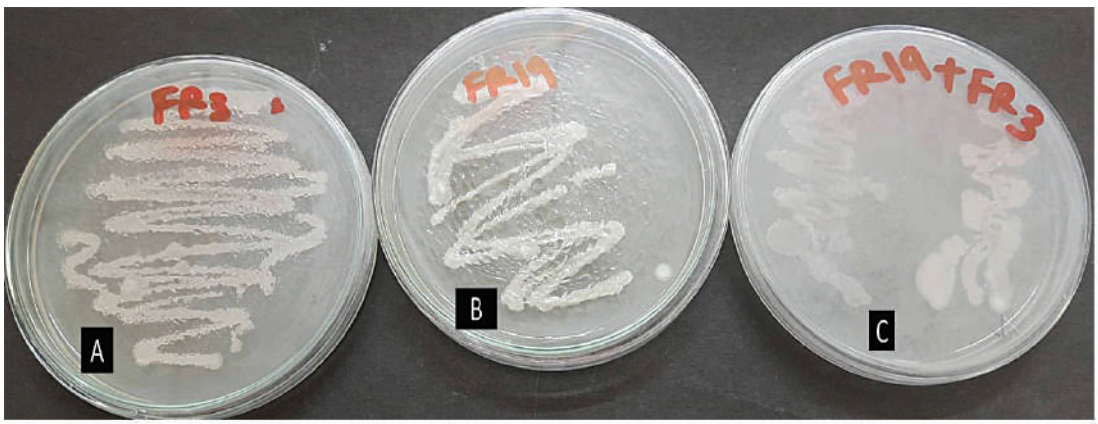

Plate 1. Pure cultures of A. FR3, B. FR19 and C. FR3+FR19

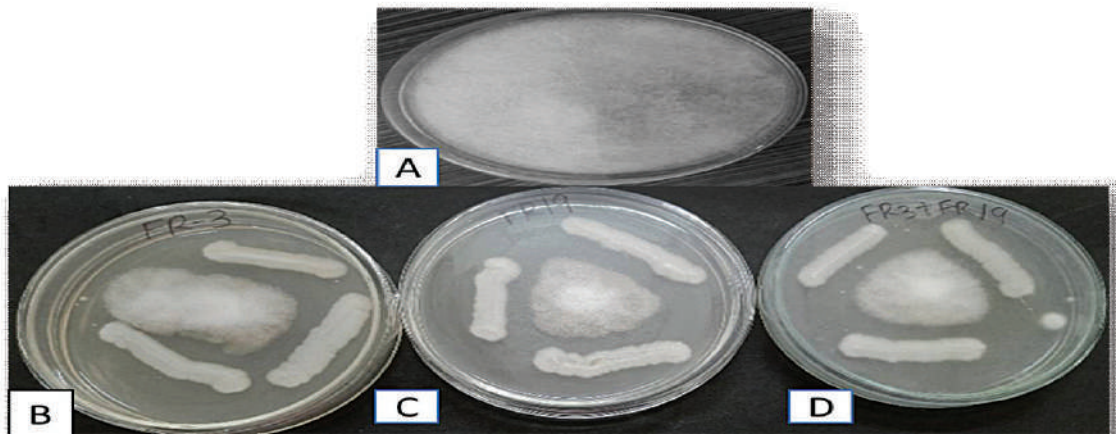

Plate 2. Fungal antagonism A. control, B. FR3, C. FR19 and D. FR3+FR19

were developed by using the streak plate method (Plate 1). The results of this study showed the compatibility of FR3 and FR19 to grow under standard culture media. Pure cultures of FR3, FR19, and FR3 +FR19 were screened for fungal antagonism against *F. oxysporum*. by dual culture method shown in (Table 1, Plate 2, and Fig. 2).

Table 1. Antifungal activity of bacterial endophytes against *Fusarium oxysporum* (F.O)

S.No.	Endophytic bacterial combinations	Zone of inhibition (mm) of *Fusarium oxysporum* (FO)			
		Diameter(cm)	Area ($A = \pi r^2$)	Circumfe-rence	% Inhibi-tion
1	*Fusarium oxysporum* (FO) (Control)		4	12.56	12.56
2	FR3	1.25	4.90	7.85	39.1
3	FR19	3.8	11.80	11.50	93.96
4	FR3+FR19	0.75	1.76625	4.71	37.5

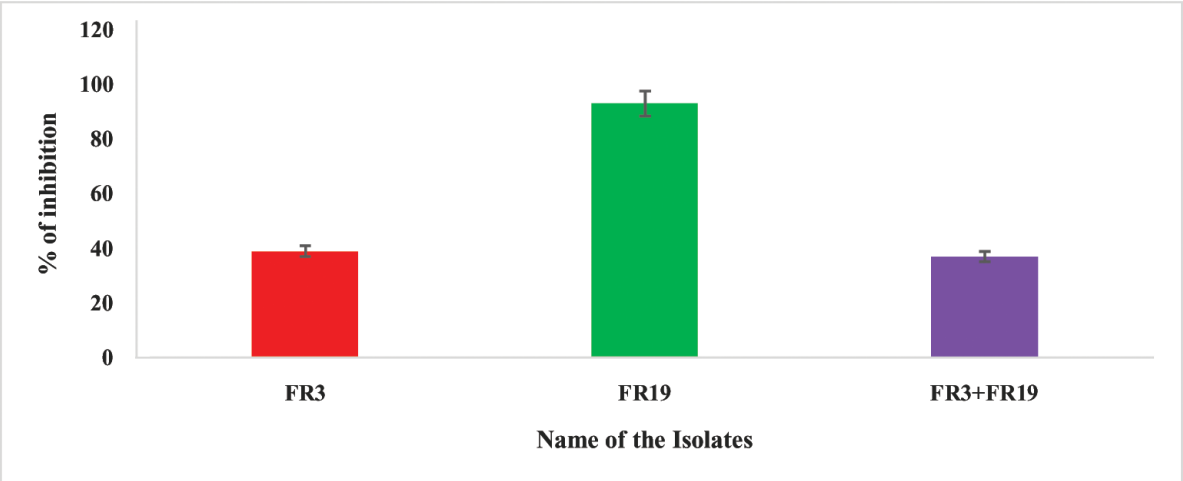

Figure 1. Antifungal activity of bacterial antagonists alone and in consortia against *Fusarium oxysporum* f.sp. *lycopersici*. The data is the mean ± SD (n=3)

Optimization of culture conditions

The culture growth conditions of FR3 and FR19 were optimized at different physio-chemical factors such as temperature, nitrogen, and carbon. Among six temperatures (5 °C, 25 °C, 35 °C, 45 °C 55 °C, and 65 °C) tested for optimization, 35 °C was found optimum, as the isolates, FR3 and FR19, showed maximum growth at 35 °C. Out of the nine different pHs tested, for maximizing the growth, it was observed that pH 7 was optimal for FR3+FR19. Out of the nine different carbon sources (Starch, Sucrose, Fructose, Mannitol, Dextrose, Lactose, Glucose, Glycerol, and Maltose) tested both the isolates FR3 and FR19 showed maximum growth with sucrose and glucose. However, sucrose was the best carbon source as the growth was higher than glucose Out of the nine different nitrogen sources, (Peptone, Beef extract, Yeast, Tryptone, Urea, NH_4SO_4, NH_4Cl, $NaNO_3$, KNO_3) tested for optimization and growth of both the isolates FR3

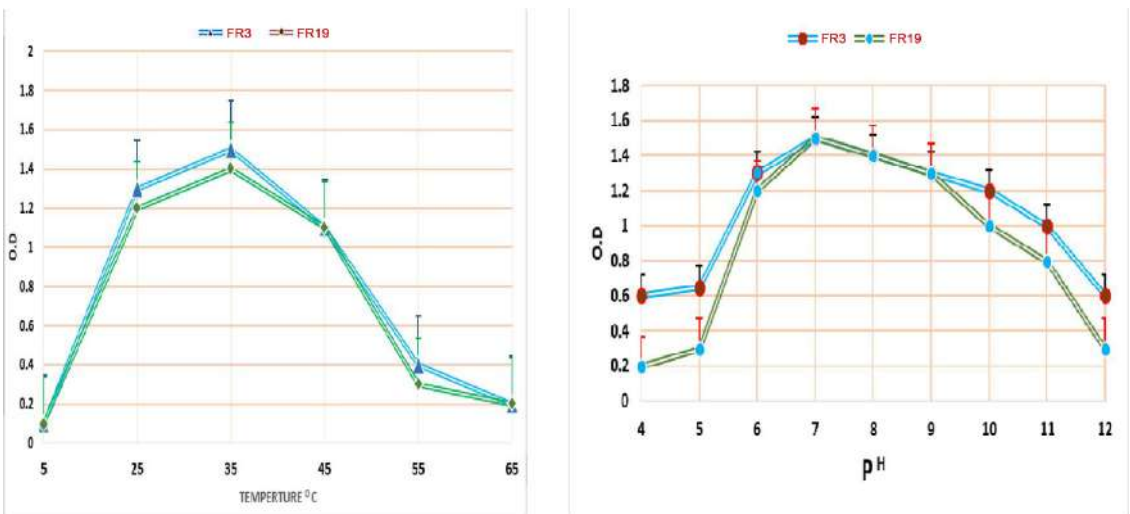

Figure 2. Effect of temperature and pH on growth (O.D. at 600 nm) of endophytic bacteria

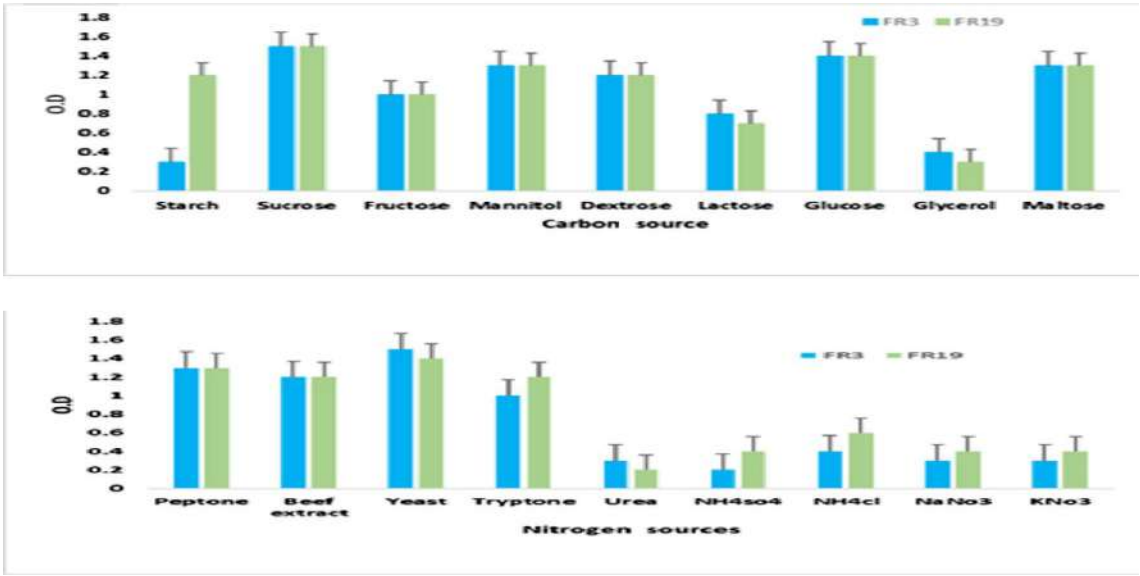

Figure 3. Effect of carbon and nitrogen sources on growth (O.D. at 600 nm) of FR3 and FR19. The data is mean + standard deviation (n=3)

and FR19 showed maximum growth with yeast and peptone. However, yeast was the best nitrogen source (Fig. 2 and Fig. 3).

Qualitative analysis of plant growth promoting traits

Qualitative analysis of plant growth-promoting traits such as IAA production, phosphate (PO_4) solubilization, ammonia, and volatile compounds of FR3, FR19, and FR3+FR19 were estimated qualitatively (Table 2). Results revealed that all the three isolates *viz.,* FR3, FR19, and FR3+FR19, had higher potential producing IAA and Ammonia, Phosphate solubilization. They were moderately reported positive to volatile compounds (Table 2).

Plant growth promotion of tomato plants treated with bioformulations

Endophytic *Pseudomonas* and *Bacillus* reported significant improvements in morphological traits of plantlets treated with combinations than controls under pot conditions. *Pseudomonas aeruginosa* and *Bacillus megaterium* inoculations showed positive responses in black pepper stem cuttings germination, number of leaves, root biomass,

Table 2. Qualitative screening of plant growth-promoting traits

Isolates	IAA Production	Ammonia production	Phosphate solubilization	Volatile compounds
FR3	+++	+++	+++	++
FR19	+++	+++	+++	++
FR3+FR19	+++	+++	+++	++

+ =minimum, ++= moderate and +++= maximum

and total plantlets (Aravind *et al*., 2012; Ting *et al*., 2008). Plant growth promotion potential of bio formulation of FR3, FR19, and FR3+FR19 were studied separately. The administration of 10ml of formulation to the collar region of the tomato seedlings showed a significant difference from the 4th week to the 18th week. FR3-treated tomato seedlings showed the enhancement of number. of leaves (13%), shoot height (80%) and root length (13%), and FR19-treated seedlings enhancedthe number of leaves (13%),shoot length (76%) and root length (60%), FR3+FR19 showed the enhancement of number of leaves (13%), root shoot length (62%), length (55%)(Table 3 and Fig 4). The researcher attempted to understand the impact of FR3, FR19 and FR3 +FR19 formulations on nodes, branches, flowers, fresh weight, and root/shoot ratio after 18 weeks of treatment. In the 18th week, the number of nodes was high in tomato seedlings treated with FR3+FR19 and FR3 (133.33%), followed by FR19 (100%) in tomato plant growth when compared to the control. Moreover, the number of branches was also significantly high in the seedlings treated with FR3 + FR19 (95%)**,** followed by FR19 (86.49%) and FR3 (41%) in tomato plant growth when compared to the control(Table 3 and Fig. 4). The number of flowers was also high in the seedlings treated with FR3+FR19 (800%), followed by FR19 (500%) and FR3 (200%) tomato plant growth when compared to the control (Table 3 and Plate 3). Plant biomass was increased significantly in plants treated with FR 3+FR19 (311.48%), followed by FR3 (205%) and FR19 (189%). Similarly, root biomass was triggered in FR3 (312%), FR3+FR19 (244%),and FR 19(163%) and also shoot biomass in FR3+FR19 (317%), FR3(199.65%) and FR19(189.24%) in tomato plant growth when compared to control (Table 3). It was also noticed that the root/shoot ratio was reported to be 0.08 in FR3 and 0.08 in FR3+FR19, and 0.07 in FR19-treated plants compared to the control (Table 3 and Fig. 4). Our results are in conformity with the working of Ebtesam *et al*. (2022) who reported that inoculated tomato plants with *B. subtilis* and *B.amylolique faciens* increased tomato growth and yield. The results revealed that FR3, FR19, and FR3+FR19 stimulated holistic growth as bio stimulators rather than a biofertilizer. All the growth and yield parameters were found highly significant under inoculation treatments. The number of leaves, shoot and root length, number of branches, and shoot biomass showed highly significant with FR3 and FR19, and highly significant interactions were found between FR3 and FR19 inoculated plants (Fig 4), while root-to-shoot ratio and number of branches were found non-significant between FR3 and FR19 treatments and also non-significant interactions were found between FR3 and FR19 treatment plants (Fig. 4). A high correlation was observed in all the parameters (Table 5).

Suppression of pathogen aggressiveness

Pathogen suppression was analyzed in tomato seedlings treated with a suspension of *F.oxysporum* + FR3, *F.oxysporum*+FR19, and *F.oxysporum*+FR3+FR19 showed variation in the growth attributes of tomatoes. Shoot length was significantly increased compared to *F.oxysporum* from the 4th week to 10th week. (Except F.O) in treatment, the remaining treatments of *F.oxysporum*+FR3*, F.oxysporum*+ FR-19 and *F.oxysporum*+FR3 + FR19 showed a significant increase in shoot length compared to

Table 3. Effect of bacterial inoculation on growth attributes of tomato plant

	Number of leaves plant^{-1} (%)			Shoot length (cm) (%)			Root length (cm) (%)			No.of flowers plant $^{-1}$ (%)		
Weeks	FR3	FR19	FR3+ FR19	FR3	FR19	FR3+	FR3	FR19	FR3+ FR19	FR3	FR19	FR3+ FR19
4th	13	13	13	80	76	62	13	60	55			
8th	40	108	42	67	19	59	14	3.2	16.4			
12th	32	63.2	58	68	15	73	7.3	3.6	26.1			
16th	13	35.5	29.0	65	16	110	6.0	12.2	36.7			
18th	37	25.7	42.1	64	12	101	8.9	12.2	37	200	500	800
Week	Plant biomass g plant^{-1} fresh .wt (%)			Shoot biomass g plant^{-1} fresh.wt (%)			Root biomass g plant^{-1} fresh.wt (%)					
18th	205	189	311.5	199.7	189.2	317	312.5	163 %	244			
Week	Root/shoot ratio			No.of nodes plant^{-1} (%)			No.of branches plant^{-1} (%)					
18th	0.08	0.07	0.08	100	100	133.33	41	86.49	95			

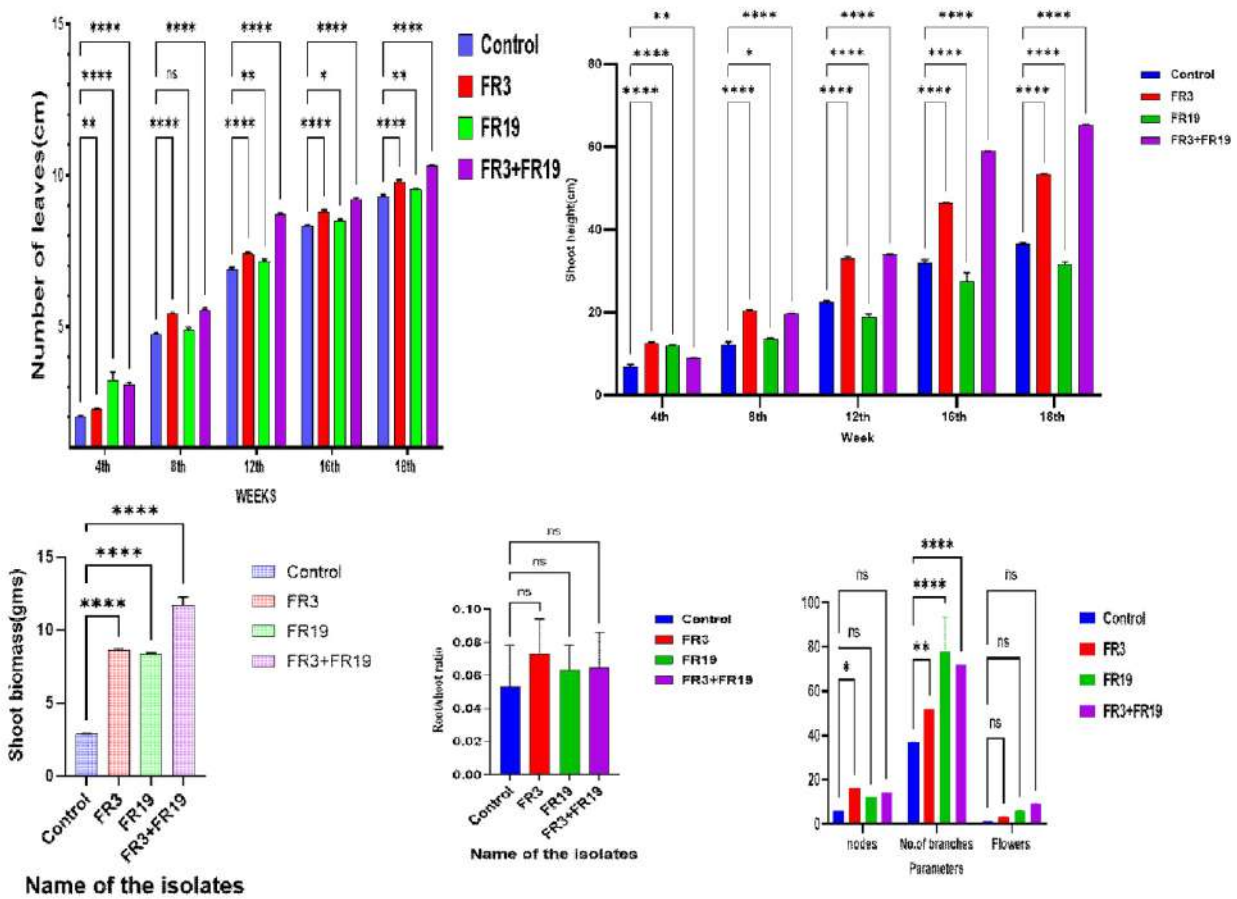

Fig 4. Impact of bioformulation on growth attributes of tomato (Dunnett's multiple comparisions using the GraphPad prism tool). The data are the mean ± SD (n=3)

Plate 3. The efficacy of bioformulation on growth attributes of tomato

Table 4. Pathogen suppression by endophytic bacterial inoculation (F.O, F. O+FR3, F.O+ FR-19, and F. O+FR3 + FR19)

Parameter	Week	Control	F. O*	F. O*+ FR3	F.O* + FR19	F. O*+FR3+ FR19
Shoot length	4th	17±0.02	12±0.0	13.5±0.3	22±0.0	18.5±0.6
	8th	20±0.01	13.5±0.1	17.5±0.2	34.5±0.1	32.5±0.5
	10th	22±0.0	14.5±0.1	20±0.3	48±0.3	40.5±0.3
Number of leaves	4th	5±0.02	5.5±0.1	6.5±0.3	8.3±0.0	8.5±0.6
	8th	8.2±0.01	6.5±0.1	10.2±0.2	12.5±0.1	15.3±0.5
	10th	9.5±0.0	8.5±0.1	12.5±0.3	15.3±0.3	18.2±0.3

The data are the mean ± SD (n=3)* *Fusarium oxysporum* (F.O)

the control (Table 4). The number of leaves of tomato seedlings was suppressed in *F.oxysporum* when compared to control from the 4th to 10th week. Treatments of F.O+FR3, F.O+FR19, and F.O+FR3+FR19 showed a significant increase in the number of leaves compared to the control. Biocontrol formulation *B. subtilis* are partially effective against clubroot pathogen (Zhu *et al*., 2019**)** and the results agreed with Uwaremwe *et al.* (2022). A nodosum (seaweed) extract, extracts from sugar beet enriched in amino acids, potassium phosphonate, and lime showed positive effects in increasing plant performance, primarily due

Table 5. Correlation of different growth parameters on tomato among FR3 and FR19 and F.O, F.O + FR3, F. O + FR19 inoculations

S.No.	Parameter	Number of leaves			
		Control	FR3	FR19	FR3+FR19
1	Control	1			
2	FR3	0.97	1		
3	FR19	0.98	0.94	1	
4	FR3+FR19	0.98	0.99	0.96	1
		Shoot length			
1	Control	1			
2	FR3	1.00	1		
3	FR19	0.99	1.00	1	
4	FR3+FR19	0.99	0.99	1.00	1
		Root length			
1	Control	1			
2	FR3	1.00	1		
3	FR19	0.98	0.98	1	
4	FR3+FR19	0.97	0.97	0.99	1
		Shoot length			
		Control	F. O	F. O+FR3	F. O+FR19
1	F. O	1	1		
2	F. O+FR3	1	1	1	
3	F. +FR19	0.99	0.99	0.99	1
4	F. +FR3+FR19	1	1	1	0.98
		Number of leaves			
1	F. O	0.91	1		
2	F. O+FR3	0.99	0.95	1	
3	F. +FR19	0.99	0.95	1	1
4	F. +FR3+FR19	1	0.91	1	0.99

* *Fusarium oxysporum* (F.O)

to their colloidal alginates and minerals (Dhargalkar and Pereira, 2005). A high correlation was observed in all the parameters (Table 5).

CONCLUSIONS

The two isolates enhanced plant growth and good PGP attributes. FR19 showed significantly higher activities such as phosphate solubilization, Ammonia production, and IAA production. FR3 and FR3+FR19 showed phosphate solubilization and IAA production ability. FR19 strain reported higher antifungal activity than the FR3 strain, while **(**FR3) had higher endophytic efficacy than *Bacillus spp***.** (FR19) for plant growth and development. These two endophytic bacterial strains (FR3 and FR3) would be useful for yield enhancement in tomato and other solanaceous crops.

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REFERENCES

Amrutha V. A., Sudhir, A., N. Pradeep Kumar and Chowdappa, P. 2014. The Plant growth promoting potential of a novel endophytic curtobacterium CEG: Isolation, evaluation and formulation. Journal of Scholars Research Library Annals of Biological Research. 5 (5):15-21.

Ahmed, S. M., Mohamed., El Saadony,E., Ahmed, M. S, El Sayed, M., Amira, M. D., El Tahan, M. M., Synan,R., Abu Qamar, F.,Khaled and El Tarabily, A. 2022. The use of microbial inoculants for biological control, plant growth promotion, and sustainable agriculture: A review. European Journal of Plant Pathology. 62:759-792.

Alori, E. T and Babalola, O. O. 2018. Microbial inoculants for improving crop quality and human health in Africa- A Review. Frontiers Microbiology. 9:1-11.

Aravind, R., Kumar, A and Eapen, S. J. 2012. Pre-plant bacterization: a strategy for delivery of beneficial endophytic bacteria and production of disease-free plantlets of black pepper (*Piper nigrum* L.). Archives of Phytopathology and Plant Protection. 48: 1-12.

Bertoldo, C., Gilardi, G and Spadaro, D. 2015. Genetic diversity and virulence of Italian strains of *Fusarium oxysporum* isolated from Eustoma grandiflorum. European Journal of Plant Pathology. 141:83-97.

Brookie, K. L., Best, G. I and Conner, T. S. 2018. Intake of raw fruits and vegetables is associated with better mental health than intake of processed fruits and vegetables. Frontiers in Psychology. 9: 487.

Chohan, S and Perveen, R. 2015. Phytochemical analysis and antifungal efficacy of rhizome extracts of various plants against fusarium wilt and root rot of tomato. International Journal of Agriculture and Biology. 17: 1193-1199.

Dhargalkar, V. K and Pereira, N. 2005. Seaweed: promising plant of the millennium. Science and Culture. 71:60-66.

Ebtesam, A., Gashash,N.A,. Abdulaziz.O.A., Alsahli, Heba M., Hewait, Ashmawi E., Ashmawi, K.S., Alshallash, A.M., El-Taher, E.S., Azab,H., Abd El-Raouf.,M and Ibrahim. 2022. Effects of plant-growth-promoting rhizobacteria (PGPR) and Cyanobacteria on botanical characteristics of tomato (*Solanum lycopersicon* L.) Plants. 11 (20):10.3390/plants11202732.

Ghosh, R., Barman, S., Mukherjee, Rand Mandal, N.C. 2016. Role of phosphate solubilizing *Burkholderia spp.* for successful colonization and growth promotion of *Lycopodium cernuum* L. (Lycopodiaceae) in lateritic belt of Birbhum district of West Bengal, India. Microbiological *Research*. 183: 80-91.

Raaijmakers, J.M., Paulitz, T.C and Steinberg, C. 2009. The Rhizosphere: A playground and battlefield for soil borne pathogens and beneficial microorganisms. Plant and Soil. 321: 341-361.

Rat,A., Henry, D., Niko, N.N.,Grigoriadou, K.,Maloupa,E.,Verela, A.A., Schneider, C., Vassilios, P., Papageorgiou, N.N., Nikolaos-safantakis,A.,Fokialakis,N and Willems.A. 2021. Endophytic bacteria from the roots of the medicinal plant *Alkanna tinctoria* tausch (Boraginaceae): Exploration of plant growth promoting properties and potential role in the production of plant secondary metabolites. Frontiers in Microbiology. 12:1-14.

Ting, A. S. Y., Meon, S., Kadir, J., Radu, S and Singh, G. 2008. Endophytic micro-organisms as potential growth promoters of banana. Bio Control. 53: 541-553.

Uwaremwe, C.,Yue, L.,Wang, Y.,Tian,Y., Zhao, X.,Liu,Y., Zhou, Qand Zhang,Y.R.2022.An endophytic strain of *Bacillus amyloli quefaciens* suppresss *Fusarium oxysporum* infection of Chinese wolfberry by altering its rhizosphere bacterial community. Frontiers Microbiology.12: 10-11. DoI: https://doi.org/10.3389/fmicb.2021.782523

Zhu, M., He,Y., Li,Y., Ren,T., Liu, H., Huang, J., Jiang, D., Hsiang,T and Zheng, L. 2019. Two new biocontrol agents against clubroot caused by *Plasmodiophora brassicae,* Frontiers in Microbiology. 10 - 2019.https://doi.org/10.3389/fmicb.03099

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DoI: https://doi.org/10.58537/jorangrau.2023.51.2.06

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EVALUATION OF QUALITY OF THE VIRGIN COCONUT OIL EXTRACTED BY TRADITIONAL AND COLD CENTRIFUGATION METHODS

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ABSTRACT

The study was conducted in the year 2022 to assess the quality of VCO obtained using various extraction methods. VCO was extracted from fresh and mature kernels of the *Kerasree* coconut variety using traditional (TVCO) and cold centrifugation (CCVCO) methods. TVCO showed the highest mean score of 8.99 for overall acceptance based on the organoleptic evaluation. Physicochemical properties of VCOs were statistically analysed and compared to the guidelines for edible oils established by the Asian Pacific Coconut Community (APCC). The findings revealed that there was a significant difference ($p<0.05$) in oil recovery, content of tocopherol and total phenol, total antioxidant activity and fatty acid profile of TVCO and CCVCO. High oil recovery and low moisture content were observed in TVCO. CCVCO contained more lauric acid (46.15%), tocopherol (26.25 μg/g), total phenol content (8.87 GAE μg/g) and total antioxidant activity (25.95 μg/mg) than TVCO.The findings demonstrated that the quality of VCO was affected by extraction methods.

Keywords: Cold centrifugation, Organoleptic evaluation, Physico-chemical properties, Virgin coconut oil

INTRODUCTION

Coconut (*Cocos nucifera*) is one of the most valuable trees and all of its parts are beneficial to people. Because of its various functions, the coconut is referred to in Indian mythology as “kalpavriksha” or “Tree of heaven” (Kalimuthu and Dharani, 2020). Coconut belongs to the palm family (*Palmae* or *Arecaceae*) which has about 190 genera and over 2800 species. Around 12 million hectares of land are used to grow coconuts, with a potential yearly production of 70 billion nuts. It offers the people options for a sustainable way of life through farming, processing, marketing, and trade-related industries. Therefore, it significantly affects rural economies.

Virgin coconut oil (VCO) is a comparatively new, high-quality coconut product that is becoming more popular as a functional food throughout the world. It is the purest kind of

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coconut oil with a fresh coconut aroma. VCO is naturally extracted using heat or without it, from fresh and mature coconut kernels. VCO differs from other vegetable oils because of its high content of lauric acid, vitamin E, polyphenols and antioxidants.VCO is high in medium-chain fatty acids (MCFAs) at about 63% and contains lauric, myristic, palmitic, capric, stearic, oleic, and linoleic acids. Monolaurin, a monoglyceride form of lauric acid, boosts the immune system and protects young children from bacterial, viral, and protozoal infections (Nasir *et al*., 2018). Lauric acid, which has antibacterial and antiviral characteristics, and the phenolic compounds included in VCO, which have anti-mutagenic, anti-proliferative, and anti-carcinogenic properties, are some of the health benefits of VCO.

VCO is extracted using a variety of methods, which are generally categorised into dry and wet methods. In the dry method, the coconut kernel is heated under particular conditions to eliminate the content of moisture in it to prevent scorching and microbial invasion, whereas,in the wet method, heat is not applied to the coconut kernel. The wet method can be further divided into chilling, thawing, fermentation, enzymatic, and pH methods, or any of these in combination as the main intention is to destabilise the coconut milk emulsion. In the dry technique, the kernel was mechanically pressed to extract the oil after being dried using controlled heating. The qualities of VCO can vary by applying various extraction techniques. Thus, the objective of the study was to evaluate the physicochemical composition and organoleptic quality of VCO extracted from traditional and cold centrifugation methods.

MATERIALS AND METHODS

Collection of ingredients

The study was conducted in the year 2022 at the Department of Community Science in the College of Agriculture, Kerala Agricultural University (KAU), Vellanikkara, Kerala.The matured coconuts of the variety *'Kerasree'* were procured from the Instructional farm of KAU, Vellanikkara, Thrissur, and RARS, Pilicode, Kasaragode.

Extraction of VCO

Preparation of coconut milk

The matured coconuts (10-11 months old) were used for milk extraction. After being dehusked, the coconut kernel was grated using a coconut grater. The coconut milk was extracted using a white muslin towel from the grated coconut kernel.

VCO extracted by traditional Method (TVCO)

Coconut milk was heated at 100 – 120 °C for 60 min to completely evaporate the water. The proteins in coconut milk become denatured when heated, which causes the milk emulsion to become unstable. The coagulated protein was removed using a muslin filter and the remaining residue was boiled again to release additional oil.

VCO extracted by cold centrifugation method (CCVCO)

Coconut milk was centrifuged at 10000 rpm for 10 minutes a 4 °C and the upper cream layer was removed for chilling. The cream was chilled at 4 °C for 24 h before being gradually thawed at 50 °C in a water bath. Then oil was filtered using Whatman filter paper No. 1 and stored in glass bottles.

Organoleptic evaluation

A group of 15 judges were selected by a standard procedure for the organoleptic evaluation. A nine -point hedonic scale was used by the selected group of judges to evaluate the organoleptic qualities of VCO.

Physico-chemical analysis

Physico-chemical properties such as oil recovery, moisture content, tocopherol content, phenol content total antioxidant activity and fatty acid profile of VCOs were analysed using standard procedure.

Statistical analysis

The data were recorded and analysed as a completely randomised design (CRD). The organoleptic scores were evaluated by Kendall's coefficient of concordance (W). The physicochemical properties of TVCO and CCVCO were statistically compared by independent t-test.

RESULTS AND DISCUSSION

In this study, sensory characteristics and physicochemical properties of the VCOs were analysed. The findings were confirmed with suitable statistical analysis and discussed under the following subheadings.

Organoleptic evaluation

The sensory evaluation was carried out for the extracted VCOsby using nine point hedonic scale with a group of 15 judges considering the six sensory attributes (appearance, colour, flavour, taste, texture and overall acceptability). The organoleptic mean scores were calculated and are shown in Table 1. The mean scores for the sensory attributes of each treatment were statistically analysed using Kendall's coefficient of concordance. In the study, the organoleptic evaluation scores revealed that acceptability was highest for the VCO extracted by the traditional method.TVCO had the highest mean score for flavour, taste and texture. CCVCO scored highly on the organoleptic mean score for appearance and colour when compared to traditional VCO.

Dumancas *et al*. (2016) reported that VCO had a water like appearance and fresh coconut aroma. Ndife *et al.* (2019) found that all samples of VCO were colourless except VCO extracted

Table 1. Mean scores for organoleptic qualities of VCOs

S.No.	Sensory attributes	TVCO	CCVCO	Kendall's [W] value
1	Appearance	8.97(1.4)	9(1.6)	0.20**
2	Colour	8.97(1.4)	9(1.6)	0.20**
3	Flavour	9(1.80)	8.82(1.20)	0.60**
4	Texture	9(1.60)	8.85(1.40)	0.20**
5	Taste	9(1.75)	8.95(1.25)	0.50**
6	Over all acceptability	8.99(1.80)	8.92(1.20)	0.45**
7	Total score	53.93	53.54	

Values in parenthesis are mean rank scores based on Kendall's W. (**significant at 1% level); TVCO-VCO extracted by traditional method; CCVCO - VCO extracted by cold centrifugation method

Table 2. Physicochemical properties of VCOs

S.No.	Parameter	TVCO	CCVCO	t value	APCC standard
1	Oil recovery (%)	39.37	38.82	32.75*	-
2	Moisture (%)	0.09	0.11	1.177NS	0.1 - 0.5
3	Tocopherol content ((µg/g)	17.81	26.25	496.57*	-
4	Total phenol content (GAE µg/mg)	7.78	8.87	4.903*	-
5	Total antioxidant activity (µg/mg)	17.52	25.95	763.13*	-

NS – Non Significant, *Significant at 5%; TVCO- VCO extracted by traditional method; CCVCO- VCO extracted by cold centrifugation method

by dry method. In this study, the colour of TVCO was slightly yellow and CCVCO was colourless. This yellow colour could be a result of a continued heating process.

Physico-chemical properties of VCOs

Oil recovery

The quantity of oil recovered is dependent on a lot of factors, including the age of coconuts and copra and the time of coconut harvest. Oil recovery provides a quantitative measurement of the effect of different extraction techniques on the quantity of oil produced. Table 2 showed the percentage recovery of VCO extracted by traditional and cold centrifugation processes. From the Table, it is evident that oil recovery was higher in the TVCO.There was a significant difference ($p<0.05$) in the oil recovery of the two samples.Narayanankutty *et al*. (2018) reported that the use of heat can help increase the oil yield. Similarly, Ajogun *et al.* (2020) found that the hot process gave a significantly higher oil recovery of 58%, while the cold process gave 50% oil recovery.

Moisture

The quality of the VCO is significantly influenced by moisture. High moisture content encourages the hydrolytic rancidity of oils. Low moisture content will extend the shelf life by slowing the process of oxidation and rancidity. In this study, the moisture content of the samples revealed that TVCO had the lowest moisture level (Table 2).This might be the result of using a high temperature that significantly removes the water components from the VCO.Ajogun *et al.* (2020) also found that moisture content was low in hot processed VCO (0.05%) than in cold processed VCO (0.07%).

Tocopherol content

Tocopherols are lipid-soluble, natural antioxidants that are mostly present in vegetable oils. It has significant antioxidant activities that prevent lipid peroxidation and reactive oxygen species scavenging (Kumar and Krishna, 2015). According to Ndifa *et al.* (2019), VCO had 2.92 mg to 4.28 mg of tocopherol per 100 g. In this study, the tocopherol content of VCO extracted using traditional and cold centrifugation processes ranged from 17.81 to 26.25 µg/g. There was a significant difference ($p<0.05$) in the tocopherol contents of the two samples. High tocopherol content was obtained from CCVCO

(Table 2). According to Srivastava *et al.* (2016), VCO extracted using the cold method had a higher tocopherol content (27.65 µg/g) than VCO extracted using the hot method (17.87 µg/g).

Total phenol content (TPC)

VCO contains high concentrations of polyphenols. According to Ghani *et al*. (2018), the TPC of VCO extracted using various techniques ranged from 1.16 to 12.4 mg GAE/g. In this study, the TPC in VCOs was observed to be between 7.78 and 8.87 GAE µg/mg(Table 2). There was a significant difference ($p<0.05$) in the total phenol content of TVCO and CCVCO. The variation in phenolic concentration in VCO may be caused by the varied extraction methods. Mulyadi *et al.* (2018) also observed the total phenol concentration in VCOs extracted using various methods and found that the phenol content varied depending on the method used. In this study, the highest concentration of total phenols was found in CCVCO.

Total antioxidant activity

The primary factor affecting the antioxidant activity of VCO is the amount of polyphenols present in VCO. The total antioxidant activity of VCO samples ranged from 17.52 to 25.95 µg/mg (Table 2). There was a significant difference ($p<0.05$) in the total antioxidant activity of the two oil samples. The variation in antioxidant activity among the VCO samples could be the result of the various processing methods. CCVCO showed more antioxidant activity than TVCO. A similar result was noted by Mulyadi *et al.* (2018). They reported that VCO extracted from the dry method showed the lowest antioxidant activity than the wet method because of the destruction of the polyphenols by heat.

Fatty acids

The most predominant fatty acid in VCO is lauric acid, which is followed by myristic, palmitic, capric, stearic, and small amounts of unsaturated fatty acids including oleic and linoleic

Table 3. Fatty acids composition of VCOs

S. No.	Fatty acids	TVCO	CCVCO	t value	APCC standard
1	Caprylic acid (C8 : 0)	7.00	6.58	14.27*	5.00 – 10.0
2	Capric acid (C10 : 0)	5.95	5.83	6.35*	4.50 – 8.00
3	Lauric acid (C12 : 0)	45.14	46.15	67.31*	43.0 – 53.0
4	Myristic acid (C14 : 0)	21.04	17.73	194.74*	16.0 – 21.0
5	Palmitic acid (C16 : 0)	9.20	7.71	111.50*	7.50 – 10.0
6	Stearic acid (C18 : 0)	1.23	ND	NS	2.00 – 4.00
7	Oleic acid (C18 : 1)	9.46	10.83	80.21*	5.00 – 10.00
8	Linoleic acid (C18 : 3)	0.98	ND	NS	1.00 – 2.50

ND- Not Detected; NS – Non Significant; *Significant at 5%; TVCO- VCO extracted by traditional method; CCVCO- VCO extracted by cold centrifugation method

acids. This is seen in Table 3, where the total lauric acid in VCO obtained by various extraction techniques ranged from 45.14% to 46.15%. Mohammed *et al.* (2021) also reported that lauric acid was the predominant fatty acid present in VCO, ranging from 47.95% to 48.83%. A small percentage of stearic acid and linoleic acid were present in TVCO, but not detected in CCVCO.The overall saturated fatty acid (SFA) content of TVCO and CCVCO was 89.56% and 84% while the total unsaturated fatty acid (UFA) ranged from 10.44% to 10.83%. The findings demonstrated that fatty acid content might vary depending on the extraction method used, and cold centrifugation is the best method for obtaining high lauric acid composition.Ghani *et al*. (2018) also pointed out that fatty acid composition may change depending on the extraction methods. Ajogun *et al.* (2020) also found that the fatty acid profile was different in hot processed coconut oil (91.60% SFA and 8.4% UFA) and cold processed oil (90.95% SFA and 9.05% UFA).

CONCLUSIONS

The study intended to evaluate the quality of VCO obtained using traditional and cold centrifugation extraction methods. The findings showed that the quality of VCO was affected by extraction methods. VCO extracted from the traditional method (TVCO) secured the highest mean score in an organoleptic evaluation. There was a significant difference ($p<0.05$) in oil recovery, tocopherol content, total phenol content, total antioxidant activity and fatty acid profile of TVCO and CCVCO. In comparison to traditional and cold centrifugation methods, CCVCO had higher levels of lauric acid, tocopherol, total phenols, and antioxidant activity. The increased levels of lauric acid, tocopherol, polyphenols, and antioxidant activity provide the oil with a significant medical value. As a result, VCO has a great future as a functional oil. The nutritional value of a variety of food products can be improved using it.

REFERENCES

Ajogun, C. O., Achinewhu, S. C., Kiin-Kabari, D. B and Akusu, M. O. 2020. Effect of extraction methods on the physicochemical properties, fatty acid profile and storage stability of virgin coconut oil (*Cocos nucifera*). Asian Food Science Journal. 18(4):27-40.

Dumancas, G. C., Viswanath, L. C. K., De Leon, A. R., Ramasahayam, S., Maples, R., koralege, R. H., Perera, U. D. N., Langford, J., Shakir, A and Castles, S. 2016. Health benefits of virgin coconut oil. In: Holt, B. (Ed.), Vegetable Oil: Properties, Uses and Benefits. Nova Science Publishers, New York. pp. 161-194.

Ghani, N. A. A., Channip, A. A., Chok HweeHwa, P., Ja'afar. F., Yasin, H. M and Usman, A. 2018. Physico-chemical properties, antioxidant capacities, and metal contents of virgin coconut oil produced by wet and dry processes. Food Science and Nutrition. 6(5):1298-1306.

Kalimuthu, M and Dharani, S. 2020. A study on marketing problems faced by coconut producers with special reference to Sulurtaluk. ERPAInternational Journal of Research and Development. 5(11):181-186.

Kumar, P. P and Krishna, A. G. 2015. Physico-chemical characteristics of commercial

coconut oils produced in India. Grasas Aceites. 66(1):62-69.

Mohammed, N. K., Samir, Z. T., Jassim, M. A and Saeed, S. K. 2021. Effect of different extraction methods on physicochemical properties and antioxidant activity of virgin coconut oil. Materials Today: Proceedings. 42(2):2000-2005.

Mulyadi, A. F., Schreiner, M and Dewi, I. A. 2018. Phenolic and volatile compounds, antioxidant activity, and sensory properties of virgin coconut oil: occurrence and their relationship with quality. In: AIP Conference Proceedings. AIP Publishing LLC. 2021(1): 12-19.

Narayanankutty, A., Illam, S. P and Raghavamenon, A. C. 2018. Health impacts of different edible oils prepared from coconut (*Cocos nucifera*): A comprehensive review. Trends in Food Science and Technology. 80:1–7.

Nasir, N. A. M. M., Abllah, Z., Jalaludin, A. A., Shahdan, I. A and Manan, W. N. H. W. A. 2018. Virgin coconut oil and its antimicrobial properties against pathogenic microorganisms. Advances in Health Science Research. 8(2):192-199.

Ndife, J., Obot, D and Abasiekong, K. 2019. Quality evaluation of coconut (*Cocos nucifera L.*) oils produced by different extraction methods. Asian Food Science Journal.8(4):1-10.

Srivastava, Y., Semwal, A. Dand Majumdar, A. 2016. Quantitative and qualitative analysis of bioactive components present in virgin coconut oil. Cogent Food and Agriculture. 2:1-13.

Nivya, E. M., Panjikkaran, S. T., Aneena E. R., Sharon, C. L and Lakshmy, P. S. 2023. Evaluation of qulaity of the virgin coconut oil extracted by traditional and cold centrifugation methods. The Journal of Research ANGRAU. 51(2): 52-58.
DoI: https://doi.org/10.58537/jorangrau.2023.51.2.06

DoI: https://doi.org/10.58537/jorangrau.2023.51.2.07

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STANDARADIZATION OF MEAT ANALOGUES INCORPORATED WITH TENDER JACKFRUIT

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ABSTRACT

The study was carried out for three months during 2021 at Department of Community Science, College of Agriculture, Kerala Agricultural University, Vellanikkara and standardization was done formulating varied treatments of meat analogues followed by organoleptic evaluation in which sensory attributes such as appearance, colour, flavour, taste, texture and overall acceptability of tender jackfruit incorporated cowpea and chickpea meat analogues were evaluated. The results revealed that among different treatments, the treatments T5 (40% CWP+25% TJ +25% WG +5% DSF +5% OMF) and T10 (50% CP+20% TJ+20% WG +5% DSF +5% OMF) were observed to have highest scores for all the sensory attributes including appearance, colour, flavour, texture, taste and overall acceptability of tender jackfruit incorporated meat analogues, respectively. Statistical analysis by applying Kendall's (W) test showed that Kendall's (W) value among different treatments of each set of both tender jackfruit incorporated meat analogues was highly significant with regards to all quality attributes. This study revealed that incorporation of wheat gluten along with tender jackfruit both at 20-25 percent showed improved sensory qualities such as texture, flavour, taste and overall acceptability with higher consumer preference.

Keywords*:* Chickpea, Cowpea, Meat Analogue, Tender Jackfruit, Wheat Gluten

INTRODUCTION

The term "plant-based diets" refers to a variety of eating routines that are higher in plant-based foods like vegetables, fruits, whole grains, legumes, nuts, and seeds and lower in animal products. The majority of the energy and other elements in our diet, including proteins, phytochemicals, and antioxidants, come from vegetarian sources. They are a better option for consuming due to the abundance in vitamins including the vitamin B complex, vitamin C, and other provitamins (Ferreira *et al.,* 2021).

Diet related chronic diseases such as obesity, diabetes, cardiovascular diseases (CVDs) remain to be serious health concerns at community level owing to the widespread changes in diet and lifestyle (Cho *et al.,* 2018).

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Surveys revealed that obesity and overweight as observed in 13 and 39 percent of the global adult population in 2016 are potential risk factors for type- 2 diabetes, cardiovascular diseases and cancer (Cho *et al.,* 2018 and Malik *et al*., 2018). The overall global prevalence of diabetes doubled from 4.7 to 8.5 percent during the timeline of 1980 and 2014 observed more in low and middle income countries (Cho *et al.,* 2018).The estimated percentage of all fatalities attributed to non-communicable diseases (NCDs) has risen from 37.09% in 1990 to 61.8% in 2016, according to the ICMR India State-Level Disease Burden Study. Recent report from the National Family Health Survey (NFHS) of 2015-16 revealed that 15% of men and 11% of women within the years of 15 and 49 suffer hypertension. Also, Hemler and Hu (2019) reported that consumption of processed, unprocessed, and total red meat was linked to 12 percent, 32 percent and 14 percent higher risk for type- 2 diabetes, respectively.

Langelaan *et al.* (2010) reported that major concerns with regard to meat production which include issues regarding the environment, public health and animal welfare. Meta-analyses and large prospective studies in Western countries reveal that total mortality rates are considerably higher in subjects who prefer higher intakes of both red and processed meat (Rohrmann *et al.,* 2013). Meat analogue is a food product that approximates the aesthetic qualities and chemical characteristics of meat. These are made from non-animal proteins and are simulated meat like products with similar texture, flavour, colour, and nutritive value which can be substituted directly for meat to all sections of the society. Different ingredients such as pulses, cereals, nuts, oil seeds, fungi, algae, vegetables could structure one with such characteristics and can be made into one unit within the three dimensional network of the compound (Kumar *et al.,* 2017).

Pulses such as chickpea and cowpea are not only versatile but possess sensory characteristics that could along with other suitable ingredients simulate meat along with contributing to its nutritional profile. Tender jack fruit which is alike to meat in its characteristics, flavour and often used by vegans as meat replacer is a good choice for incorporation into meat analogues.

Indian indigenous plant based food sources such as jackfruit is used in mock-meat products for their meat like flavour (Ragone, 2014). *Artocarpus heterophyllus* (jackfruit) holds a prominent place in dietary use as it is an important source of carbohydrates, protein, fat and micronutrients such as vitamins and minerals due to which it has remarkable antioxidant, anti-inflammatory, antibacterial, anti carcinogenic, anti-fungal, antineoplastic, hypoglycaemicand wound healing properties. Other major ingredients used extensively in the 'meat analogue' industry are soy protein, pea protein, mushrooms, wheat gluten, egg albumen, carrageenan, gums which with suitable production techniques could imitate the sensory properties of meat (Singh *et al*., 2021).

The research aimed at including ingredients such as tender jackfruit, wheat gluten, oyster mushrooms and defatted soy flour and formulating them in different combinations of meat analogues and observing their sensory properties followed by their standardisation.

MATERIALS AND METHODS

Collection of raw materials

Cowpea, chickpea, defatted soy flour, wheat gluten, spices and other ingredients were procured from the local market. Tender jackfruit (*koozha*) was collected from homesteads and oyster mushroom (*Pleurotus florida*) was collected from the Department of Plant Pathology, College of Agriculture, Vellanikkara from which the flour was made as per standard procedures. The research was conducted for a period of three months in the year 2021 at Department of Community Science, College of Agriculture, Kerala Agricultural University, Vellanikkara, beginning from February 2021 which is the prime time for jackfruit tree fruiting.

Preparation of raw materials

Whole pulses such ascowpea and chickpea were washed and roasted for 15 minutes under low to medium flame and soaked in water containing one percent sodium bicarbonate. The raw tender jackfruit were cut and separated from the rind. The flesh within was cut into uniform sized slices followed by blanching for one minute. The blanched pieces were then immersed in lukewarm water with 0.2 percent KMS solution for ten minutes and dried in cabinet drier at 55 ^{o}C to 60 ^{0}C for 12 h. Fresh mushrooms were cleaned and sliced into thin slim strips and blanched in boiling water for two minutes and immersed in cold water for two minutes. The mushrooms were immersed in water containing 0.2 percent potassium metabisulphite and one percent citric acid. These were dried in cabinet drier at 600 C for six to eight hours. Dried materials were powdered and sieved to get uniform flour. The meat analogues were boiled in solution containing 1: 0.4: 0.2: 0.3 of water, salt, turmeric and pepper.

Standardisation of tender jackfruit incorporated meat analogues

Ingredients such as pretreated cowpea, chickpea, wheat gluten, tender jackfruit flour, defatted soy flour and mushroom flour in varied combinations were used for meat analogue preparation. The treatments and their compositions are given in Tables 1 and 2. In this study the 11 treatments were divided into two sets with T0 to T5 using cowpea (CWP), as the first and T6 to T11 using chickpea (CP), as the second set with tender jackfruit (TJ), wheat gluten (WG), oyster mushroom flour (OMF) and defatted soy flour (DSF) as common ingredients with varied proportions corresponding to their respective treatments.

Preparation of meat analogues

After gentle wash, the pretreated pulse was blended with the other ingredients. Later the mass was pressure cooked for 20 minutes at 121 ^{o}C and pressure of 15 psi. After the steam settled, the pressure cooked mass was transferred to a clean cutting board and cut into square shaped, even cubes. These fresh cubes of meat analogues were immersed in the spice broth for 10 minutes and dried in cabinet drier at 65 ^{o}C for 8 h to 12 h (Fig. 1).

Organoleptic evaluation

The meat analogues underwent a series of sensory evaluation by a panel of 20 selected judges using the nine-point hedonic scale. Meat analogues were reconstituted in lukewarm water for 20 minutes. A standard procedure for recipe was followed in which meat was replaced with the reconstituted meat analogues as shown in

Table 1. Proportion of ingredients in tender jackfruit incorporated cowpea meat analogues

S.No.	Treatment	Cowpea (CWP) (%)	Tender jackfruit (TJ) (%)	Wheat gluten (WG) (%)	Defatted soy flour (DSF) (%)	Oyster Mushroom flour (OMF) (%)
1	T0 (Control)	100	-	-	-	-
2	T1	80	5	5	5	5
3	T2	70	10	10	5	5
4	T3	60	15	15	5	5
5	T4	50	20	20	5	5
6	T5	40	25	25	5	5

Table 2. Proportion of ingredients in tender jackfruit incorporated chickpea meat analogues

S.No.	Treatments	Chickpea (CP) (%)	Tender jackfruit (TJ) (%)	Wheat gluten (WG) (%)	Defatted soy flour (DSF) (%)	Oyster Mushroom flour (OMF) (%)
1	T6 (Control)	100	-	-	-	-
2	T7	80	5	5	5	5
3	T8	70	10	10	5	5
4	T9	60	15	15	5	5
5	T10	50	20	20	5	5
6	T11	40	25	25	5	5

Fig. 1. Meat analogues

Fig. 2. Meat analogue curry

Fig. 2. The sensory evaluation was carried out and quality attributes such asappearance, colour, flavour, texture, taste and overall acceptability was evaluated.

RESULTS AND DISCUSSION

The developed fresh meat analogue cubes were soft, springy with distinctive 'pulse' flavour and the cut surface showed defined interconnected inner framework of its ingredients. These dried meat analogues had similar appearance to dried beef with notable rigidity which, when reconstituted, showed regained springiness.

The mean scores obtained for the organoleptic attributes of meat analogues of set I (T0 to T5) are presented in Table 3.The highest total score for set I of meat analogues was seen in the treatment (T5) with a highest total score of 51.62 followed by T4, T3, T2, T1 and T0 with total score of 48.93, 47.10, 46.24, 43.82 and 43.26, respectively. Control T0 (100 percent CWP) had lowest score (7.62) in the attribute appearance and the highest score for appearance was seen in T5 (8.50) of set I. With regards to colour, treatments T1 and T2 ranked the lowest (7.81) with the highest (8.45) score for colour seen in T5 of set I. Treatment T1 had the lowest score in both flavour (7.21) and texture (6.24) while the treatment T5 had the highest scores of flavour (8.53) and texture (8.78) of set I respectively. The control T0 had lowest (7.50) score for taste and the highest (8.55) was observed in T5 of set I, correspondingly. In overall acceptability of different treatments of meat analogues, T0 ranked the lowest (6.54) while T5 of set I ranked the highest (8.81). Treatment T5 was observed to have highest scores for all the sensory attributes including appearance, colour, flavour, texture, taste and overall acceptability. Mean scores obtained for the organoleptic attributes of tender jackfruit incorporated chickpea meat analogues of set II (T6 to T11) are presented (Table 4).

Treatment T10 had the highest total score for set II of tender jackfruit incorporated chickpea meat analogues with highest total score of 51.01 followed by T11, T8, T9, T6 and T7 with total score of 48.25, 45.88, 45.43, 44.35, and 42.43, respectively. The treatment T7 had lowest score (7.36) in the attribute appearance and the highest score (8.64) for appearance was seen in T10 of set II. With regards to the attribute colour, treatment T9 ranked the lowest (7.57) with the highest score (7.85) for colour seen in T10 of set II. Treatment T7 had the lowest score for sensory attributes flavour (6.24) texture (6.40) and taste (7.45) while the treatment T10 of set II had the highest scores of flavour (8.48) texture (8.76) and taste (8.64), respectively. Incase ofoverall acceptability of different treatments of meat analogues, T6 ranked the lowest (7.16) while T10 of set II ranked the highest (8.64) in overall acceptability. Treatment T10 was observed to have highest scores for all the sensory attributes including appearance, colour, flavour, texture, taste and overall acceptability.

Figures in parentheses indicated mean rank scores * - Significant at 5% level in this study, an improvement in texture, flavour, taste and over all acceptability was observed with theincrease in the proportion of wheat gluten and tender jackfruit. Wheat gluten of 20 to 25 percent added better textural properties such as chewiness, elasticity, springiness and flavour retention. According to Cunsolo *et al.* (2012) the components of gluten namely glutenin which

Table 3. Mean scores for the organoleptic qualities of tender jackfruit incorporated cowpea meat analogues – Set I (T0 – T5)

S.No.	Treatment	Appea-rance	Colour	Flav-our	Texture	Taste	Overall accep-tability	Total score
1	**T0**(100% CWP)	7.62 (3.89)	7.93 (5.82)	7.27 (5.29)	6.40 (5.64)	7.50 (5.14)	6.54 (4.79)	43.26
2	**T1** (80%CWP+5%TJ +5% WG+5%DSF +5%OMF)	7.71 (2.89)	7.81 (1.75)	7.21 (1.43)	6.24 (1.93)	7.74 (1.50)	7.11 (2.29)	43.82
3	**T2**(70%CWP+10%TJ +10% WG +5%DSF +5%OMF)	7.71 (3.93)	7.81 (3.11)	7.74 (3.29)	7.62 (2.64)	7.81 (3.18)	7.55 (3.29)	46.24
4	**T3**(60%CWP+5%TJ +5% WG +5%DSF +5%OMF)	7.81 (3.72)	7.86 (4.61)	8.00 (4.36)	7.81 (4.64)	7.76 (4.39)	7.86 (4.21)	47.10
5	**T4**(50%CWP+20%TJ +20% WG +5%DSF +5%OMF)	8.02 (3.29)	7.88 (2.46)	8.11 (2.86)	8.45 (2.79)	8.02 (2.96)	8.45 (2.93)	48.93
6	**T5**(40%CWP+25%TJ +25% WG +5%DSF +5%OMF)	8.50 (3.79)	8.45 (3.25)	8.53 (3.79)	8.78 (3.36)	8.55 (3.82)	8.81 (3.50)	51.62
7	Kendall's value (W)	0.11*	0.67*	0.58*	0.64*	0.49*	0.26*	

CWP – Cowpea, TJ – Tender jackfruit, WG – Wheat gluten, OMF – Oyster mushroom flour, DSF - Defatted soy flour

Figures in parentheses indicate mean rank scores * - Significant at 5% leve

Table 4. Mean scores for the organoleptic qualities of tender jackfruit incorporated chickpea meat analogues – Set II (T6 – T11)

S.No.	Treatment	Appea-rance	Colour	Flav-our	Texture	Taste	Overall accep-tability	Total score
1	T6(100% CP)	7.50	7.78	7.64	6.69	7.57	7.16	44.35
2		(3.89)	(5.82)	(5.29)	(5.64)	(3.82)	(2.93)	
	T7 (80%CP+5%TJ +5%	7.36	7.62	6.24	6.40	7.45	7.36	42.43
	WG +5%DSF +5%OMF)	(3.93)	(1.75)	(1.43)	(1.93)	(1.50)	(2.29)	
3	T8(70%CP+10%TJ +10%	7.45	7.64	7.59	7.78	7.64	7.78	45.88
	WG +5%DSF +5%OMF)	(2.39)	(4.36)	(3.11)	(2.64)	(3.18)	(3.39)	
4	T9 (60%CP+5%TJ +5%	7.69	7.57	7.40	7.40	7.59	7.78	7.78
	WG +5%DSF+5%OMF)	(3.71)	(2.29)	(3.29)	(3.36)	(5.14)	(4.79)	
5	T10(50%CP+20%TJ +20%	8.64	7.85	8.48	8.76	8.64	8.64	51.01
	WG +5%DSF +5%OMF)	(3.79)	(4.61)	(3.79)	(4.64)	(4.39)	(3.50)	
6	T11(40%CP+25%TJ +25%	7.93	7.64	7.78	8.45	7.90	8.55	48.25
	WG +5%DSF +5%OMF)	(3.29)	(2.46)	(2.86)	(2.79)	(2.96)	(3.25)	
7	Kendall's value (W)	0.17*	0.67*	0.58*	0.64*	0.49*	0.27*	

CP – Chickpea, TJ – Tender jackfruit, WG – Wheat gluten, OMF – Oyster mushroom flour , DSF - Defatted soy flour

adds high elasticity and rubbery character that makes the food product resistant to shear along with gliadins that enhance extensibility and product quality. Samtiya *et al.* (2020) reported that addition of optimal gluten could induce properties such as flexibility, gas retention, strengthening, controlled expansion, enhanced water absorption, and increased shelf life to the food product.

Pretreatments and heat processing of tender jackfruit were shown to increase its capacity for water and oil absorption (Odoemelam, 2005). Addition of tender jackfruit shows greater affinity to fat due to its proximate composition which improves the texture and increases the consumer acceptability of the food system to which they were added (Sultana *et al*., 2015). Along with wheat gluten and other ingredients tender jackfruit added to the gumminess and cohesiveness of the meat analogues as textural properties such as its springiness, adhesiveness and chewiness showed inverse proportional relation with maturity (Rana *et al*., 2019), Kang *et al*. (2017) reported that defatted soy flour exhibits improved water retention due to the absence of impediments to water absorption along with variety of other functional properties such as solubility, water and oil absorption capacityas well as emulsifying, swelling, gelling and foaming nature. Pretreated oyster mushroom flour shows better water retention and higher swelling capacity (Maray *et al*., 2018).

CONCLUSIONS

Plant based meat analogues were developed to mimic the sensory characteristics of the meat. The overall acceptability of the best treatments of meat analogues was between 8.55 to 8.81 implying that consumers' preference was between 'like it very much' to 'like it extremely' on a nine- point hedonic scale. These novel meat alternatives have received more attention by food industries and research departments across the globe for their nutritional and functional superiority.

REFERENCES

Cho, N.H., Shaw, J.E., Karuranga, S., Huang, Y., da Rocha Fernandes, J.D., Ohlrogge, A.W and Malanda, B.I.D.F. 2018. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Research and Clinical Practice. 138: 271-281.

Cunsolo V., Muccilli V., Saletti R and Foti, S. 2012. Mass spectrometry in the proteome analysis of mature cereal kernels. Mass Spectrometry Reviews. 31:448–465.

Ferreira, H., Vasconcelos, M., Gil, A. M and Pinto, E. 2021. Benefits of pulse consumption on metabolism and health: A systematic review of randomized controlled trials. Critical Reviews in Food Science and Nutrition. 61(1): 85-96.

Hemler, E.C and Hu, F.B. 2019. Plant-based diets for personal, population, and planetary health. Advances in Nutrition. 10 (4):S275-S283.

International Institute for Population Sciences (IIPS) and ICF. 2021. National Family Health Survey (NFHS-5), India, 2019-21: Mizoram. Mumbai: IIPS. Retrieved from the website on March 23, 2023. (https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf).

Kang, S.W., Rahman, M. S., Kim, A. N., Lee, K. Y., Park, C. Y., Kerr, W. L and Choi, S, G. 2017. Comparative study of the quality characteristics of defatted soy flour treated by supercritical carbon dioxide and organic solvent. Journal of Food Science and Technology. 54(8):2485-2493.

Kumar, P., Chatli, M. K., Mehta, N., Singh, P., Malav, O. P and Verma, A. K. 2017. Meat analogues: health promising sustainable meat substitutes. Critical Reviews in Food Science and Nutrition. 57(5): 923-932.

Langelaan, M.L.P., Boonen, K.J.M., Polak, R.B., Baaijens, F.P.T., Post, M.J and Van der Schaft, D.W.J. 2010. Meet the new meat: Tissue engineered skeletal muscle. Trends in Food Science and Technology. 21: 59–66.

Malik, M. A and Saini, C.S. 2018. Improvement of functional properties of sunflower protein isolates near isoelectric point: Application of heat treatment. LWT-Food Science and Technology. 98: 411-417.

Maray, Ahmed, R. M, Mostafa, K. Mostafa., Alaa El Din, M. A and El Fakhrany. 2018. Effect of pretreatments and drying methods on physico chemical, sensory characteristics and nutritional value of oyster mushroom. Journal of Food Processing and Preservation. 42(1): e13352.

Odoemelam, S. A. 2005. Functional properties of raw and heat processed jackfruit (*Artocarpus heterophyllus*) flour. Pakistan Journal of Nutrition. 4(6):366-370.

Ragone, D. 2014. Breadfruit nutritional value and versatility. Breadfruit Institute of the National Tropical Botanical Garden and Hawaii Homegrown Food Network, State of Hawaii Department of Agriculture. Retrieved from the website (https://hdoa.hawaii.gov/add/files/2014/05/Breadfruit-Nutrition-Fact-Sheet.pdf) on 02.2.2023.

Rana, S. S., Pradhan, R. C and Mishra, S. 2019. Image analysis to quantify the browning in fresh cut tender jackfruit slices. Food Chemistry. 278: 185-189.

Rohrmann, S., Overvad, K., Bueno-de-Mesquita, H. B., Jakobsen, M. U., Egeberg, R., Tjonneland, A., Nailler, L., Boutron-Ruault, M.C., Clavel-Chapelon, F., Krogh, V and Palli, D. 2013. Meat consumption and mortality-results from the European prospective investigation into cancer and nutrition. BioMed Central Medicine. 11(1): 1-12.

Samtiya, M., Aluko, R.E and Dhewa, T. 2020. Plant food anti-nutritional factors and their reduction strategies: an overview. Food Production, Processing and Nutrition (2): 6-7.

Singh, M., Trivedi, N., Enamala, M. K., Kuppam, C., Parikh, P., Nikolova, M. P and Chavali, M. 2021. Plant-based meat analogue (PBMA) as a sustainable food: A concise review. European Food Research and Technology. 247(10): 2499-2526.

Sultana, A., Parvin, R., Alam, M.K., Akter, F and Alim, M.A., 2015. Physico-chemical, functional properties and storage characteristics of jackfruit seed flour. Bangladesh Journal of Veterinary and Animal Sciences. 3(1):20-25.

Nova, H.J.K., Lakshmy, P.S., Seeja, T.P., Sharon, C.L. and Ayyoob, K.C. 2023. Standardization of meat analogues incorporated with tender jackfruit. The Journal of Research ANGRAU. 51(2): https://doi.org/10.58537/jorangrau.2023.51.2.07

DoI: https://doi.org/10.58537/jorangrau.2023.51.2.08

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ACCEPTANCE AND USAGE OF ENERGY-EFFICIENT SOLAR DEVICES BY THE RESIDENTS OF COIMBATORE CITY

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ABSTRACT

The study investigated the usage of energy-efficient solar in regards to demographics of the residents. Data from 400 households in Coimbatore city (that installed minimum of one solar efficient device) was gathered bewtween 2019 and 2020. The magnitude of the energy-efficient solar device acceptability level by the households was calculated. The results revealed that respondents were open to use energy-efficient solar devices. However, devices were unable to be used as alternative sources because of limitations such as their high cost and households' ignorance on the benefits that energy-efficient solar devices can offer. The study revealed that 45.3 percent of households agreed to use energy-efficient solar devices because they are environmentally safe, whereas, 31 percent of the households strongly agreed. The Households that agreed to utilize energy-efficient solar devices to lower their electricity bills were 49.8 percent and 34.8 percent strongly agreed for the same. Only 8.5 percent of households strongly agreed, while 40.5 percent strongly disagreed, that energy-efficient solar devices had extra benefits. Only 8.5 percent of the respondents strongly agreed that they use energy-efficient devices to get benefits from government subsidies, whereas, 32.3 percent strongly disagreed. Only 4.8 percent of the repsondents (out of 38%) strongly agreed that energy-efficient solar devices had diverse applications.

Keywords: Alternative sources, Coimbatore, Energy-efficient, Solar devices

INTRODUCTION

Gorjian and Shukla (2020) reported that solar cells, often known as "photovoltaic cells," are electrical devices that convert solar energy into direct current. Photons are absorbed by these cells when they are exposed to sunlight, which causes an electrical current to start flowing in the device. Solar energy was first put into use practically a few decades ago when researchers were looking for a cost-effective and effective approach to produce electricity by using renewable resources. However, solar

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Fig. 1. Photovoltaic cells

energy continues to be the most productive renewable energy source because it can meet the growing energy needs of a population with rising standards of living.

Patel and Rao (2016) explained that the widespread adoption of innovative technologies such as renewable energy technology depends on social acceptance. The usage solar energy technologyand the implementation of government laws require strong public opinion and participation. Their paper discussed the views of the residents of the villages of Gajner, Kolayat, and Nokha on solar energy technology. The three villages are located close to the Rajasthan town of Bikaner. There were several solar power installations nearby these settlements. The survey adopted a "Qualitative and Quantitative" approach to investigate public opinion and the effects of technology on daily lives of the residents. The research involved a survey of 172 residents of these villages who live close to solar PV power installations. Every respondent was given 14 questions to answer the questionnaire, through personal interviews method. According to this study, 91 percent of the respondents would prefer to install rooftop solar panels to meet their household energy demands, and 91.27 percent of the residents supported the construction of a new solar power plant next to their agricultural fields. Eighty-nine percent of the respondents from these villages said that the power plant offers jobs and electricity to them. However, only 7 percent of respondents felt that solar power plants would not benefit them.

Yuan *et al.*(2011) used a quantitative methodology to look at end users' perceptions of the social acceptance of solar energy technology in Shandong province, China. A n extensive questionnaire survey was carried out. The findings indicated that solar water heaters were widely accepted in society and are known to the general public. However, other uses of solar PV, has not attained a high degree of societal acceptance in Shandong province.

The decision-making process by the Government over the sources of power

generation that will meet the rising energy demand may succeed or fail depending on how well these sources are accepted in the society. This study examined the variables influencing the social acceptance of solar energy in Peninsular Malaysia and conceptualises the circumstances that encourage investor confidence by drawing on research interviews. To examine the societal acceptance of solar energy technology from the viewpoint of users, this research utilised a quantitative methodology. Intriguingly, the findings of the study indicated that many societal levels still have a serious lack of knowledge on solar energy. This study also revealed that the high initial cost of solar panels is pushing people to utilise power produced by burning fuels [Solangi *et al.* (2013)].

Priyaand Antony (2018), reported that it is essential to assess the level of satisfaction of consumers of solar energy products, and they also emphasised how important it is to understand their usage patterns. They highlighted how the Coimbatore city market has a large selection of solar energy goods that are used for a wide range of needs both at home and in society. It is important to consider how satisfied solar energy users are with their purchases. The nature of product was identified and its duration of usage was measured. The respondents were also asked about the frequency and hours of usage of solar energy products. The increase in duration, frequency of usage, implies that the respondents are more informative about the devices. When the respondents were using the products more frequently, it was easy to measure their level of acceptance of devices.

Therefore, the research was conducted to determine the reasons behind consumer acceptance and usage of energy-efficient solar devices among the selected respondents in the city of Coimbatore based on socio-demographic with the aim of identifying the energy-efficient solar devices used by the selected households and creating awareness on additional benefits that solar devices can offer.

MATERIALS AND METHODS

The researcher undertook the study because solar energy has become a popular choice among Coimbatore city residents and because the city has a large number of shops that sell solar products. The sample for the study consisted of 400 households who used at least one solar device. The TEDA (Tamilnadu Energy Development Agency) website (https://teda.in) was used to gather data on the city's solar device consumers in June 2019. Among those who utilised minimum one solar device were 1300 respondents who were already registered with TEDA. To choose the respondents, convenience sampling was used. To collect the data, an interview schedule was developed, and tested and participants wereinterviewed. The data was collected between July 2019 and January 2020. The five-point rating scale was formulated where households had to select the number that represented best the reason behind their acceptance and usage of energy-efficient solar device from the given set of statements which are environmentally safe, reduce electric bills, offer additional benefits, government subsidy and diverse applications. The rating scale was as follows: 1- Strongly disagree, 2- disagree,

Table 1. Socio-demographic features of the selected households (n=400)

S.No.	Socio-demographic profile	Categories	f	Percentage (%)
1	Age (completed years)	25-35	123	30.8
		36-45	122	30.5
		46-55	67	16.8
		56-65	64	16.0
		66-75	24	6.0
2	Gender	Male	189	47.3
		Female	211	52.3
3	Locality	Urban	229	57.3
		Semi-urban	171	42.8
4	Qualification	Illiterate	90	22.5
		School	111	27.8
		Graduate	122	30.5
		Postgraduate	77	19.3
5	Occupation	Full-time homemaker	97	24.3
		Govt. service	40	10.0
		Pvt. Service	92	23.0
		Business	81	20.3
		Retired	45	11.3
		Agriculture	45	11.3

3- Neither Agree nor Disagree, 4- Agree and 5 - Strongly Agree.

RESULTS AND DISCUSSION

The researcher briefly discussed the results after using various statistical methods to evaluate and interpret the data collected. To examine the data, SPSS version 27 was utilized. The outcomes were categorized, collated, and subjected to analysis in accordance with the aim of the research program. The investigator collected data on socio-demographic variables such as age, gender, locality, qualification, and occupation because in social survey these are required to interpret the data (Hoffmeyer and Warner, 2018).

Table 1 interprets that 30.8 percent of the respondents were between the age of 25 and 35, while 30.5 percent of the respondents were between the age of 36 and 45. Only six percent of them fell under the 66–75 year age range. Forty-seven percent of the respondents were male and 53 percent were female. Fifty-seven percent of the respondents lived in

Table 2. Solar devices used by the selected households (n=400)

S. No.	Devices	f	Percentage
1	Solar light	282	71
2	Solar heater	194	49
3	Solar uninterrupted power supply	2	0.5
4	Solar phone charger	3	0.8
5	Solar water pumps	8	2
6	Solar air conditioning	4	1

** Multiple responses Table*

urban locations, and the remaining 43 percent live in semi-urban locations. Because of technology innovations, there are numerous energy -efficient solar devices in the market that has variety of applications, however, households might not be well-infomed of all of them.

A large majority of the respondents (71%) used solar-lights because they are effective in meeting domestic power needs. (Table 2) Only Forty-nine percent of the respondents were using a solar heater, but they reported discontinuation at the time of the survey and stated that solar heater need more space for the panels which they don't have installed. The solar heater was not functional at night, rainy, or foggy days was also the reason for discontinuation. Even though solar devices like solar uninterrupted supply, solar phone chargers, solar water pumps, and solar air conditioning were available on the market, consumers did not prefer them because they cost more to purchase than conventional devices. Anupama and Thilakam (2022) executed a survey to determine consumer satisfaction with energy-efficient solar energy devices. According to their findings, approximately 35 percent of the participants were satisfied with the ease of installation of solar energy devices. Whereas, 47.5 percent of the respondents were satisfied with the easy operation and maintenance of solar devices. Participants expressing satisfaction with the solar device's durability were 44.8 percent. Twenty-four percent of solar device users communicated that they are satisfied with the availability of after-sales services.

It is evident from Table 3 that 45.3 percent of the households agreed to use solar devices. They stated that solar devices are environmentally-safe and contribute to a sustainable future, whereas, 31 percent strongly agreed to utilise solar devices since it is green and lowers carbon footprints. As solar devices can lower electricity bills and save money that can be used for other useful purposes, 49.8 percent of the households agreed to accept solar devices, and 34.8 percent strongly agreed, stating that the solar power system will either reduce or completely waive off the electricity bill. Additionally, investing on solar-powered devices is a one-time investment that will provide them with

Table 3. Acceptance percentage of energy-efficient solar devices by the respondents (n=400)

S.No.	Feature	SDA		DA		NAD		A		SA	
		n	%	n	%	N	%	N	%	n	%
1	Environmentally safe	1	0.3	-	-	94	23.5	181	45.3	124	31
2	Reduce electric bills	9	2.3	3	0.8	50	12.5	199	49.8	139	34.8
3	Offers additional benefits	162	40.5	157	39.3	42	10.5	34	8.5	5	1.3
4	They can avail government subsidy	129	32.3	65	16.3	101	25.3	71	17.8	34	8.5
5	Diverse application	19	4.8	20	5.0	87	21.8	152	38.0	122	30.5

Note: Strongly disagree (SDA), Disagree (DA), Neither agree nor disagree (NAD), Agree (A) and, Strongly (SA)

savings all year long. Only 8.5 percent of the the households agreed that solar devices offered additional benefits. These households claimed that solar devices are dependable as well as beneficial because net metering allows them to sell their excess electricity to the utility company for even lower energy bills.

In contrast, 40.5 percent strongly disagreed with their usage because the energy supply is inconsistent (Table 3). This demonstrates that respondents were unaware of the additional gains of solar devices. Therefore, it is necessary to raise public awareness on the additional benefits of the solar devices. Only 8.5 percent of the respondents strongly agreed that their usage of solar devices was to receive government subsidies, while 32.3 percent strongly disagreed because they never received subsidies even though they applied for subsidies. This demonstrates that despite government efforts to encourage the use of solar technology, people will not adopt it until they are persuaded to do so. Therefore, steps should be taken to help them comprehend the numerous advantages of solar devices so that they will choose to put solar technology in their homes. Only 4.8 percent of the households strongly agreed, and 38 percent agreed that solar energy had diverse applications such as solar distillation, solar drying of agricultural and animal products, solar greenhouse etc (Table 3).

Data was statistically analysed to determine the association between gender and the solar devices. The findings of the gender-specific mean acceptance scores are shown in Table 4.The mean acceptance score for males is 16.83, which is marginally higher than for females (16.20). The difference between the acceptances score of males and females was statistically tested using the following hypotheses, and the results are given below:

H0: The mean acceptance score does not varysubstantially between males and females.

H1: The mean acceptance score varies sub stantially between males and females.

The t-test for equality of means was conducted to test the null hypothesis. The calculated t-value was 2.381, which is higher than the critical value of 1.966 at 5 percent level. Hence, it is inferred that there is a

Table 4. Mean acceptance score of energy efficient solar devices based on gender

S.No.	Gender	n=400	Acceptance of solar energy	
			Mean	S.D
1	Male	189	16.83	2.70
2	Female	211	16.20	2.56
3	Total	400	16.50	2.64

Table 5. t-test for equality of means

S.No.	t	df	Significance
1	2.381	398	*
2	Critical value:		1.966

substantial variation in the mean acceptance scores between male and female respondents. Hence, null hypothesis is rejected. El-Khozenadar *et al*. (2022) set out to assess how well-liked solar-powered cooking equipment is in the Gaza Strip. The respondents' knowledge of using solar cooking equipment, financial status, educational attainment, age, career, and gender are only a few of the factors utilised to assess their social acceptance of solar energy cooking systems. The findings showed that 94.55 percent of the participant's preferred lighting as the best application for solar energy. Only 37.7 percent of the participants favoured using solar energy for cooking. Additionally, it was shown that there was significant gender variation in solar energy use for cooking because the further investigation revealed that that only 19.7 percent the respondents believed that direct solar energy is a suitable method for cooking.

Similarly, the mean acceptability score was determined based on the locality where the respondents were residing. The results are shown in Table 6. Urban areas have a higher mean acceptance score (16.23) than semi-urban areas. The following hypotheses was statistically evaluated to see if there was a variation in the acceptability scores of urban and semi-urban locations. The results are shown below:

H0: The mean acceptance score does not substantially vary among urban and semi-urban locale respondents.

H1: The mean acceptance score substantially varies among urban and semi-urban locale respondents.

The null hypothesis was tested using the t-test for equality of means. The estimated t-value of 2.403 exceeds the critical value at (1.966) the 5 percent level of significance. As a result, it is implied that respondents from urban and semi-urban locales have substantial variation in mean acceptance scores. Hence, the null hypothesis is rejected. Place has an impact on solar energy output because multi-story buildings in cities may block sunlight, but

Table 6. Mean acceptance of solar devices based on locality

S.No.	Locality	n	Acceptance of solar energy	
			Mean	S.D
1	Urban	229	16.23	2.36
2	Semi-urban	171	16.87	2.95
3	Total	400	16.50	2.64

Table 7. t-test for equality of means

S. No.	t	df	Significance
1	2.403	398	*
2	Critical value:		1.966

there are no such buildings in semi-urban locations, where there is ample sunlight. Silva *et al.* (2021) pointed out that site selection is a key step in the construction of a solar power plant. Several essential factors were noted and urged to be considered, including solar radiation, proximity to power lines, weather conditions, etc. As per the study of Silva *et al.* (2021), geographic factors should be considered more importantly in choosing a location to reduce large capital investment.

CONCLUSIONS

Consumers welcomed solar devices because they were renewable energy source, decreased their electricity bill, offered extra benefits, and they could avail government subsidies. It was reported that there is a significant difference between the mean acceptance scores of male and female respondents because the calculated t-value was 2.381, which was higher than the critical value of 1.966 at 5 percent level. Also, there was a significant difference between the mean acceptance scores of solar devices among the respondents from urban and semi-urban locales as the calculated t-value of 2.403 was higher than the critical value at (1.966) 5% level of significance. Respondents' acceptance of solar devices was influenced by their gender and location. The study reported that there was lack of awareness on the diverse application of solar energy. Hence, consumers should be made aware by the manufacturers and dealers by giving education and hands-on experience on solar technology benefits.

REFERENCES

Anupama, C and Thilakam, M. R. 2022. Assessing the satisfaction level of consumers towards energy efficient solar products in Coimbatore city. The Journal of Research ANGRAU. 50 (3): 79-86.

El-Khozenadar, H. J., Khatib, T., Attaee, B and El-Khozondar, R. J. 2022. Assessment of solar e-cookers social acceptance in Gaza Strip. Scientific Reports. 12(1): 1-9.

Gorjian, S and Shukla, A. 2020. Photovoltaic solar energy conversion: technologies, applications and environmental impacts. Academic Press. pp. 27-41.

Hoffmeyer-Zlotnik, J. H and Warner, U. 2018. Sociodemographic questionnaire modules for comparative social surveys. Springer International Publishing. Midtown Manhattan, New York City. pp. 126.

Priya, N. L and Antony, K. 2018. A study to evaluate the solar energy product usage practices and its satisfaction level among the consumers with reference to Coimbatore District, Tamilnadu. South Asian Journal of Marketing & Management Research. 8(1): 11-18

Patel, S and Rao, K. V. S. 2016. Social acceptance of solar energy technology in India. International Conference on Energy Efficient Technologies for Sustainability.Nagercoil, India. pp. 142-147.

Silva, K., Janta, P and Chollacoop, N. 2021. Points of consideration on climate adaptation of solar power plants in Thailand: How climate change affects site selection, construction and operation. Energies. 15(1): 171.

Solangi, K. H., Saidur, R., Luhur, M. R., Aman, M. M., Badarudin, A., Kazi, S. N and Islam, M. R. 2015. Social acceptance of solar energy in Malaysia: users' perspective. Clean Technologies and Environmental Policy. 17(7): 1975-1986.

Tamilnadu Energy Development Agency. 2021. List of empanelled installers. Retrieved from the website (https://teda.in.) on 20.2.2023.

Yuan, X., Zuo, J and Ma, C. 2011. Social acceptance of solar energy technologies in China—End users' perspective. Energy Policy. 39(3): 1031-1036.

Anupama, C and Thilakam, M. R. 2023. Acceptance and use of energy-efficient solar devices by the residents of Coimbatore city.The Journal of Research ANGRAU. 51 (2): 68-76.
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ANTHROPOMETRY ASSESSMENT OF NUTRITIONAL STATUS OF TRIBAL ADOLESCENT GIRLS OF KEONJHAR DISTRICT, ODISHA

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ABSTRACT

This study was conducted in year 2021 -2022 in Keonjhar district of Odisha, in which 45% of the population belongs to tribal community. The study was conducted in five tribal dominated blocks of Keonjhar (Banspal, Keonjhar, Harichandanpur, Joda, Ghatgaon) among 301 adolescent girls aged between 16 and 18 years. The study revealed that the average height of the tribal adolescent girls was 149.82±2.265 cm, body weight was 39.126±0.022 kg and BMI was 17.43351±1.059 kg m^{-2}. The mean weight, height was found to be less than that of 50th percentile of NCHS standards in every age group. Only 20.6% of tribal adolescent girls were found to be within the normal range of BMI value (18.5-22.9 kg m^{-2}) and the rest 79.4% were underweight (< 18.5 kg m^{-2}) category. The research revealed that there was a statistically significant association between number of family members, family income and socio-economic status with BMI. However, no significant association was found in between age and educational qualification of the respondents with BMI value.

Key Words: Adolescent Girls, Anthropometry, BMI, Nutritional Status, Odisha Tribal Girls

INTRODUCTION

Adolescence is one of the most important and vulnerable period of human life in terms of growth, development and maturation. It is a period of gradual transition from childhood to adulthood which normally begins with the onset of signs of puberty and is characterized by important psychological and social changes, along with physiological changes. WHO has defined adolescents as persons aged 10-19 years.Adolescence period is the transitional phase between childhood and adulthood, characterized by rapid increase in height, weight and hormonal changes resulting in sexual maturation. Owing to sudden and special growth taking place in this phase, the nutritional requirement also increases tremendously compared to preceding years of growth. The nutritional status of adolescent girls is particularly important as being the future mothers they shape the nutritional status of future generation and the community at large (Singh *et al*., 2014).

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In a developing country like India, adolescent girls face serious health problems due to socio-economic, environmental conditions, nutrition and gender discrimination. Increased physical activity combined with poor eating habits and the onset of menstruation contributes to accentuating the potential risk for adolescent's poor nutrition. The tribal societies in India are undisputedly considered to be the weakest sections of population in view of common socio-economic and socio-demographic factors such as poverty, illiteracy, lack of developmental facilities, lack of adequate primary health facilities etc. (Nagamani, 2014) and the tribal girls and women suffer from various nutritional and health issues due to inadequate nutritional intake leading to malnutrition, anaemia, early marriage, early and frequent pregnancy and various socio-cultural practices perpetuating the vicious cycle of undernutrition (Sridhar and Gauthami, 2017). Odisha is the home for the largest number of tribal communities (62 tribes including 13 primitive tribes) of India with a population of 9.59 million constituting 22.8% of the state's total population (Govt. of India, 2011) and 9.19 % of the total tribal population of the country. Tribal people are amongst the poorest and most marginalised population groups experiencing extreme levels of health deprivation.

Keonjhar district of Odisha, which was the study locale has nearly half of its total population *i.e.* 818,878 (45.4%) as tribals and is one of the tribal concentrated districts of Odisha. Bhuyan and Juang are the two main tribes of Keonjhar and the other tribes were Bathudi, Bhumij, Gond, Ho, Kharwar, Kisan, Kolha(Kol), Kora, Munda, Oraon, Santal, Saora, Sabar and Sounti. The literacy rate among the tribals in males is 44.06% and tribal female literacy rate is 41.56% in Keonjhar district (Govt. of India, 2011). Although several studies on adolescent health and nutritional status have been carried out in India among the general population, there is a dearth of information pertaining to the health and nutritional status among adolescent girls in tribal populations. Hence, the study was conducted to determine the nutritional and overall health status of the tribal adolescent girls in 2021-22.

MATERIALS AND METHODS

Out of the13 blocks of Keonjhar district, 5 blocks were selected where the tribal population was high namely Banspal, Keonjhar, Harichandanpur, Joda, Ghatgaon. A total of 301 tribal adolescent girls were selected as the respondent and the data was collected in year 2021- 22. Age of the respondents was between 16 and 18 (non-pregnant, non-lactating) years and considered to the nearest whole number. Keeping the objectives of the study in mind, an interview schedule was formulated for recording general and socio-economic information along with anthropometric parameters. Methods of assessment of nutritional status were anthropometric measurement (height (cm), weight (kg) were recorded and Body Mass Index (BMI) was computed. Height of the respondents was measured to the nearest 0.1 cm, using a portable Anthropometry rod. Weight was measured using a digital weighing machine. The respondents were instructed to wear light weight clothes and not to wear foot-wear for more accuracy in weight and height measurement. The formula for Body Mass Index (BMI) prescribed by WHO, weight (kg)/ height (m^2) was used to calculate the Body Mass Index (BMI).Statistical analysis such as arithmetic mean, standard

Table 1. Socio-economic and demographic profile of tribal adolescent girls (n= 301)

S.No.	Variables	Number of Respondents	Percentage (%)
1	2	3	4
1	**Age of the Respondents**		
	16 years	116	38.54
	17 years	112	37.21
	18 years	73	24.25
2	**Type of Family**		
	Joint	56	18.60
	Nuclear	245	81.40
3	**Total Number of Family Members**		
	5 or less	40	13.29
	6 – 7	194	64.45
	More than 7	67	22.26
4	**Educational Status of the Respondent**		
	Illiterate	52	17.2
	Primary (Completed Grade5)	149	49.5
	Upper primary (Completed Grade7)	40	13.29
	Secondary (Class 8 to Class 10)	58	19.27
	Higher Secondary	02	0.6
	Graduation	00	70
5	**Marital Status of the Respondent**		
	Married	74	24.6
	Unmarried	227	75.4
6	**Occupation of the head of the family (Modified Kuppuswamy's SES Scale)**		
	Skilled Agricultural and Fishery Workers	15	4.9
	Craft and Related Trade Workers	51	16.9
	Plant and Machine Operators and Assemblers	25	8.4
	Elementary Occupation	210	69.8
	Unemployed	0	0

Table 1 Contd.

Table 1 Contd...

S.No.	Variables	Number of the Respondents	Percentage (%)
1	2	3	4
7	**Total Monthly Family Income (Rs.)**		
	Less than Rs. 5000	0	0
	In between Rs. 5001 – Rs 8000	205	68.1
	In between Rs. 8001 – Rs 10,000	79	26.25
	More than Rs. 10,000	17	5.65
8	**Kuppuswamy's Socio-Economic Status**		
	Upper (I)	0	0
	Upper Middle (II)	0	0
	Lower Middle (III)	0	0
	Upper Lower (IV)	107	35.55
	Lower (V)	194	64.45

deviation, percent distribution, and chi-square test of individuals according to different variables. Chi square test was used to evaluate the statistical significance between the variables.

RESULTS AND DISCUSSION

Table 1 depicts the demographic profile of the respondents who fell under different category of age groups, type of family, number of members in family, monthly family income, educational status, marital status of the respondents. Socio – economic details of family members were assessed by using Modified Kuppuswamy's SES Scale (Saleem, 2020). All the respondents belonged to Hindu households.

A total of 81.4% of the respondents were from nuclear or extended families and 18.6% belonged to joint families which showed the decreasing joint family system among the tribal population. Similar results were reported by Nanda and Dhar (2017), Santhanam and Maheswari (2022). Highest number of respondents were of 16 years age (38.54%) and the mean age was 16.85 years. Majority of the respondents (64.45%) had 6-7 members in the family and 22.26% had more than 7 members in their family. Santhanamand Maheswari (2022) reported that majority (51%) of household had family members in between 5 – 7. Nanda and Dhar (2017) in their study on nutritional status of adolescent girls of Dongria Kondh tribe found that the 70.97% households had 7-9 members in the family.

A total of 49.5% of the tribal adolescent girls had education up to primary level, 13.29 % had educational qualification up to upper primary and 19.27% had secondary education. 17.2% of the respondents were illiterate. As per the Census

of India (2011), Keonjhar district had tribal female literacy rate of 41.56% with a gender gap of 22.5. Odisha Economic Survey 2019-20 indicated that the enrolment percentage of tribal girls in elementary education is decreasing year by year since 2016-17.Santhanam and Maheswari (2019) reported that the same type of result *i.e.*, majority 51% of the respondents had education till middle school. Sridhar and Gauthami (2017) in their study reported that majority of the subjects (41.2%) had education up to primary school, 22.8% less than primary school, 6.4% up-to high school and 25.9% were illiterates.Financial issues, negative attitude of parents who were themselves illiterate, early age marriage, linguistic barriers, unwillingness of parents to spare the labour force and allow the girl child to school for education are some of the reasons for low enrolment rate and high dropout rates of tribal girls.In context of marital status, 24.6% of the respondents were married and 75.4% were unmarried and the mean age of married tribal adolescent girls was found to be 17.2 years. Sridhar and Gauthami (2017) reported that 41.4% of the respondents had conception by the age of 17. Early age marriage is one of the major causes for malnutrition, anaemia, maternal and neonatal mortality among the females.

Majority (69.8%) of the respondents were from the household where the head of the family had elementary occupation (agricultural labours, labours, collection of forest amenities, marginal farmers). Fathers of 8.4% of respondents worked in the mining factories. 16.9% respondents' family head was engaged in trade of local alcoholic drink known as 'Handia', and goat, poultry farming utilising the poverty funds provided by the Government. Only 4.9% respondents were from the family where the head of family were skilled agricultural farmer. Jana and Ghosh (2015) in their study on socio-economic conditions and quality of life in the tribal areas of Orissa with special reference to Mayurbhanj District found that the majority of the tribals (Mean 48.3) were earning their livelihood as agricultural labourer followed by other workers.

Two-third of the respondent's family had monthly income in between Rs. 5000 – 8000 per month and only 5.65% family had monthly income more than Rs.10,000. Devi and Patil (2019) found that 31.2% of the tribals had monthly income in-between Rs.5000 – Rs.10,000. Mallick *et al.* (2021) in their study on the living standards of the Kandha people in Kandhamal District of Odisha reported that majority (29.25%) of the tribal household had a monthly income in between Rs. 5000 – 7000. Illiteracy, geographical isolation, ignorance about using modern techniques makes the tribal economy still marginalised.George *et al.* (2022) in their study found that 32.2% of the respondent's parents had monthly income between Rs.4810 and Rs. 8009. Modified Kuppuswamy's SES Scale (Saleem,2020) revealed that 64.45% of the respondents' family belonged to lower socio-economic group and 35.55% belonged to upper-lower socio-economic group and lacked all the basic household amenities.

The age-wise mean weight of the respondents was calculated and was found to be 39.33 kg, 38.95 kg and 39.06 kg for 16, 17 and 18 years of tribal adolescent girls, respectively. There was a mild decline in average weight from 16 to 17 years and again an increasing trend was observed from 17 to 18 years of respondents. The mean weight was

Table2. Mean weight and height of the respondents compared with NCHS standards

S.No.	Age in years	N	%	Weight (in kg)			Height (in cm)		
				Mean	SD	NCHS (50th percentile) weight in kg	Mean	SD	NCHS (50th percentile) height in cm
1	2	3	4	5	6	7	8	9	10
1	16	116	38.54	39.336	±2.067	54	149.612	±2.332	162.5
2	17	112	37.21	38.955	±2.483	55.3	149.973	±2.295	163
3	18	73	24.25	39.068	±2.562	56.2	149.931	±2.518	163.2
4	Total	301	100	39.126	±0.022		149.82	±2.265	

found to be less than that of 50th percentile of NCHS standards in every age group. Sridhar and Gauthami (2017), Singh and Mondal (2014)reported similar findings among the tribal adolescent girls of various parts of India. Das and Gautam (2022) in their research found the mean body weight of 16, 17 and 18 years of Dongria Kondh adolescent girls of Niyamgiri Hills of Odisha, 42.6±4.6, 43.0±4.2 and 45.1±4.6 respectively which was significantly lower than 50th percentile of NCHS standards.

The age-wise mean height of the tribal adolescent girls was calculated and was found to be 149.61±2.332 cm, 149.97±2.295 cm and 149.93±2.518 cm for 16, 17 and 18 years of respondents respectively. There was a mild increasing trend age-wise but was negligible. The mean height was found to be less than that of 50th percentile of NCHS standards in every age group. Stunting (low height for age) resulted from prolonged nutritional deficiency since early life of the child. Much lower height for age as compared to NCHs 50th percentile was also observed by Singh *et al.* (2014), Santhanam and Maheswari (2022), Singh and Mondal (2014) in their studies. George *et al.* (2022) found the mean and standard deviation of height as 150.8±6.2 cm which suggested stunting among the adolescent tribal girls of Namkum block of Jharkhand. Banik *et al.* (2016) in their study among the children and adolescents of Limbu and Mech tribal communities of West Bengal reported that the mean height of 16 – 18 years old adolescent girls were 149.27±4.50cm and 153.04±5.66cm.UNICEF (2016) has reported that significant number of children in India were suffering from stunting. Nutritional stress in early period of life is the major cause of retarded growth leading to stunting and thinning. The respondents of all the three-age groups had significantly lower height and weight as per the age. The burden of physical work pressure, prolonged scarcity of nutritionally adequate food,

Table 3. BMI of the tribal adolescent girls (n = 301)

S. No.	Age in years	N	%	BMI	
				Mean	SD
	1	2	3	4	5
1	16	116	38.54	17.574	±1.013
2	17	112	37.21	17.323	±1.100
3	18	73	24.25	17.379	±1.057
4	Total	301	100	17.43351	±1.059

lack of awareness, poverty led to the problem of stunting and thinning among the adolescent girls.

BMI calculation is the best set of measurement found to be simple and useful indicator for nutritional status of adolescents. Body Mass Index was calculated by using the height and weight of the respondents. The mean BMI for 16, 17 and 18 years of tribal adolescent girls were found to be 17.57±1.013, 17.32±1.100 and 17.37±1.057 respectively and total average was 17.43±1.059. Prevalence of undernutrition in all age group was found to be high resulting in growth retardation, stunting, thinning among the tribal adolescent girls. From the research of Varoda *et al.* (2020), it was found that the mean BMI of Baiga tribal adolescent girls in Chhattisgarh District was 18.2, 17.9 and 18.0 respectively for 16, 17 and 18 years of respondents. Sinha (2014) in her study nutritional profile of tribal adolescent girls of Ranchi district

Table 4. Distribution of respondents based on BMI (n = 301)

S. No.	NIH and WHO Grade of Malnutrition BMI (kg m^{-2})	f	%	Asian- Indian Specific Guidelines BMI (kg m^{-2})	f	%
	1	2	3	4	5	6
1	<16.5 - Severely underweight	70	23.25	< 18.5 - Underweight	239	79.4
2	<18.5 - Underweight	169	56.15	18.5 – 22.9 Normal	62	20.6
3	18.5 - 24.9 - Normal weight	62	20.6	>23 – 24.9 Overweight	0	0
4	25 - 29.9 – Overweight	0	0	>25 Obesity	0	0
5	>30 - Obesity	0	0	-		

of Jharkhand found the mean BMI of the tribal adolescent girls was 17.09±2.54. However,Singh and Mondal (2014) in their study among the adolescents (belonged to Mongoloid tribal population) of Assam reported the mean BMI for girls of age 16, 17 and 18 years as 19.84±1.43, 20.27±1.64 and 20.69±1.04, respectively. Like a silent emergency, malnutrition, particularly undernutrition continues to be a major public health issue in India among the children and adolescents. Adolescence period is possibly less vulnerable to infection than a younger age and is commonly regarded as a relatively healthy period of the life cycle leading to, they being somewhat neglected. The vicious cycle of poverty, intergenerational malnutrition and chronic disease among the tribal adolescent girls can be interrupted by nutritional intervention.

Out of the 301 tribal adolescent girls studied, as per WHO grade of malnutrition cut off, 23.25% were severely underweight, 56.15 % of respondents were underweight and 20.6% were within normal range of BMI. As per Asian Indian specific guidelines for defining and managing overweight and obesity (2004), 79.4% of the respondents were underweight and 20.6% were having normal BMI. Ravula *et al*. (2017) in their research of adolescent girls of tribal regions of Telangana reported that 54% of the respondents of late adolescence and 82% of the respondents from early adolescence were suffering from undernutrition. Pandurangi *et al*. (2022) in their study reported that most of the adolescent were suffering from double burden of malnutrition in terms of stunting and thinning.

Table 5 depicts the association between different socio-economic variables with BMI of the tribal adolescent girls of Keonjhar district. Chi square test for correlation was carried out to know the association. No association was found in between the Kuppuswamy's Socio-Economic Status of the family, age and educational qualification of the respondents with BMI value. But a statistically significant association was found between number of family members of the respondents and total monthly income of the family with the BMI value of the respondents ($p < 0.05$). The incidence of under-nutrition was found to be more with the increase in the number of family members. With scare resources, the quantity and quality of food consumed were low with increase in number of members in family. Similarly, the respondents belonging to the family with more monthly income were found to have better BMI status than those who belonged to the family with less monthly income. Monthly income was one or have only the most significant determinants in terms of access, afford and availability of adequate food. Education serves as a key factor in development of any person/ community. As majority of the respondents were either illiterate or have only primary education, they hardly had any knowledge about the importance of balance diet, or requirements of proper nutrition for a healthy leaving. Parents educational qualification, occupational status and amount of monthly income serves as the most important determinant in the nutritional status of the children. Type of occupation of the parents/ head of the family leads to purchasing power of the family, leading to consumption of amount and type of food and ultimately nutritional status. A total of 69.8% of the respondents' fathers were engaged in the elementary jobs *i.e*. daily wage labours, agricultural/ mining labours, collection of forest products which leads very low income and purchasing power. Access to food, availability

Table 5. Association of different socio-economic variables with BMI (n= 301)

S.No.	Variables	BMI					Chi-Square value	p-value
		Under Weight (%)	Normal (%)	Over Weight (%)	Obese (%)	Total		
		<18.5	18.5-22.9	23-24.9	>25			
1	2	3	4	5	6	7	8	9
1	**Age (Years)**						**2.805**	**0.83**
	16	87	29	0	0	116		
	17	90	22	0	0	112		
	18	62	11	0	0	73		
2	**Education**						**2.153**	**0.999**
	Illiterate	41	11	0	0	52		
	Primary (Completed Class 5)	117	32	0	0	149		
	Upper primary (Completed Class 7)	31	09	0	0	40		
	Secondary (Class 8 to Class 10)	49	09	0	0	60		
	Higher Secondary	01	01	0	0	02		
3	**Total Number of Family Members**						**21.655***	**0.0014**
	5 or less	22	18	0	0	40		
	6 – 7	155	39	0	0	194		
	More than 7	62	05	0	0	67		
4	**Total Monthly Family Income**						**59.592***	**0.000**
	Less than Rs. 5000	0	0	0	0	0		
	In between Rs. 5001 – Rs. 8000	184	18	0	0	202		
	In between Rs. 8001 – Rs. 10,000	49	31	0	0	80		
	Rs.10,000	06	13	0	0	19		

Table 5 Contd...

Table 5 Contd...

S.No.	Variables	BMI					X2 Chi-Square value	p-value
		Under Weight (%)	Normal (%)	Over Weight (%)	Obese (%)	Total		
		<18.5	18.5-22.9	23-24.9	>25			
1	2	3	4	5	6	7	8	9
5	**Kuppuswamy's Socio-Economic Status**						**6.477**	**0.371**
	Upper (I)	0	0	0	0	0		
	Upper Middle (II)	0	0	0	0	0		
	Lower Middle (III)	0	0	0	0	0		
	Upper Lower (IV)	118	44	0	0	162		
	Lower (V)	121	18	0	0	139		

Chi square value p<0.05, significant

of medical facility, availability of food throughout the year, care given to the children, etc were important determinants in shaping the health and nutritional status of the children and adolescents (Khan and Raza, 2014). Baliga *et al.* (2014), Kshatriya and Acharya (2016), Banik*et al.* (2016), Kuiti *et al.*(2022) in their respective studies suggested that various socio-economic determinants such as literacy, type of occupation, total family income, family size were directly associated with the overall nutritional status of tribal adolescent girls and significant association between type of family, size of land holdings and occupation type of parents with the nutritional status of the adolescent girls.

CONCLUSIONS

The nutritional status of tribal adolescent girls (16 – 18 years) of Keonjhar district of Odisha was low.The mean BMI was 17.43351 ±1.059. Stunting, thinning was prevalent and age-wise height and weight was found to be less than that of 50th percentile of NCHS standards. Adolescence is a period of rapid growth and girls reach their peak stage of growth during this period. However, the problems such as illiteracy, poverty, ignorance, geographical isolation, large family size, unavailability of basic healthcare facilities, etc. have made the tribal adolescent girls vulnerable to malnutrition, anaemia and other nutrition related problems.

REFERENCES

Baliga, S.S., Naik, V.A and Mallapur, M.D. 2014. Nutritional status of adolescent girls residing in rural area: A community-based cross-sectional study. Journal of the Scientific Society. 41:22-5.

Banik,S.D., Bhattacharjee, P and Mukhopadhyay, B. 2016. Low height-for-age among Limbu and Mech children and adolescents from

two districts of West Bengal, India. Epidemiology Biostatistics and Public Health. 13 (4): e12082-1-12. DOI: 10.2427/ 12082

Das, D and Gautam, R.K. 2022. Growth and nutritional status among adolescents of Dongria Kondh- A PVTG of Niyamgiri Hills of Odisha, India. Human Biology Review. 11(1): 54-65.

Devi, S.K and Palit, S. 2019. Assessing the perpetuity of tribe indebtedness: An empirical analysis. Academic Journal of Interdisciplinary Studies. 8(2):102. DOI: 10.5901/ajis.2019.v8n2r

George, L., D'Souza, S. R. B and Sequira, L. 2022. A study to determine the nutritional status, quality of life and explore the epidemiological factors affecting nutrition among young adolescent tribal girls of Namkum block, Jharkhand: A mixed method study. Available at SSRN: https://ssrn.com/ abstract=4090269 or http://dx.doi.org/ 10.2139/ssrn.4090269. (Retrieved on (01.01.2023).

Jana, N. C and Ghosh, P. K. 2015. Socio-economic conditions and quality of life in the tribal areas of Orissa with special reference to Mayurbhanj district. Space and Culture, India. 3(2): 25–41. https:// doi.org/10.20896/saci.v3i2.145

Khan, R.E.A and Raza, M.A. 2014. Nutritional status of children in Bangladesh: Measuring Composite Index of Anthropometric Failure (CIAF) and its determinants. Pakistan Journal of Commerce and Social Sciences. 8 (1): 11-23.

Kshatriya, G.K and Acharya, S.K. 2016. Gender disparities in the prevalence of undernutrition and the higher risk among the young women of Indian tribes. PLOS ONE. 11(7): e0158308. https://doi.org/ 10.1371/journal.pone.0158308

Kuiti, B. K., Acharya, S., Satapathy, K. C., Barik, D. K and Patra, P. K. 2022. Composite Index of Anthropometric Failure (CIAF) among Juang children and adolescents of Keonjhar district in Odisha, India. Man, Environment and Society. 3(1): 133-154. DOI: 10.47509/ MES.2022.v03i01.10

Mallick, M., Khatua, P and Swain, R. N. 2021. An analysis of the living standards of the Kandha people in Kandhamal district of Odisha. International Journal of Economic Perspectives.15(1): 249–264.

Nagamani, G. 2014. Clinical nutritional status of Indian girls in deprived and disadvantaged communities: A special reference to select macro and micro nutrients. Global Journal for Research Analysis. 3(2):60-61.

Nanda, S and Dhar, R.N. 2017. A study on nutritional status of adolescent girls of Dongria Kondh tribe. International Journal of Community Medicine and Public Health. 4:1573-6.

Pandurangi, R., Mummadi, M.K., Challa, S., Reddy, N.S., Kaliaperumal, V., Khadar Babu, C., Telikicherla, U.R., Pullakandham, R., Geddam, J.J.BandHemalatha, R. 2022. Burden and predictors of malnutrition among Indian adolescents (10-19 Years): Insights from comprehensive national nutrition survey data. Front Public Health.

15(10):877073. DOI: 10.3389/fpubh.2022.877073. PMID: 35784251; PMCID: PMC9240318

Ravula, P., Pramanik, S., Kasala, K and Selvaraj, A. 2017. Nutritional dynamics of adolescent girls in selected tribal regions of Telangana, India. Nutri-Food Basket Project, ICRISAT.

Saleem, S.M. 2020. Modified Kuppuswamy socio-economic scale updated for the year 2020. Indian Journal of Forensic and Community Medicine.7(1):15-21.

Santhanam, G and Maheswari, K. 2022. Socio-demographic profile of the selected scheduled tribe adolescent girls in Kodaikanal-Tamil Nadu. International Journal of Food and Nutritional Sciences. 11:126-132. Dol: 10.4103/ijfans_186_22

Singh, H.S., Ghritlahre, Mand Das, S. 2014. Nutritional status among females of Bhaina tribe of Bilaspur, Chhattisgarh, India: An Anthropological Insight. Journal of Anthropology. Volume 2014: 1-7. https://doi.org/10.1155/2014/897893. Dol: 10.1155/2014/897893

Singh, J and Mondal, N. 2014. Use of upper-arm anthropometry as measure of body-composition and nutritional assessment in children and adolescents (6-20 years) of Assam, northeast India. Ethiopian Journal of Health Sciences. 24(3):243-253. Dol: http://dx.doi.org/10.4314/ejhs.v24i3.8

Sridhar, Dand Gauthami, N. 2017. Nutritional status of adolescent tribal girls: A community-based study. MedPulse International Journal of Community Medicine. 4(1): 01-04.

Varoda, A., Venugopal, R and Chakravarty, M. 2020.Growth and nutritional status of the Baiga adolescent girls - A primitive tribe of Chhattisgarh, India. Indian Journal of Physical Anthropology and Human Genetics. 39 (2): 109-117.

WHO Expert Consultation. 2004. Appropriate body-mass index for Asian population and its implications for policy and intervention strategies. Lancet (London, England). 363(9403): 157–163. https://doi.org/10.1016/S0140-6736(03)15268-3

Vijayeta, P and Biswal, G. 2023. Anthropometry assessment of nutritional status of tribal adolescent girls of Keonjhar District, Odisha. The Journal of Research ANGRAU. 51(2): 77-88. https://doi.org/10.58537/jorangrau.2023.51.2.09

DoI: https://doi.org/10.58537/jorangrau.2023.51.1.10

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FEASIBILITY OF DEVELOPING BANANA-COTTON FABRIC AS A SUSTAINABLE TEXTILE

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ABSTRACT

Agro-based fibres for textiles are trying to substitute conventional fibres in some form as blending with other fibres or by themselves. Studies showed that fibres from banana pseudostem possess beneficial qualities that can be used for textiles. They are to be treated to carry out the spinning process and woven into a fabric as they possess considerable stiffness. Banana-cotton mixture or blended fabric is most suitable because both are cellulose in nature, and blending can be done homogeneously. The biodegradability of banana fibres and its availability as an agro waste can be considered as a sustainable source for textiles. This study conducted in the year 2019 attempted to find out the feasibility of using banana fibre to produce yarn and then weave it into fabric in an eco-friendly process. The woven material was evaluated for its physical properties. This could further be used for different end uses, can be produced on a larger scale and provide scope for the development of rural employment.

Keywords: Agro-waste, Banana fabric, Banana fibre, Banana pseudostem, Eco fabric, Natural fibre

INTRODUCTION

India has abundant sources of natural fibre. There is plenty of scopes to explore and use natural fibres in traditional methods and provide to the consumers' needs (Pappu *et al.*, 2015). The potential of utilizing non-conventional fibres from nature on a regular basis needs to be studied.

Banana fibres being agricultural residues, have the advantage over others. Banana as a fruit crop is called kalpatharu. It belongs to *the Musa* family, particularly *M. acuminate* (Sucharita and Vasugi, 2018).

In the banana plant, after fruits are harvested, a large quantity of pseudostem, leaves and suckers are generated (Vigneswaran *et al*., 2015). Pseudostem of banana that provides fibre are usually disposed of as waste after banana cultivation. Banana fibres are biodegradable, and being natural fibres, products made from them are in demand in the market at the global level. They are non-toxic,

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and their production does not affect man or the environment. At present, banana fibres are used for making handicraft products in the cottage industry. In countries such as Japan and Nepal, banana fibres are used in making textile products and accessories. Most research is being done on developing woven fabric and non-woven composites from banana pseudostem fibres. Banana fibre is a natural fibre with high mechanical properties which can be blended easily with various other fibres or materials (Ramachandran *et al*., 2016). Banana fibres are available year-round and also affordable. This creates good market potential and has scope for export. In India, products from banana fibre are made on a small scale though being one of the largest banana producers. The potential of banana pseudostem fibre has not been fully utilized despite its abundant availability. The use of this fibre in textiles is limited in application as it has high stiffness and less spin ability. The fibres obtained from banana pseudostem need to be softened to produce yarn. Generally, chemicals are used to treat and soften them to spin or blend into a yarn, which is not eco-friendly. Hence an eco-friendly method of treating the banana fibre into a fabric should be followed for the fabric to be eco-friendly and sustainable. This will help generate farmer income, provide better opportunities, and develop agro-based rural industries.

MATERIALS AND METHODS

Selection of fibre

Banana fibre has emerged as a new eco-friendly fibre since it is produced from banana pseudostem, as a waste material after harvesting the banana fruit as an agricultural residue (Ortega *et al*., 2016). Banana fibre can be spun to produce yarns, mixed or not mixed with other fibres. Banana fibres are used in building materials and also in textile materials (Vinoth *et al*., 2018). The fibres are longer, have tensile strength and can provide more yarns. These fibres can be blended with other natural or synthetic fibres (Sarma and Deka, 2016). This study was conducted in the year 2019 attempted to weave fabric using yarn made from banana fibres. Bananas being an all-season crop, produce a considerable mass of pseudostem waste throughout the year, providing a regular supply of raw material for fabric production. Cotton is versatile in nature; its appearance, performance and comfort properties make it an important fabric in our daily life. It can be blended with many other fibres and contribute to the characteristics of the blended yarns and fabrics. Cotton and banana yarn were used for the study. Banana pseudostem fibres are biodegradable and thus can be categorized as environment-friendly. Banana pseudostem fibre can be spun using almost any method of spinning (Subagyo and Chafidz, 2018).

Softening of Banana fibres

Banana fibres were extracted from pseudostem by hand as per the procedure suggested by Sucharita and Vasugi (2018). Banana fibres extracted from pseudostem contain pectin and hemicelluloses. After extraction, degumming banana fibres is essential for the removal of gummy materials that are non-cellulosic. The degummed fibres were dried well to remove moisture (Sarma and Deka, 2016). The fibres have limited use in textiles because of their high stiffness and less cohesive properties. Banana fibres treated with chemicals such as alkali and peroxide show considerable weight loss (Doshi and Karolia, 2016).

Figure 1a. Hand-spun banana yarn

Figure 1b. Fabric -1 (F1)

Figure 1c. Fabric -2 (F2)

Treating fibres with a high concentration of caustic soda resulted in fibre damage and further led to shrinkage in length (Subashini *et al*., 2020). The banana fibres softened with castor oil, cotton seed oil and soap reduce their flexural rigidity (Tholkappiyan, 2016). Banana fibres need to be treated to reduce their stiffness. First, the fibres were rinsed in water and boiled for five minutes. Then the fibre was softened by boiling in five per cent castor oil and a few drops of wetting agent for one hour. The material liquor ratio of 1:20 was followed. The treated fibres were rinsed in a non-ionic soap solution and again boiled in water for five minutes. The treated fibres were then dried completely under shade.

Weaving of Banana fabric

Spinning Banana Fibres: The treated and dried fibres were loosened and cut into small lengths of about five inches, arranged parallelly

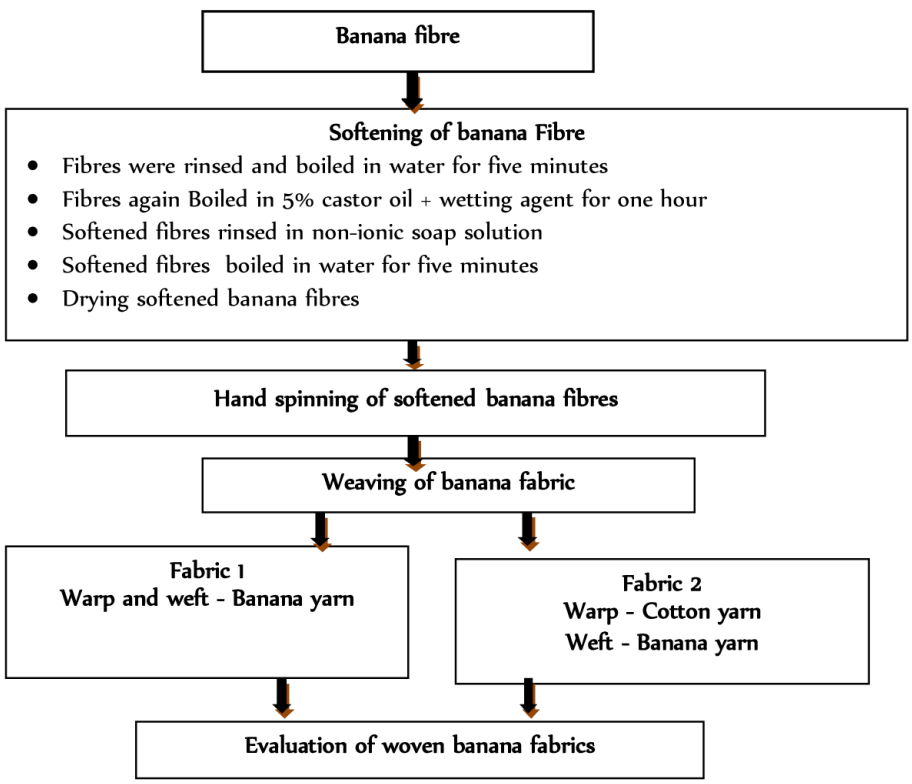

Figure 2. Flow chart depicting softening banana fibre to banana fabric weaving

and spun manually. The spun yarn was tested for its Yarn strength and elongation using IS: 1670:1991 standards and Yarn twist using IS 832: 1985. The yarn strength tests were carried out in Textile Committee, Coimbatore.

Weaving banana yarn to fabric: The hand-spun banana yarn was then woven into fabric. Banana-cotton mixed fabric weaving was carried in handloom. Two fabrics were produced, namely Fabric one (F1) and Fabric 2 (F2). F1 was made with 100% banana yarn in both warp and weft direction, and F2 was a cotton banana mixture fabric with banana yarn in the weft and cotton yarn in the warp. Cotton yarn used for weft is 20s/2 count yarn with an S twist. The woven fabrics were then evaluated for their properties.

Evaluation of mechanical properties of softened banana fibre

Untreated and softened banana fibres were tested for single-fibre tensile strength and elongation per cent. The fibres were tested at standardized conditions of 21°± 1ºC temperature and 65% ± 2% relative humidity. The test was done in SITRA, Coimbatore, using a Zwick roell strength testing instrument with 1kN load, gauge length of 50 mm and a speed of 10 mm/min.

Analysis of woven fabrics

Physical and mechanical properties of banana fabric: Woven banana fabric was analyzed for its thickness, count and strength. The thickness of the fabric was measured with a thickness tester using ASTM-D1777-96 (2015) test method. The fabric was stretched out on the flat area below the pressure foot without wrinkles and face side up. Pressure was applied on the test fabric for 5 to 6 seconds until full pressure was reached, and then the thickness was recorded in mm. The thickness of the fabrics was noted at different points, and the average was calculated.

Fabric count is the determination of the number of threads or ends, and picks per unit length of the fabric are very important for the analysis of the fabric. The fabric count was done using pick glass. The tensile strength of the fabrics was tested following ISO 13934-1-2013 standards. It is evaluated by stretching the test samples to their breaking point.

Absorbency test: The absorbency test was conducted to measure the time taken by the fabric to absorb a drop of water. The absorption of the droplet by the fabric varies according to the thickness of the fabric. The drop

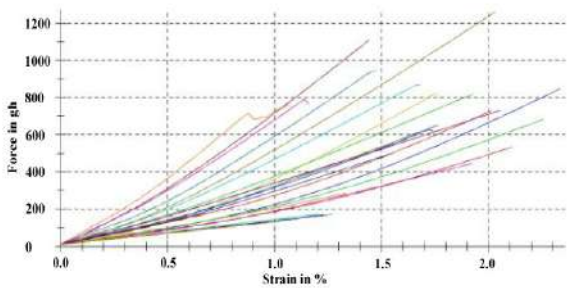

Figure 3. Breaking Strength Graph for raw banana fibre

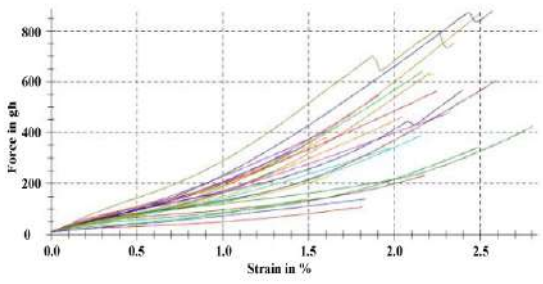

Figure 4. Breaking Strength Graph for treated banana fibre

test was carried out according to AATCC Test Method 79-1995.

RESULTS AND DISCUSSION

Mechanical properties of banana fibre

Single fibre strength was carried out for banana fibres. The strength of the treated fibres had a significant decrease when compared to raw fibre. The softening treatment has reduced fibre strength by twenty-five per cent. The graph of strain% for breaking strength of raw and treated fibres are given in figure 3 and figure 4.

The results of the mechanical properties of banana fibres are presented in Table 1. The mean elongation of the softened fibres had increased. This could be due to the oil, which had softened the fibre. The tenacity of softened fibre has increased as a result of an increase in fineness. There is an improvement in fibre fineness after the softening process. The fineness had increased by around twelve per cent. Earlier studies showed that the chemical treatment of banana fibre changed from 140 Denier to 90 Denier (Tholkappiyan, 2016)

From the above table, t-test analysis shows significance at a 1% level for breaking strength, breaking elongation % and fibre fineness between raw and softened banana fibre. This

Table 1. Mechanical properties of raw and softened banana fibre

S.No.	Properties Samples	Mean Breaking Strength(gf)	Mean Breaking Elongation %	Tenacity (g/den)	Fibre Fineness (Denier)
1.	Raw Fibre	598	1.6	1.54	387
2.	Fibre treated with Castor oil	441	2.0	1.75	252

Table 2. Statistical analysis for mechanical properties of raw and softened banana fibre

S.No.	Variable	Mean	SD	SE	T-value	Sig	
1.	Mean Breaking Strength (gf)	Raw Fibre	598.0	1.58	.71	157.0	.004*
		Fibre treated with Castor oil	441.0	1.58	.71		
2.	Mean Breaking Elongation %	Raw Fibre	1.6	.16	.07	-4.0	.004*
		Fibre treated with Castor oil	2.0	.16	.07		
3.	Fibre Fineness (Denier)	Raw Fibre	387.0	1.58	.71	135.0	.000*
		Fibre treated with Castor oil	252.0	1.58	.71		

***= Significant at 1% level, **=Significant at 5% level, NS = Non-Significant**

indicates that there is a difference after the raw fibre was treated with castor oil and a wetting agent.

Hand-spun banana yarn analysis

The properties of hand-spun yarn produced using the softened fibres are presented in Table 3. The yarn produced had three twists per inch in the 'Z' direction. The yarn count was less than one. Though the yarn was rough, the softening of banana fibres with castor oil improved its spinability when compared to raw fibre, which was difficult to be spun.

Table 3. Analysis of banana single yarn

S.No.	Yarn properties	Results
1.	Twist per inch	3.2
2.	Twist Direction	Z
3.	Yarn count	0.63s Ne
4.	Single yarn strength	10.4 Kg
5.	C.V.% of yarn strength	24.6
6.	Elongation % at break	6.1
7.	C.V.% of elongation	19.9

Evaluation of woven banana fabric

The evaluation of the properties of woven banana fabric samples is presented in Table 4. The fabric count of F1, which was banana yarn on warp and weft, was less than that F2, which is a mixture fabric with cotton yarn along the warp direction. The number of yarns per inch in F1 may be less due to the thickness of the yarn, as the hand-spun banana yarn was used in both the warp and weft directions. In the F2, the cotton yarn utilized for warp was thin, and this caused the closeness of banana yarn along the weft direction also. The thickness of banana yarn has reduced the fabric count in F1. The fabric thickness of F1 was found to be higher than F2, which might also be due to the yarn thickness. Similarly, the fabric weight of F1 was also higher than F2.

The air permeability of F1 was much higher than F2 due to the porous construction of the fabric. The tensile strength of the F1 warp direction was less than the weft direction, which is not usual in a textile material. Similarly, the

Table 4. Fabric properties of developed banana fabrics

S.No.	Fabric	EPI	PPI	GSM (g/m2)	Thickness (mm)	Air permeability Cubic feet / sq ft/min	Tensile strength (kg)		Absorbency (secs)
							Warp	Weft	
1.	**Fabric 1 - F1** (Warp and weft - banana yarn)	11	10	350	3.23	435.9	48.6	50.1	2
2.	**Fabric 2 - F2** (Warp-cotton and weft-banana yarn)	21	20	234	1.84	178.7	20.6	95.6	26

Table 5. Statistical analysis for woven banana fabric

S.No.	Variable	Mean	SD	SE	t-value	Significance	
1.	GSM(g/m2)	Fabric 1 - F1	350.0	1.58	.71	116.0	.000*
		Fabric 2 - F2	234.0	1.58	.71		
2.	Thickness (mm)	Fabric 1 - F1	3.2	.02	.01	139.0	.000*
		Fabric 2 - F2	1.8	.02	.01		
3.	Tensile Strength	Fabric 1 - F1	48.6	.16	.07	280.0	.000*
	(kg)Warp	Fabric 2 - F2	20.6	.16	.07		
4.	Tensile Strength	Fabric 1 - F1	50.1	.16	.07	-455.0	.000*
	(kg) Weft	Fabric 2 - F2	95.6	.16	.07		
5.	Absorbency	Fabric 1 - F1	2.4	1.1	.51	-27.071	.000*
	(secs)	Fabric 2 - F2	26.0	1.6	.71		

***= Significant at 1% level, **=Significant at 5% level, NS = Not Significant**

tensile strength of the warp direction in F2 was much lesser than its weft direction. This indicates that the banana yarns have good tensile strength. Similar results were noted in the study conducted by Sucharita and Vasugi, (2018), where the tensile strength in the warp direction was less than that of the weft in which the banana fibre was used. The absorbency was quicker in F1 due to its porous construction. In comparison, F2 had lesser absorbency than F1, as the yarns were arranged closer.

Table 5 showed the t-test analysis between Fabric 1 and Fabric 2. The statistical analysis of the values for F1 and F2 showed that there is statistical significance at a 1% level in fabric GSM, fabric thickness, tensile strength and absorbency of the two fabrics.

CONCLUSIONS

Banana fibre being an agro waste and eco-friendly natural fibre, can be a substitute for synthetic fibres in the textile industry. Researchers say that if produced on a large scale, it can be a cheaper and more sustainable alternative to conventional natural fibres. The fibre can be softened and spun into yarn through an eco-friendly process. Usually, chemicals are used to soften the banana fibre. The use of castor oil is an eco-friendly way to soften the fibre for spinning and was found to be effective. The properties of banana cotton mixture fabrics show that they can certainly be used as an effective textile material. The thickness and strength of the developed fabric show that it has a prospect of being used in packaging and home textiles. The banana fabric produced may be used as backing material for home textiles such as carpets and rugs. This may help create employment for rural people in fibre extraction. The fabrics made using banana fibre will certainly be eco-friendly materials and sustainable fabrics of the future.

REFERENCES

Doshi, A and Karolia, A. 2016. Optimization of enzyme treatment for banana fibre, International Journal of Textile and Fashion Technology. 6 (2):1-8.

Ortega, Z., Morón, M., Monzón, M.D., Badalló, P and Paz, R. 2016. Production of banana fibre yarns for technical textile reinforced composites. Materials. 9 (5): 370.

Pappu, A., Patil, V., Jain, S., Mahindrakar, A., Haque, R and Thakur, V.K. 2015. Advances in industrial prospective of cellulosic macromolecules enriched banana biofibre resources: A review. International Journal of Biological Macromolecules. 79:449-458.

Ramachandran M., Bansal, S and Raichurkar, P. 2016. Experimental study of bamboo using banana and linen fibre-reinforced polymeric composites. Perspectives in Science. 8: 313-316.

Sarma, I and Deka, A.C. 2016. Banana fibre extraction by mycogenic pectinase enzyme(s) - an eco-friendly approach. Imperial Journal of Interdisciplinary Research. 2 (10): 996-1006.

Subagyo, A and Chafidz, A. 2018. Banana Pseudo-Stem Fibre: Preparation, Characteristics, and Applications. Intechopen DOI: http://dx.doi.org/10.5772/intechopen.82204.

Subashini, B., Wickramasinghe, GL. D and Wijayapala, UG.S. 2020. A novel approach for banana (Musa) pseudo-stem fibre grading method: Extracted fibres from Sri lankan banana cultivars. Journal of Engineered Fibres and Fabrics. 15: 1– 9.

Sucharita, R and Vasugi, N. 2018. A Comparative study on three varieties of cotton banana mixture fabric treated with enzymes and natural dyes. Ph.D. Thesis submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. India.

Tholkappiyan, E. 2016. A Preliminary Study for Improving the Banana Fibre Fineness Using Various Chemical Treatments. Global Journal of Researches in Engineering. 16 (3):17-21.

Vigneswaran, C., Pavithra, V., Gayathri, V and Mythili, K. 2015. Banana fibre: Scope and value-added product development. Journal of Textile and Apparel, Technology and Management. 9 (2): 1–7.

Vinoth, R., Gokulnath K.S., Barathkumar K.J., Ahildarshan, K and Gokulprakash, E. 2018. A study of banana fibre: A Review. International Journal for Scientific Research and Development. 6 (09):127-131.

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EXPLORATION OF PARENT-CHILD INTERACTION AMONG ANGANWADI CHILDREN AND THEIR PARENTS

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ABSTRACT

The study conducted in the year 2022 aimed to analyze the parent-child interaction between Anganwadi children and their parents in the Kannur district of Kerala. Through purposive sampling, 197 samples were selected. The sample includes 114 parents from rural areas and 83 from urban areas. Data collection was done through a self made rating scale. Major findings of the study conclude that the Parent child interaction rate was more than 75%. Significant difference doesn't exists between urban and rural areas in the Parent child interaction rate, the mean score of parent child interaction rate do not differ with age groups, educational qualification and professions. However, the mean score of Parent child interaction rate differs with income groups.

Keywords: Anganwadi, Early Childhood Care and Education, Parent-child interaction, Parenting

INTRODUCTION

Developmental psychology has a long history of investigating interactions between parents and children. However, very little of this studies has focused on whether and how parents influence a child's development. One of the most significant, impactful, and meaningful connections in a person's life is their relationship with their parents (Horstman *et al.,* 2016).

The relationship between mother and child begins in the womb and continues after birth. From infancy, parents and children child interaction serve as the setting for social learning (Zdanevych *et al.,* 2020). Parent-child interactions are the initial contexts in which a number of social-cognitive and socio-emotional processes, including emotion control and recognition, referencing, gaze following, pointing, and communicating, become visible (Iarocci and Gardiner, 2015).

However, between the ages of 3 and 6 years, there is a noticeable drop in time spent in direct contact with parents and a concomitant increase in time spent with peers in typically developing children (Iarocci and Gardiner, 2015). Hearing compliments, setting clear expectations for positive behaviors, and positively interacting with the child should

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boost self-confidence and promote the growth of communication and good habits (Potharst *et al.,* 2021). Children thrive in a positive environment (Noldus, 2022).

A child's capacity to develop social and emotional skills depends on their ability to maintain emotional regulation (Li, 2022). This effects how they will create relationships in the future and can even insulate them from trauma. Children who have affectionate relationships with their parents during infancy and early childhood form solid bonds with them are substantially more likely to succeed in school (WHO, 2018).

In order to provide for a child's requirements as per the cultural norms that change from generation to generation, a parent must practice good parenting (Lanjekar *et al.*, 2022). The emotional controls in the preschool year influence future behaviors. If a child's mother or father struggles to control their emotions in front of the children, the youngster may not form close friendships with other kids (Lanjekar *et al.*, 2022).

Through a home learning environment, children learn to investigate the world and know develops attitudes and behavior in family contexts (Kumalasari and Sugito, 2021). A home learning environment has long and short-term effects on early childhood development. It plays an essential role in preparing children before entering formal school (Niklas *et al.,* 2016). This shows parent-child interaction is essential for promoting the holistic development of children.

The objectives of the study are: 1) to evaluate parent child interaction rate, 2) to find out the difference in parent child interaction rate between rural and urban parents, 3) to find out the relation between age and parent child interaction rate, 4) to find out the relation between education and parent child interaction rate, 5) to find out the relation between job and parent child interaction rate and to 6) find out the relation between income and parent child interaction rate.

MATERIALS AND METHODS

The sample for the study comprised 197 mothers of Anganwadi children from 197 Anganwadi under four ICDS projects; these include Edakkad ICDS, Iritty ICDS, Kuthuparamb ICDS, and Thalassery ICDS in the Kannur district. The sample consisted of 114 mothers from rural Anganwadi and 83 from urban. The data was collected in the year 2022 through a purposive sampling method. A self-designed rating scale was utilized for data collection. The scale was made up of a total of 44 statements and only 10 major statements were selected for exploring parent-child interaction. A pilot study consisting of 30 samples was conducted and modifications were made accordingly. By doing Cronbach's Alpha test a score of 0.793 is obtained and hence the scale is reliable. Each statement of the scale scored 5,4,3,2 and 1and a sample can score a minimum of 10 and a maximum of 50. Permission has been taken from the ICDS program officer, District Level ICDS Cell Kannur. After that permission from the CDPO of Edakkad ICDS, Iritty ICDS, Kuthuparamb ICDS, and Thalassery ICDS projects was obtained. After getting permission the researcher approached Anganwadi centers and a parent-child interaction rating scale was

Table 1. Parent - child interaction rate

S.No.	Variable	n	Mean	Standard Deviation	Mean % score	CV	Z	p value
1	Parent child interaction rate	197	39.62	5.92	79.24	14.94	5.025	<0.001

administered to the parents of Anganwadi children with instructions to complete all questions honestly. The data was analysed using SPSS version 25 with mean, standard deviation, frequency, Pearson correlation, ANOVA, and t-tests.

RESULTS AND DISCUSSION

To find the level of parent-child interaction rate, the respondents are asked questions on five - point Likert scale. The scores for responses were given as 1 for 'hardly ever', 2 for 'once in a while', 3 for 'sometimes', 4 for 'often' and 5 for 'almost always'.

Mean percentage result score of parent child interaction rate is 79.24% which indicates that parent child interaction rate is high or excellent. The CV indicated that this score is stable as the value is less than 20%. To test whether the sample information that observed exists in the population or to verify Parent child interaction rate is high or not, a hypothesis was formulated.

H0: The Parent child interaction rate is equal to 75 percent of the total score (H0:MPS=75%)

H1: The Parent child interaction rate more than 75 percent of the total score (H1:MPS>75%)

To test the above hypothesis one sample Z test has been used. The result is exhibited in Table 1. From the Table 1, the p value is less than 0.05. The z value is positive, which indicated that the test is significant. Hence null hypothesis was rejected. And it was concluded that the Parent child interaction rate is more than 75% *i.e.* excellent.

Giulia Dotti Sani and Judith Treasa (2016) revealed that there has been a steady rise in the amount of time parents spend with their children over the past five decades. With the diversification of family structures, parents and children spend more time together, which results in positive growth (Tamborini, 2021). Stuart *et al.* (2021) found that during the interactions, the higher quality subgroup demonstrated more positive behaviours, while the lower quality subgroup demonstrated more negative behaviours. The findings suggested that vulnerable families frequently have depleted parent-child interactions.

Difference in parent child interaction rate between urban and rural parents

To compare the mean score of variables of two different groups (that is, rural and urban) an independent sample Z test was used. Hence, a Z test was conducted. The results are shown in Table 2. The results showed that no significant difference exists between rural

Table 2. Means, Z value and SD for residents of rural and urban areas (n=197)

S.No.	Variable	location	n	Mean	Standard Deviation	Z	p value
1	Parent child interaction rate	Rural	114	39.66	6.07	0.107	0.915
		Urban	83	39.57	5.74		

and urban areas for Parent child interaction rate as the p value in this case is above 0.05.

Only limited studies were available to compare the quality of the time spent by parents with their children during their first six years. Parents in rural areas report more coercive parenting, fewer positive encouragements, and poorer parent-child relationships compared to urban parents (Han *et al*., 2023). Mercier *et al. (1988)* revealed that living near to the child was the most important contributor to a high quality relationship for rural parents, followed by having an internal locus of control and low filial expectations. For urban parents, the internalized locus of control was the most important factor in maintaining high-quality relation with their children. In a study by Saimons (2014), it is reported as there was no significant difference in parent-child relationships between urban and rural boys and girls, but there is a difference overall.

Relation between age and parent child interaction rate

A one sample analysis of variance was used to test hypotheses about means when there are three groups or more than three groups of one independent variable. In this case, age was considered as the independent variable. This included four groups (a) 18-20 (b) 21-31 (c) 32-42 (d) 43-53. Hence, comparison of the mean scores of different age groups was done using ANOVA (Table 3).

The results of the ANOVA test (Table 3) revealed that the value of p is more than 0.05 for Parent child interaction rate. Hence, it was concluded as the mean score of Parent child interaction rate do not differs with age groups. There is recent evidence in the socio-demographic literature that later motherhood is related with better educational outcomes for children (Fall *et al*., 2015; Myrskyla *et al*., 2017). As a result of being more prepared and more satisfied with childbearing, older fathers and mothers may be able to provide better

Table 3. Means, F value and Standard deviation for Age variable (n= 197)

S.No.	Variable	location	n	Mean	Standard Deviation	Z	p value
1	Parent- child interaction rate	18-20	1	44.00		2.535	0.058
		21-31	121	38.81	6.00		
		32-42	69	40.64	5.67		
		43-53	6	43.50	4.32		

Table 4. Means, F value and Standard deviation for Education variable (n= 197)

S.No.	Variable	Education	n	Mean	Standard Deviation	Z	p value
1	Parent child interaction rate	Illiterate	1	36.00		0.514	0.766
		Primary school certificate	6	41.33	4.23		
		High school certificate	65	40.02	6.02		
		Intermediate or diploma	27	38.26	6.21		
		Graduate	78	39.68	5.85		
		Profession or Honours	20	39.60	6.24		

parenting practices and interactions to their children (Fall *et al.,* 2015). Uzun *et al.* (2021) revealed that there is no significant difference by age variable in fathers' parent child relationship total and sub-dimensions; there is a sign of significant difference between age of the mothers and the role sub-dimension.

Relation between education and parent child interaction rate

In this case, education was considered to be the independent variable, which included six groups (a) Illiterate (b) Primary school certificate (c) High school certificate (d) Intermediate or diploma (e) Graduate (f) Profession or Honours. Hence, ANOVA was used to compare the mean scores of different qualifications and the result is exhibited in Table 4.

The results of the ANOVA test illustrated in the Table 4 revealed that the statistical value of p is more than 0.05 for Parent child interaction rate. Hence, it was concluded that the mean score of Parent child interaction rate do not differs with educational qualification. Influence of parents' education, interaction with child and child outcomes are much less researched than parenting practices and child outcomes (Winter *et al.,* 2012).

Uzun *et al.* (2021) found that there was no significant difference between fathers' education levels and PCRI and its sub-dimensions; however, there can found a significant difference between mothers' education levels and discipline, autonomy, participation, and role sub-dimensions.

Relation between profession and parent -child interaction rate

A one sample analysis of variance is used to test hypotheses. Profession was considered as the independent variable. This included six groups (a) Unemployed (b) Craft & Related Trade Workers (c) Skilled Agricultural & Fishery Workers (d) Skilled Workers and Shop & Market Sales Workers

Table 5. Means, Z value and Standard deviation for Education (n= 197)

S.No.	Variable	Profession	n	Mean	Standard Deviation	Z	p value
1	Parent child interaction rate	Unemployed	154	39.34	6.08	0.784	0.562
		Craft & Related Trade Workers	33	40.18	5.46		
		Skilled Agricultural & Fishery Workers	3	40.33	5.77		
		Skilled Workers and Shop & Market Sales Workers	4	42.00	3.56		
		Clerks	2	41.00	4.24		
		Professionals	1	49.00			

(e) Clerks (f) Professionals. Hence, to compare the mean scores of different professions ANOVA test was used (Table 5).

The results of the ANOVA test (Table 5) revealed that the statistical value of p is more than 0.05 for parent-child interaction rate. Hence, it can be concluded that the mean score of Parent child interaction rate do not differs with professions. Researchers have found that children with working parents spend more time without parental supervision at a younger age. As a result, the children's performance in school may be impaired and their risky behaviors may increase (Grogger and Karoly, 2005). Additionally, working parents earn money they can use to improve how they care for their children and the environment in which they live (Heinrich, 2014).

Roeters *et al*. (2010) found that less parent-child time and more working hours were associated with less parent-child time and long working hours, more restrictive organizational norms, stress, flexibility, nonstandard hours (mothers only), and the work engagement rised the disruption of parent-child activities. Less and more disturbed parent-child activities were associated with a lower quality of parent-child relationship. Furthermore, work engagement and working hours had a direct and positive impact on the quality of parent-child relationships.

Relationship between income and parent - child interaction rate

To test hypotheses a one sample analysis of variance was used. Independent variable here was considered as income , which included seven groups (a) Up to 6174 (b) 6,175-18,496 (c) 18,497-30,830 (d) 30,831-46,128 (e) 46129-61,662 (f) 61,663-123,321 (g) Above123,322. Hence, to compare the mean scores of different income groups ANOVA was used (Table 6).

The results of the ANOVA test given in Table 6 reveals that the statistical value of p is

Table 6. F value, Mean and Standard deviation for Income (n-197)

S.No.	Variable	Income (Rs.)	n	Mean	SD	F	p value
1	Parent child interaction rate	Upto 6,174	74	39.50	5.83	2.180	0.047
		6,175-18,496	49	41.20	5.28		
		18,497-30,830	22	40.27	4.83		
		30,831-46,128	8	35.63	7.07		
		46129-61,662	13	36.00	8.02		
		61,663-1,23,321	8	38.50	6.23		
		Above1,23,322	23	39.83	5.73		

less than 0.05 for Parent child interaction rate. Hence, the conclusion was that the mean score of Parent child interaction rate differs with income groups. Parental involvement in cognitively stimulating activities and creating a supportive (Yeung *et al.,* 2002), affectionate parenting environment, family income is found to indirectly affect children's cognitive competence (Mistry *et al.,* 2008).

Uzun *et al. (2021)* in their study revealed that there is observed a significant difference in the family income variable and the satisfaction subscale of mothers. Ho *et al.* (2022) revealed that employment status, parental stress, and harsh parenting were all significantly related to parent-child relationships. The qualitative findings revealed that parents from low-income families faced a wide range of difficulties, which made these parents more likely to experience parental stress, increasing their proclivity to adopt harsh parenting practices that harmed the parent-child relationship.

CONCLUSIONS

The purpose of this research was to understand the involvement of parents with their preschoolers. Through analyzing the results of the study it was discovered that the Parent child interaction rate is more than 75% *i.e.* excellent. From the study, it was reported that urban and rural areas are not a determining factor in parent child interaction. Results also revealed that the mean score of Parent child interaction rate do not differ with age groups, educational qualification and professions. The parent-child interaction rates mean scores differ with income groups. The result of the study indicates that the middle income families show low Parent child interaction when compared to other income group. High income and low income families show better parent child interaction when compared to middle income groups.

REFERENCES

Dotti Sani, G.M and Treasa, J. 2016. Educational gradients in parents' child care time across countries, 1965–2012. Journal of Marriage and Family. 78(4):1083-1096.

Fall, C.H., Sachdev, H.S., Osmond, C., Restrepo-Mendez, M.C., Victora, C., Martorell, R and Richter, L.M. 2015.

Association between maternal age at childbirth and child and adult outcomes in the offspring: A prospective study in five low-income and middle-income countries (COHORTS collaboration). The Lancet Global Health. 3(7):e366-e377.

Grogger, J and Karoly, L.A. 2005. What Children Need; Welfare Reform: Effects of a decade of Change; Cambridge, MA: Harvard University Press.

Han, J., Hao, Y., Cui, N., Wang, Z., Lyu, P and Yue, L. 2023. Parenting and parenting resources among Chinese parents with children under three years of age: rural and urban differences. BMC Primary Care. 24(1):1-10.

Heinrich, C. J. 2014. Parents' employment and children's wellbeing. The future of children. 121-146. Retrieved from the web site (https://files.eric.ed.gov/fulltext/EJ1029033.pdf) on 03.02.2023.

Horstman, H.K., Hays, A and Maliski, R. 2016. Parent-child interaction. Oxford Research Encyclopedia of Communication. Nussbaum, J. Oxford University Press Editors. Doi:10.1093/acrefore/9780190228613.013.278.

Ho, L.L.K., Li, W.H.C., Cheung, A.T., Luo, Y., Xia, W and Chung, J.O.K. 2022. Impact of poverty on parent–child relationships, parental stress, and parenting practices. Frontiers in Public Health. 10.

Iarocci, G and Gardiner, E. 2015. Social competence during adolescence across cultures. International Encyclopedia of the Social and Behavioral Sciences. 216-221.

Kumalasari, P.I and Sugito, S. 2020. The role of student's parent in shaping home learning environment (HLE) for early childhood. Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini. 5(2): 1521-1535.

Lanjekar, P.D., Joshi, S.H., Lanjekar, P.D and Wagh, V. 2022. The effect of parenting and the parent-child relationship on a child's cognitive development: A Literature Review. Cureus. 14(10).

Li, P. 2022. Emotional Regulation in Children - A Complete Guide. Parenting for Brain. Retrieved from the website (https://www.parentingforbrain.com/self-regulation-toddler-temper-tantrums/) on 20.02.2023.

Mercier, J.M., Paulson, L and Morris, E.W. 1988. Rural and urban elderly: differences in the quality of the parent-child relationship. Family Relations. pp. 68-72.

Mistry, R.S., Biesanz, J.C., Chien, N., Howes, C and Benner, A.D. 2008. Socioeconomic status, parental investments, and the cognitive and behavioral outcomes of low-income children from immigrant and native households. Early Childhood Research Quarterly. 23(2):193-212.

Myrskyla, M., Barclay, K and Goisis, A. 2017. Advantages of later motherhood. Der Gynäkologe. 50(10):767–772.

Niklas, F., Cohrssen, C and Tayler, C. 2016. Home learning environment and concept formation: A family intervention study with kindergarten children. Early Childhood Education Journal. 44:419-427.

Noldus. 2022. Parent-child interaction. Retrieved from the website (https://www.noldus.com/applications/parent-child-interaction) on 15.02.2023.

Potharst, E.S., Leyland, A., Colonnesi, C., Veringa, I.K., Salvadori, E.A., Jakschik, M and Zeegers, M.A. 2021. Does mothers' self-reported mindful parenting relate to the observed quality of parenting behaviour and mother-child interaction?. Mindfulness. 12:344-356.

Roeters, A., Lippe, T and Kluwer, E.S. 2010. Work characteristics and parent-child relationship quality: the mediating role of temporal involvement. Journal of Marriage and Family. 72 (5): 1317-1328.

Saimons, S.K. 2014. A comparative study of parent- child relationship among rural and urban adolescence. Asian Academic Research Journal of Multidisciplinary. 1:350-356.

Stuart, A., Canario, C and Cruz, O. 2021. An evaluation of the quality of parent-child interactions in vulnerable families that are followed by child protective services: a latent profile analysis. Children. 8(10):906.

Tamborini, C.R. 2021. Family and health over the past decade: Review of selected studies and areas of future inquiry. Journal of family and economic issues. 42(Suppl 1):62-69.

Uzun, H., Karaca, N.H and Metin, S. 2021. Assesment of parent-child relationship in COVID-19 pandemic. Children and Youth Services Review. 120:105748.

Winter, L., Morawska, A and Sanders, M. 2012. The knowledge of effective parenting scale (KEPS): A tool for public health approaches to universal parenting programs. The Journal of Primary Prevention. 33:85-97.

WHO. 2018. Nurturing care for early childhood development: a framework for helping children survive and thrive to transform health and human potential. Switzerland. Retrieved from the website (https://apps.who.int/iris/bitstream/handle/10665/272603/9789241514064-eng.pdf) on 10.02.2023.

Yeung, W.J.J, Linver, M.R and Gunn, J,B. 2002. How money matters for young children's development: Parental investment and family processes. Child development. 73(6):1861-1879.

Zdanevych, L.V., Buchkivska, G.V., Greskova, V.V., Àndriievskyi, B.M and Perminova, L.A. 2020. Creativity formation in the context of social and psychological adaptation of preschoolers aged 5-6 years temperament, anxiety.International Journal of Cognitive Research in Science Engineering and Education. 8(Special Issue):79-91.

Akshaya, E and Nisha,V. 2023. Exploring parent-child interaction among anganwadi children and their parents. The Journal of Research ANGRAU. 51(2): 97-105.
DoI: https://doi.org/10.58537/jorangrau.2023.51.2.11

DoI: https://doi.org/10.58537/jorangrau.2023.51.2.12

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OCCUPATIONAL ATTRIBUTES AND ITS IMPACT ON HEALTH AMONG TEA PLUCKING WOMEN WORKERS OF ASSAM

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ABSTRACT

The study examined the socio-economic background, working circumstances, and potential health effects of the women who pluck tea leaves in Assam state. A sample of 100 tea plucking women workers were selected by using random sampling method from Dibrugarh and Jorhat districts, Assam.. The data was collected between April and June 2021. The tea plucking women were low waged full - time employees, who got RS.1160 per week as their wage. Most of the respondents (82%) plucked more than 20 kg of tea leaves per day, whereas 56 percent of the respondents plucked tea leaves below 20 kg. A total of 69 percent of the respondents used basket along with other personal protective equipments while plucking tea and 31% of them plucked tea leaves only with a basket. While Majority of the tea plucking women workers (63%) had problem with the basket due to its transportation issue, 94 percent of the women workers had body pain during and after their work because they have to stand all day in work with a heavy basket full of tea leaves.

Keywords: Assam, Health, Occupational attributes, Tea pluckers, Women workers

INTRODUCTION

Agriculture is a tough industry with challenging and occasionally deadly working conditions. Each plantation has its own unique set of risks that plantation employees must deal with (Asmare *et al*., 2022). Of all the plantation crops, tea requires one of the highest labour inputs. Women make essential contributions to the agricultural and rural economies in all developing countries. Rural women often manage complex households and pursue multiple livelihood strategies (Biradar, 2021). Tea plantation requires a huge number of labour forces. The women tea plantation workers are significant for the industry as they form almost 50 percent of the total workforce in the tea industry in Assam (Baishya 2016). Plantation work can lead to multiple exposures for workers due to the seasonal nature of the work, the variety of tasks, the type of working postures, and the length of the tasks. These exposures can include exposure to poisoning, infections, parasite

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diseases, allergies, toxicity, bites, infections, and other health issues (Rehena, 2018).By considering all the limitations, this study was attempted to comprehend the actual situation of female employees in tea gardens. The study was conducted to know the job characteristics and its effect on their health, occupational problems they faced, tools and personal protective equipments used by the tea plucking women workers.

MATERIALS AND METHODS

This qualitative study sought to gain a better understanding of the difficulties that female tea pickers face on the job, which was conducted between the months of April and June 2021. The purpose of the research was to identify the socioeconomic issues and challenges that tea pickers, particularly women face. The study was conducted in the districts of Jorhat and Dibrugarh of Assam. Because upper Assam has a higher concentration of tea gardens, four estates from these two districts were chosen. Female tea pluckers who lived and worked on tea estates made up the study's population. A total of 100 tea plucking women were chosen at random from four tea plantations in the Assam districts of Jorhat and Dibrugarh based on their availability and personal preferences. The primary data collection methods were observations and interviews. A detailed interview schedule was developed based on the literature review and the study objectives. During non-working hours, the researcher visited the tea plucking women workers in their homes to collect data. The main goal of the research was initially clearly explained to them. In order to obtain the most accurate and reliable information, the researcher conducted an informal interview among the target group. The informal interview was designed to make the tea picking workers feel more at ease while answering questions. The data were primarily qualitatively analysed. Percentages were calculated to analyse the demographic data while keeping in mind the study's goals. To support the quantitative data, the respondents' explanations and justifications were used as qualitative data. Chi square test was done to check the impact of categorical variables on each other such as, age of workers with problem of basket, weight of basket with workplace accidents and use of tools and equipments with health. The data were examined and interpreted for discussion and conclusions were drawn in light of the study's goal.

RESULTS AND DISCUSSION

A total of 84 percent of the respondents were between the age of 31 and 40 years (Fig.1). More than half of the respondents (67 %) were married. Because their incomes were low and their expenses were high, 90 percent of respondents came from nuclear families, making it difficult for them to maintain a joint family, which also aided in the improvement of their financial stability. Due to poverty and a lack of interest in school, 48 percent of the women who picked tea were illiterate. In the beginning, they prioritised earning money over study because they needed money to support their families. Only 19 percent had completed pre-primary school, while 33 percent had completed their primary school. They stopped attending school despite started or completed primary school due to marriage or taking on additional responsibilities to support their families financially. Similar findings were reported by Ansari and Sheereen (2016), Sharma and Bhuyan (2016), who found that

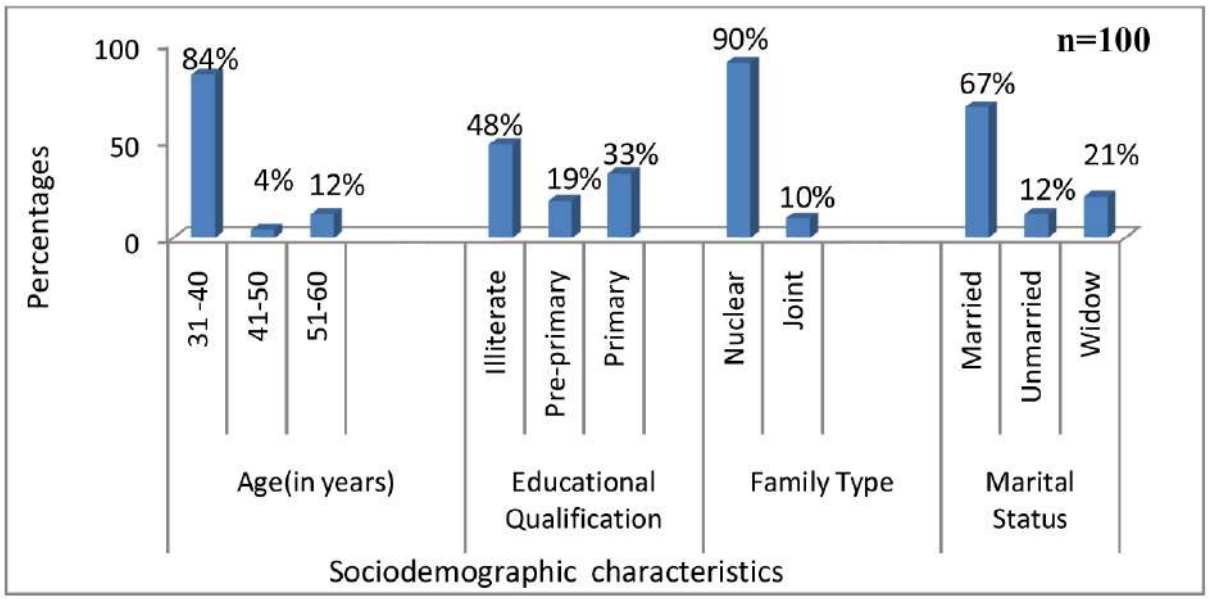

Fig.1.Socio-demographic characteristics of respondents (%)

majority of the respondents were illiterate. The respondents' monthly income was less than Rs. 5000 and all of the respondents were full time employees. The management paid them weekly wage of 1160 Rs/week. However, it could rise depending on how much tea leaves they pluck. The payment was made if they could pluck 20 kg per day, but it was deducted if they plucked less than the standard requirement. Respondents were compensated in addition to their regular payment if they plucked more than 20 kg of leaves.

The majority of tea plucking women workers (56 percent) started their jobs when they were under the age of 20 years (Fig. 2). They began picking tea when they were young and should have been studying to support their family and meet their basic needs. Eighty-four percent of them had more than five years of work experience as tea pickers. This indicates that they were more skilled and comfortable in their workplace. Because the worker colonies were close to the tea gardens, all respondents reached the workplace by walk.

The majority of respondents (62 %) picked 25-30 kg tea leaves per day. Actually they plucked extra leaves beyond the standard requirement to get payment for the extra kg. According to them livelihood is the prime concern than health. Majority of respondents (83 %) worked for 8 hours or less, with only a small percentage (17 %) has worked for long hours. Almost all respondents' work schedules included half an hour to one-hour breaks. About 69 percent of respondents carried a basket as well as other tools and personal protective equipments such as an umbrella and a thick plastic sheet wrapped around in lower part of the body while plucking. In contrast, a very small percentage of them had only a basket and no personal protective equipment during their plucking time. The majority of respondents (72 %) stored their plucked leaves in plastic net bags. Only 28 percent of female tea pluckers used

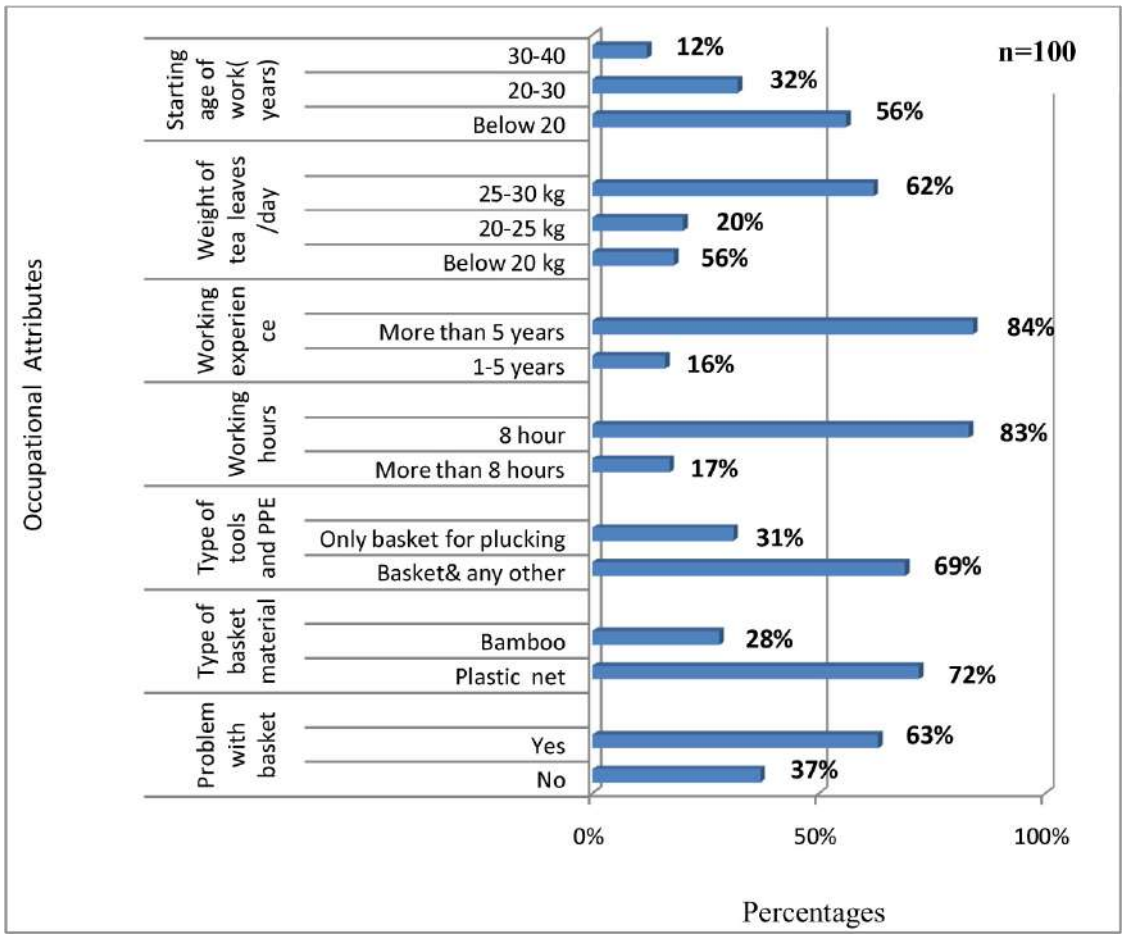

Fig. 2. Occupational attributes and provision of tool

bamboo baskets for tea plucking. None of the respondents used cushioning on their baskets to reduce stress in their bodies while carrying the basket. However, majority of respondents (63%), had issues with the basket. About 38 percent of them had difficulty moving the basket from one location to another while plucking.

Table 1 showed the association between age of workers and the problems of tea plucking basket. Most (75 percent) of the women workers of 41-50 years had problem with basket and 50 percent of the women workers of 31-40 years age group had problem with basket and other half of the respondents didn't have any problem with the basket. The chi square test was conducted to find whether there is significant relation between age of workers and problem with basket. Since the chi square calculated value (0.761) was less than the table value (5.991), hence there was no significant relation between both the variables.

Fifty percent of the respondents who plucked 21-25 kg of tea leaves were injured, while the other half were safe. In comparison, 46 percent of people who gathered 26-30 kg of tea leaves were injured (Table 2). This implies that the weight of tea leaves handled by female tea pluckers had no impact on workplace accidents. According to the X 2statistical study, there was no significant relationship between the weight of plucked leaves and the female employees' accidents. Because the calculated

Table 1. Association between age of workers and problem with basket

n=100

S.No.	Age (Years)	Problem with basket				Total		X2 value	df	Sig
		Yes		No		No.	%			
		No.	%	No.	%					
1.	31-40	6	50	6	50	12	100	0.761	2	N.S
2.	41-50	3	75	1	25	4	100			
3.	26-30	6	46.2	7	53.8	13	100			

N.S – Non-significant, Critical value/Table value: 5.991

Table 2. Association between weight of plucked leaves and accidents faced

n=100

S.No.	Weight of leaves(kg)	Faced any accidents				Total		X2 value	df	Sig
		Yes		No		No.	%			
		No.	%	No.	%					
1.	31-40	6	50	6	50	12	100	0.761	2	N.S
2.	41-50	3	75	1	25	4	100			
3.	26-30	6	46.2	7	53.8	13	100			

NS – Non-significant, Critical value/Table value: 5.991

X2 value (0.059) was less than the critical threshold (5.991). Such errors might be the result of improper body positioning at work. The findings of this research however, revealed a plethora of risks that have a negative impact on the worker's productivity. The most common hazards are those caused by the scorching heat, rain, and insect bites such as mosquitoes (Rajbangshi and Nambiar(2020).

Fig.3 reveals that majority of respondents (94%) reported body pain during or after their plucking work, which was a result of the prolonged standing required and the heavy baskets of tea leaves they must carry throughout the day(Marak *et al*., (2020). Only Eight percent of those surveyed had experienced workplace mishaps. They must jump into drains between fields while carrying a heavy tea basket and wearing minimal personal protective equipment (Venugopal *et al*., 2021). Seventy-seven percent of them occasionally experienced minor incidents. Fever, particularly malaria, diarrhoea/dysentery/ stomach pain, physical weakness, eye pain and headache were common among them. They also had chronic diseases like gastric and urinary tract infections, as well as chest pain. Tuberculosis had also been found to be prevalent among them. During the questionnaire survey, 2 percent of the workers reported fever, and 5 percent reported constant fatigue and weakness while working in tea gardens. A total of 62 percent of the female tea plantation workers reported

headaches, exhaustion, and physical pain after standing for more than eight hours a day while carrying a heavy basket on their backs. Eight percent of tea-picking women must routinely work with tea trees. When they were in contact with the plants by their hands or lower abdomens, they were exposed to pesticides. Elbows and the lower abdomen were among the bodily parts that were impacted. Sometimes the entire body could swell. The chemical odour caused female workers to have gastritis and lose their appetite. Pesticides have a negative impact on the health of tea plucking women workers, according to a study conducted by Dhananjayan *et al.* (2019). Aside from animal attacks, a few respondents said that they were bitten by leeches, mosquitoes, and other insects while working in the fields. About 45 percent of the n employees seek medical attention from a physician when they are sick. However, it has been discovered

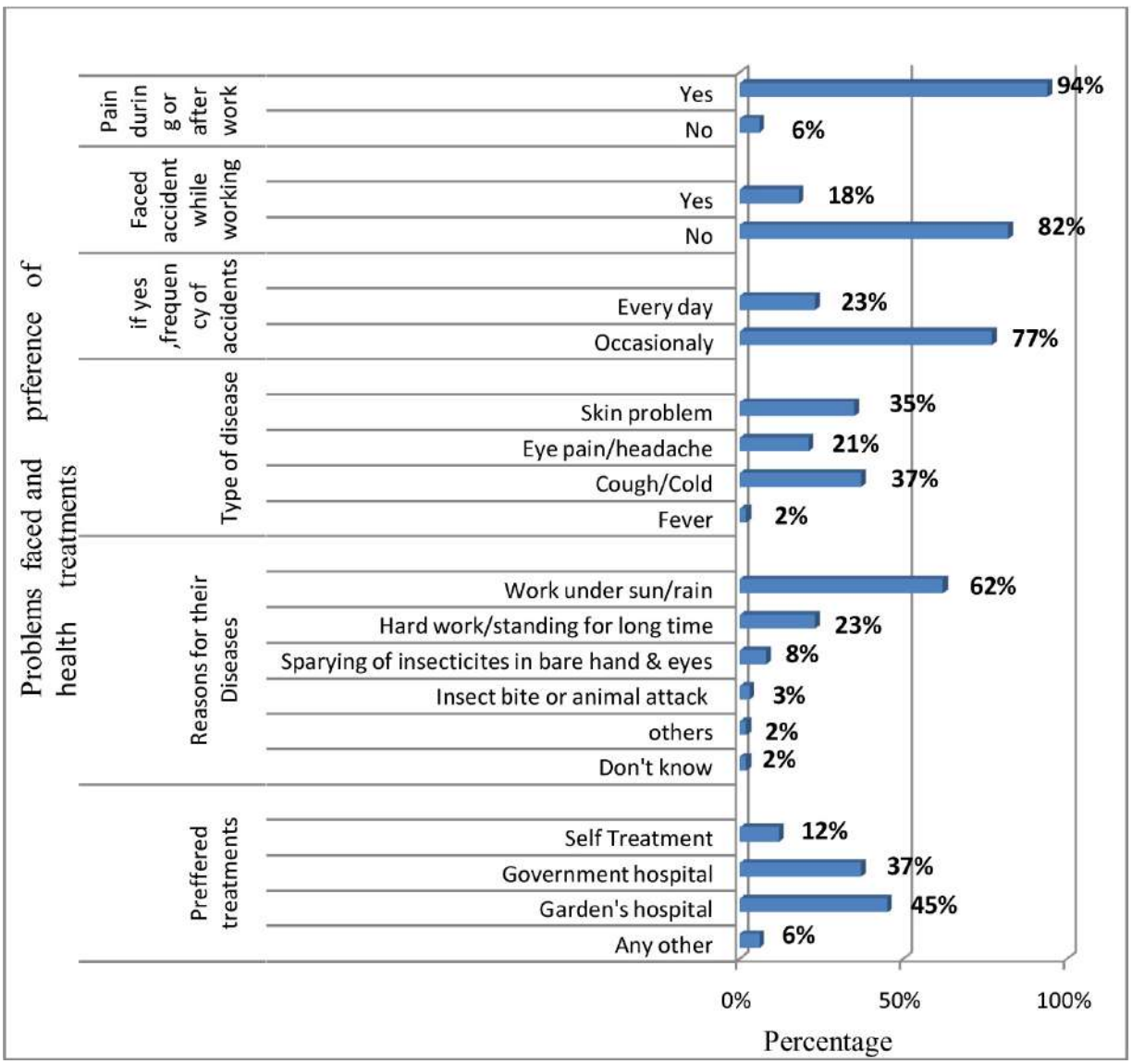

Fig. 3. Health problems faced by women workers and preferences of treatments

that the garden authority's level of medical care was unsatisfactory to the workers. They claimed that all fevers received the same treatment. Pathology services were frequently scarce. They were frustrated by the scarcity of hospitals and clinics. Even in areas with hospitals or other health-care facilities, medicine and competent doctors were frequently in short supply. Very few (6%) respondents preferred other types of treatment, such as private clinics or hospitals due to their highly charged treatments.

Table 3 outlines the diseases that affected tea plucking women as well as the tools and equipment they used. The chi square test revealed that the instruments and personal protective equipment used by tea plucking women workers had no statistically significant link with diseases such as cough or cold, eye pain or headache, fever, and skin problems. Because the chi square calculation result (6.995) was less than the critical or table value (9.448).

Table 3. Association between health problems and use of tools and equipments

n=100

S. No.	Health problem	Type of tools and PPE				Total		X^2 value	df	Sig
		Basket		Other tool						
		No.	%	No.	%	No.	%			
1.	No Disease	16	21.3	7	28.0	23	23			
2.	Cough/co-ld	14	18.7	4	16.0	18	18			
3.	Eye pain	21	28.	5	20.0	26	26	6.995	4	N.S
4.	Fever	-	-	2	8.0	2	2.0			
5.	Skin issues	24	32.	7	28.0	31	31			

N.S-Not significant, Critical value/Table value: 9.488

CONCLUSIONS

The tea plucking women of Assam were working with adverse work facilities and minimum wages which were not sufficient for their living. The study revealed that most of the women workers had insufficient tools and personal protective equipments; prolong work hours, very less wage to carry out their tea plucking work. It was found that there was no significant relation between the age of workers with problem of basket, weight of tea leaves with accidents faced and health problems with use of personal protective equipments among the tea plucking women workers.

REFERENCES

Asmare, B.A., Freyer, B and Bingen, J .2022. Women in agriculture: pathways of pesticide exposure, potential health risks and vulnerability in Sub-Saharan Africa. Environmental Sciences Europe. 34(89): 24-34.

Ansari, S and Sheereen, Z. 2016. Socio-economic condition of tea garden worker

in Alipurduar district, West Bengal. International Journal of Research in Social Science. 6 (2): 494-498.

Biradar, S. 2021. Perceived drudgery of farm women involved in agricultural activities. Indian Research Journal of Extension Education. 21(1): 103-106.

Baishya, D. 2016. History of tea industry and status of tea garden workers of Assam. International Journal of Applied Research. 2 (9): 552-554.

Dhananjayan , V., Ravichandran, B., Panjakumar, K., Kalaiselvi, K., Kausic, Rajaseka., Mala, A., Avinash ,G., Shridhar, K and Manju, A. 2019. Assessment of genotoxicity and cholinesterase activity among women workers occupationally exposed to pesticides in tea garden. Mutation Research/Genetic Toxicology and Environmental Mutagenesis. 841 (2):1-7.

Marak, T.R., Bhagat, D and Borah, S.2020. Musculoskeletal disorders of Garo women workers engaged in tea-plucking activity: An ergonomic analysis. Indian Journal of Occupational and Environmental Medicine. 24(2):60-65.

Rajbangshi, P.R and Nambiar, D. 2020. “Who will stand up for us?” The social determinants of health of women tea plantation workers in India. International Journal for Equity in Health. 19 (29): 1-10.

Rehena, P. 2018. Health and economic conditions of tea garden female workers: A study on legal rights. Green University Review of Social Science. 4(1): 111-132.

Sharma, A and Bhuyan, B. 2016. Livelihood pattern among the tea garden laborers; International Journal of Advance Research. 4 (8): 1609-1610.

Venugopal, D., Karunamoorthy, P and Beerappa, R.2021. Evaluation of work place pesticide concentration and health complaints among women workers in tea plantation, Southern India. Journal of Exposure Science and Environmental Epidemiology. 31(3): 560–570.

Kalyani, D and Sumathi, D. 2023. Occupational attributes and its impact on health among tea plucking women workers, Assam.The Journal of Research ANGRAU. 51(2): 106-113. https://doi.org/10.58537/jorangrau.2023.51.2.12

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EFFECT OF PARENTAL EDUCATIONAL STATUS ON LITERACY AND NUMERACY SKILLS OF PRESCHOOL CHILDREN

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ABSTRACT

The study was conducted to understand the effect of parental educational status on the literacy and numeracy skills of their children in their early years. A randomized sample of 300 pre-schoolers from five zones of the Coimbatore district along with their parents' information accounted for the study conducted in the year 2022. A modified Literacy and Numeracy Assessment Pack was used as a tool for the study. Results revealed that the father's and mother's educational status is an influencing factor in preschoolers' literacy skills ($F(4, 2,79)=2.62$ $p= .035$ and $F(4, 2,79)=2.67$, $p= .032$, respectively). Whereas, the interaction between the parent's educational status was also found statistically significant ($F(12, 2,79)=2.85$,$p=.001$) in relation to their children's literacy and numeracy skills. Preschooler's literacy and numeracy skill influenced by their parent's educational status and it helps children in their later experiences in shaping children's brain development.

Keywords: Literacy and Numeracy Assessment Pack, Literacy skills, Numeracy skills, Preschool children, Parental education, School readiness

INTRODUCTION

Early childhood is a developmental stage that offers a critical window of opportunity to shape the trajectory of a child's holistic development (Gerber *et al*., 2010). The quality of early experiences that a child gets makes a critical difference in creating a base for their future reading and arithmetic skills. Numeracy skills of children in their early years are said to predict their mathematical skills in school (Watts *et al*., 2014; Zhang *et al*., 2014; Koponen *et al*., 2016; Koponen *et al*., 2019; Schneider *et al*., 2017; Chu *et al*., 2018; Geary *et al*., 2018). Early language and literacy skills also had been proven to predict their later reading skills (Torppa *et al*., 2010; Ziegler *et al*., 2010; Psyridou *et al*., 2018; Hjetland *et al*., 2020).

The findings of Kleemans *et al.* (2012) and Baker (2014) reported that the parent-child literacy and numeracy practices are interrelated to the development of the child's literacy and numeracy skills, sparked a research question in the investigator- Whether the literacy and numeracy skills of children in their early years is

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predicted by the educational status of the parents?

According to Nelson *et al.* (2016) the level of education of parents has a strong association with academic problems during the beginning of the school year. Considering that early experiences create a significant impact on a child's literacy and numeracy development, a study with 3-6-year-old children becomes imperative. Moreover, the collated literature pertaining to the role of parent education in developing the literacy and numeracy skills of early childhood has warranted gaps in the Indian context. As only a handful of research was carried out in India portraying a certain understanding of the effect of parental education on early literacy and numeracy skills, additional researches are very much needed. Accordingly, the aim of the current study was to examine the association between the educational status of the parents with that of the development of emerging literacy and numeracy skills during early childhood.

The researcher is also aware that by examining the role of parental education on the literacy and numeracy skills of their children does not help the children directly but what can be done is to formulate strategies of compromising the lacunae found in the parental educational background with the education or classroom set up of the child. A major strategy that can compensate for the predicting effect of socio-demographic variables is by providing a unified curricular setup abiding by core considerations namely developmentally suitable, individually appropriate, and social & cultural relevance. These considerations form the base areas of the principle of Developmentally Appropriate Practices (DAP). DAP promotes each child's optimal development and learning through a strengths-based, play-based approach to joyful, engaged learning. DAP offers an environment to the children that promote both language acquisition, numerical knowledge, and a positive sense of self that allows children to take responsibility for their own learning. Such recourses and experiences throughout the early childhood years, birth through age eight, are thought to positively affect the development of literacy and numeracy. The objectives of the study are: to analyse the effect of parental educational status on the literacy skills of children in their early years and to analyse the effect of parental educational status on the numeracy skills of children in their early years. The hypothesis of the study is: **H01:**The educational status of the father does not have an effect on the literacy skills of the children in their early years, **H02:** The educational status of the mother does not have an effect on the literacy skills of the children in their early years, H03**:**The educational status of the father does not have an effect on the numeracy skills of the children in their early years and H04**:** The educational status of the mother does not have an effect on the numeracy skills of the children in their early years.

MATERIALS AND METHODS

A sample size of 300 preschoolers both boys and girls between the age of 3-6 years were randomly selected to analyze the effect of parental educational status on their literacy and numeracy skills. The sample for the study was drawn from all five zones of the Coimbatore district through the lottery method of selecting private-run kindergartens in the year 2022.

Survey method was adopted for this study. The children of 3-6 years after the parental consent were tested on their literacy and numeracy skills individually in their respective kindergartens during school hours by the investigator. The testing lasted roughly an hour for a child and was completed in two sessions of 30 min each and 3 hours a day on all working days. The data collection process was continuality carried out for three months.The tools used for the study arethe parental profile of the respondents: a questionnaire with items concerning the details of the parents of selected respondents regarding their educational status, filled by the respective parents; and the Literacy and Numeracy Assessment Pack – a self-formulated Literacy and Numeracy Assessment Pack based on the kindergarten common core state standards of North Carolina for language and Math (2010). Based on the developmental milestones of children aged 3-6, the assessment pack was designed. The pack comprised 22 items in two dimensions namely- emergent literacy skills and emergent numeracy skills. The number of items belonging to emergent literacy skill was 13 and emergent numeracy skill was 9. Emergent literacy skills comprised 2 major domains namely reading and writing. The reading domain has 2 sub domains, print language concept, and phonological awareness skill test. The reading domain encompasses 11 items. The minimum to the maximum range of scores for each item of print language concept was 0 to 8 (0-2= no concept, 3-5= some, 6-7=gaining, 8=control), and the minimum to the maximum range of scores for each item of phonological awareness skill test was 3 to 6 (3=frustration level, 6=mastery level).The writing domain has 2 items. The minimum to the maximum range of scores was 2 to 8 (6=basic, 7=approaching, 8= mastered).The emergent numeracy skill had a total of 9 items assessing the ability of the children incounting forward, counting and cardinality, comparing the number of objects, comparing numbers, number and operation in base ten, data analysis and measurement, operation, and algebraic thinking (addition and subtraction and making the number 10) and decomposing numbers. The minimum to the maximum range of scores was 3 to 6 (3=basic, 5=approaching, 6= mastered).

For the purpose of this study, both the face and content validity of the tool were ensured. To ensure the validity of the questionnaire, the initial drafts of the questionnaire were examined by five experts, and based on the suggestions and comments of these experts, the necessary corrections were made and the final questionnaire was trial tested on a sample of 20 preschoolers. The collected data showed that the preschoolers did not have problems responding to the items in the pack and hence used for the remaining sample.

The collected data was coded, classified, and tabulated. A two-way MANOVA was performed to examine whether the literacy and numeracy scores of the respondent kids differ by the father's and mother's educational status and it was also examined if the score differs by the interactive effect of the parental educational status. The results are interpreted and presented as below.

RESULTS AND DISCUSSION

The independent variable for the study is the 'parental educational status' that has got two groups, namely the 'father's educational status' and the 'mother's educational status'. The

Table 1. Summary statistics based on the level of parent's education (n=300)

S.No.	Dependent Variable	Education level	Father's Education		Mother's Education	
			Mean	SD	Mean	SD
1	Literacy skill	No formal education	42.83	3.22	44.71	1.98
		Primary & lower secondary	51.22	2.89	45.30	1.55
		Higher secondary	45.37	1.57	49.59	1.89
		Undergraduate	50.38	1.01	53.85	2.57
		Postgraduate and above	45.87	2.22	44.95	2.67
2	Numeracy skill	No formal education	35.66	3.50	40.90	2.15
		Primary & lower secondary	42.27	3.14	37.84	1.68
		Higher Secondary	39.07	1.71	41.48	2.06
		Undergraduate	40.19	1.10	44.51	2.79
		Postgraduate and above	45.25	2.41	41.76	2.89

dependent variable was also categorised as two, namely the 'literacy score' and 'numeracy score' of the respondents. Hence, it was decided to use multivariate analysis of variance (MANOVA) to statically compute the data.

a. Descriptive Statistics

The mean and SD of literacy and numeracy scores procured by the respondents based on the level of parental education were presented in Table 1.

The literacy skill among the respondents was higher among children, whose father's educational status was at primary & lower secondary level of education and the mother's educational status at the undergraduate level (M(SD)=51.22 (2.894) and M(SD)=53.85 (2.57) respectively). However, the lowest mean score on the literacy skills of the preschoolers corresponds to the parents with no formal education (M(SD)=42.83(3.22) and M(SD)= 44.71 (1.98)..

A higher mean on the numeracy skill corresponds to the postgraduate fathers and undergraduate mothers (M(SD)=45.25(2.41) and M(SD)=41.76(2.89), respectively). As with literacy skills, the least mean score on numeracy skills was among children whose fathers had no formal education. However, the mothers with the next level of education (i.e.) primary & lower secondary had children with a lower score in numeracy skills.

Considering the sum of assessment figures based on mean score, it can be concluded that the better the educational status of the parents, the better the literacy and numeracy scores of children in their early years.

b. Tests of assumption

The assumptions of MANOVA namely, multivariate normality, linear relationship, outliers, multicollinearity, and homogeneity of variance were carried out. For checking the homogeneity of covariance, the Box's M test for equivalence

of covariance matrices was used to compare the variations in multivariate tests, and the results are presented in Table 2.

Table 2. Test for homogeneity of covariance

S.No.	Box's M	125.761
1	F	2.104
2	df1	51
3	df2	2334
4	Sig.	.000

Box's test with Box's M=125.761,F(51, 2334)=2.10, and p=.000 indicates the heterogeneity of covariance matrices across groups. Hence, the sphericity (homogeneity) seems to be not met. Accordingly, the tests for equality of variances in the literacy and numeracy scores were also conducted presented in Table 3.

As indicated by the significant p-value, the assumption that the variance of each variable was equal across the groups was met in one of the dependent variables the literacy score. However, as the group sizes are equal, Pillai's trace was considered for further analysis.

c. Multivariate and univariate analysis of variances

The test results of the multivariate analysis within the subjects were depicted in Table 4.With Pillai's Trace criterion, the combined dependent variables (Literacy and Numeracy scores) were significantly different by the levels of fathers education (Pillai's=.08,F ((8,5,58)=3.12,p=.002, partial η2=.043). Also, there was a statistically significant difference procured by children based on the interaction effect between father's and mother's educational status (Pillai's=.16,F ((24,5,58)=2.08, p=.002, partial η2=.082). The statistically significant results confirm that the combined measure of literacy and numeracy of the respondents do indeed differ based on parental education and it can be concluded that the literacy and numeracy scores of the kids significantly depend on the educational status of the parents. This finding was partially

Table 3. Levene's test of equality of variances in literacy and numeracy scores

S. No.	Variables	F	df1	df2	p
1	Literacy score	1.81	20	27	.059
2	Numeracy score	2.25	20	27	.002

Table 4. Multivariate analysis of variance for literacy and numeracy skills

S. No.	Effect	Pillai's Trace Value	F (df1, df2)	Sig.	η2
1	Father's Education	.08	3.12 (8, 558)	.002	.043
2	Mother's Education	.05	1.81 (8, 5,58)	.072	.025
3	Father's Education and Mother's Education	.16	2.08 (24, 5,58)	.002	.082

Table 5. Univariate analysis of variance for literacy and numeracy skills based on the parents' educational status

S.No.	Source	Dependent Variable	Sum of Squares	Mean Square	F(df1, df2)	p	η2
1	Father's Education	Literacy skill	956.69	239.17	2.62(4,2,79)	.035	.036
		Numeracy skill	622.78	155.69	1.45(4,2,79)	.217	.020
2	Mother's Education	Literacy skill	974.33	243.58	2.67(4,2,79)	.032	.037
		Numeracy skill	350.59	87.64	.81(4,2,79)	.515	.012
3	Father's Education & Mother's Education	Literacy skill	3119.70	259.97	2.85(12,2,79)	.001	.109
		Numeracy skill	1993.24	166.10	1.54(12,2,79)	.107	.062
4	Error	Literacy skill	25388.13	90.99			
		Numeracy skill	29925.65	107.26			

consistent with Akinsanya *et al*. (2014) who found that parents' education had significant influence of only the numeracy skills in children. However, the current study revealed that the mothers' education (Pillai's=.05,F ((8,5,58)= 1.81,p=.072, partial η2=.025) was not statistically significant.To investigate the parental educational status effect on each of the two dependent variables-Literacy and Numeracy scores a univariate F test using an alpha level of 0.05 was performed (Table 5).

Table 5 distinctly depicts that both father's and mother's educational status were statistically significant with their child's literacy skill with F(4, 2,79)=2.62,p=.035, η2=.036 and F(4, 2,79)=2.67, p=.032, η2=.037,respectively. The above table also depicts a significant effect on the literacy score of the respondents based on the interactive effect of both parents' educational status (F(12, 2,79)=2.85, p=.001) in relation to their child's literacy skill and the partial eta square value η2 is .109, showing a moderate effect size. Majzub and Kurnia (2010), who investigated the effect of the children literacy skill based on their parents' education level observed similar result and concluded that children's literacy skill was influenced by their parent's education level.

d. Pair-wise comparisons

The mean performance difference was also checked since the multivariate and the univariate tests revealed that the literacy and numeracy scores are significantly different across the level of parental education. The mean of the literacy and numeracy scores were compared in a pair-wise format across all categories of parental education to determine which mean differences were significant (Table 6).

The literacy score of the respondents did not depend on the different levels of the father's education, though mean difference (I-J) was found. Thereby the numbered H01, which states that 'the educational status of the father does not have an effect on the Literacy skills of the children in early years' stands accepted.

Table 6. Pair-wise comparisions of father's and mother's educational status with literacy and numeracy skills (n=300)

Dependent Variable	Education level (I)	(J)	(J) Father's Education			(J) Mother's Education		
			Mean Difference (I-J)	SD	Signi-ficant	Mean Difference (I-J)	SD	Signi-ficant
Literacy skill	No formal education	Primary and Lower Secondary	-5.32	3.49	1.000	1.25	1.80	1.000
		Higher Secondary	-6.53	3.02	.315	2.84	1.73	1.000
		Undergraduate	-7.74	3.00	.105	-2.45	1.91	1.000
		Postgraduate and above	-8.47	3.27	.102	-1.11	2.38	1.000
	Primary and Lower Secondary	No formal education	5.32	3.49	1.000	-1.25	1.80	1.000
		Higher Secondary	-1.21	2.19	1.000	1.59	1.45	1.000
		Undergraduate	-2.42	2.16	1.000	-3.70	1.66	.272
		Postgraduate and above	-3.15	2.53	1.000	-2.36	2.19	1.000
	Higher Secondary	No formal education	6.53	3.02	.315	-2.84	1.73	1.000
		Primary and Lower Secondary	1.21	2.19	1.000	-1.59	1.45	1.000
		Undergraduate	-1.20	1.26	1.000	-5.29**	1.59	.010
		Postgraduate and above	-1.94	1.82	1.000	-3.95	2.14	.661
	Undergraduate	No formal education	7.74	3.00	.105	2.45	1.91	1.000
		Primary and Lower Secondary	2.42	2.17	1.000	3.70	1.66	.272
		Higher Secondary	1.20	1.24	1.000	5.29**	1.59	.010
		Postgraduate and above	-.73	1.78	1.000	1.34	2.28	1.000
	Postgraduate and above	No formal education	8.47	3.27	.102	1.11	2.38	1.000
		Primary and Lower Secondary	3.15	2.53	1.000	2.36	2.19	1.000
		Higher Secondary	1.94	1.82	1.000	3.95	2.14	.661
		Undergraduate	0.73	1.78	1.000	-1.34	2.28	1.000

Table 6 contd….

Table 6 contd….

Dependent Variable	Education level (I)	(J)	(J) Father's Education			(J) Mother's Education		
			Mean Difference (I-J)	SD	Signi-ficant	Mean Difference (I-J)	SD	Signi-ficant
Numeracy skill	No formal education	Primary and Lower Secondary	-7.08	3.79	.634	0.07	1.95	1.000
		Higher Secondary	-9.39**	3.28	.045	1.48	1.88	1.000
		Undergraduate	-8.18	3.25	.126	-2.39	2.07	1.000
		Postgraduate and above	-14.11**	3.55	.001	-4.59	2.59	.777
	Primary and Lower Secondary	No formal education	7.08	3.79	.634	-.07	1.95	1.000
		Higher Secondary	-2.31	2.38	1.000	1.42	1.58	1.000
		Undergraduate	-1.11	2.35	1.000	-2.46	1.81	1.000
		Postgraduate and above	-7.03	2.75	.111	-4.66	2.38	.515
	Higher Secondary	No formal education	9.39**	3.28	.045	-1.48	1.88	1.000
		Primary and Lower Secondary	2.31	2.38	1.000	-1.42	1.58	1.000
		Undergraduate	1.21	1.37	1.000	-3.88	1.72	.256
		Postgraduate and above	-4.72	1.97	.177	-6.08	2.32	.094
	Undergraduate	No formal education	8.18	3.25	.126	2.39	2.07	1.000
		Primary and Lower Secondary	1.11	2.35	1.000	2.46	1.81	1.000
		Higher Secondary	-1.21	1.37	1.000	3.88	1.72	.256
		Postgraduate and above	-5.92**	1.94	.025	-2.20	2.48	1.000
	Postgraduate and above	No formal education	14.11**	3.55	.001	4.59	2.59	.777
		Primary and Lower Secondary	7.03	2.75	.111	4.66	2.38	.515
		Higher Secondary	4.72	1.97	.177	6.08	2.32	.094
		Undergraduate	5.92**	1.94	.025	2.20	2.48	1.000

****Significant at 1% level** ***Significant at 5% level**

However, the mother's educational status has a significant impact on the groups of mothers in the higher secondary level of education with that of the undergraduate mothers (I-J (SD)= - 5.29(1.59),p=.010). The negative mean difference between the mother with higher secondary and the undergraduate mothers indicate that the undergraduate mothers have kids acquiring better score in literacy. With reference to clarification of hypothesis numbered H02 that states 'the educational status of the mother does not have an effect on the Literacy skills of the children in early years' stands rejected.

The numeracy score of the respondent kids did not correspond to the levels of mothers' education, though a mean difference (I-J) was found. Thereby the numbered H04, which states that 'the educational status of the mother does not have an effect on the Numeracy skills of the children in early years' stands accepted.

However, the father's educational status has a significant impact on the groups of fathers with no formal education with that of the fathers with a higher secondary level of education (I-J(SD) =-9.39,(3.28),p=.045). The negative mean difference between the father with no formal education with the other two levels of higher secondary and postgraduate fathers (I-J(SD)=-14.11,(3.55), p=.001) indicated that with higher educational status, the kids acquire better scores in numeracy.

Also, Table 6 revealed that the father's educational status has a significant impact on the groups of fathers with undergraduate fathers with that of the postgraduate fathers (I-J (SD) = - 5.92,(1.94),p=.025). The negative mean difference again indicates that the higher the father's education better is the child's numeracy score between the undergraduate fathers and the postgraduate fathers indicating that the postgraduate fathers have kids acquiring better scores in numeracy. Thereby the numbered H03, which states that 'the educational status of the mother does not have an effect on the Numeracy skills of the children in early years' stands rejected.

Drawing on the results of this study, the paper concludes that parental education does have a moderate effect on the literacy and numeracy score of children in their early years. But improving the educational status of the parents is not the possible solution whereas, looking out for a suitable solution among young children is feasible. What can we be done to enhance the literacy and numeracy skills of these children to nullify the impact of parental educational status on them?

Irrespective of the socio cultural context, and economic status, every child born is given equal access to a curricular framework that is developmentally appropriate, culturally responsive, and socially relevant. The other extraneous predictors become nullified. Aligned to this and to the Indian National Education Policy 2020, this research puts forth a recommendation to provide a unified DAP-based curriculum to children in their early years.

CONCLUSIONS

The literacy skill of the children in their early years was dependent on the mother's educational status, wherein the mothers with higher education have kids acquiring better scores in literacy (I-J(SD)=- 5.29(1.59),

p=.010).The numeracy skills of the children in their early years were dependent on the father's educational status and the fathers with a higher educational status had children with better numeracy skills (I-J(SD)=-5.92, (1.94), p=.025). Moreover, the literacy skill was not associated with the father's educational level and the numeracy skill was not dependent on the mother's education.

REFERENCES

Baker, C. E. 2014. African-American fathers' contributions to children's early academic achievement: evidence from two-parent families from the early childhood longitudinal study-birth cohort. Early Educational Development. 25: 19–35. Doi:10.1080/10409289.2013.764225

Chu, F. W., VanMarle, K., Rouder, J and Geary, D. C. 2018. Children's early understanding of number predicts their later problem-solving sophistication in addition. Journal of Experimental Child Psychology. 169: 73–92. Doi:10.1016/j.jecp.2017.12.010

Geary, D. C., VanMarle, K., Chu, F. W., Rouder, J., Hoard, M. K and Nugent, L. 2018. Early conceptual understanding of cardinality predicts superior school-entry number-system knowledge. Psychology. Science. 29:191–205. Doi:10.1177/ 0956797617729817

Gerber, R. J., Wilks, T and Erdie-Lalena, C. 2010. Developmental milestones: motor development. Pediatrics Review. 31: 267–277. Doi:10.1542/pir.31-7-267

Hjetland, H. N., Brinchmann, E. I., Scherer, R., Hulme, C and Melby-Lervåg, M. 2020. Pre-school pathways to reading comprehension: A systematic meta analytic review. Educational. Research. Review. 30: 95-98. Doi:10.1016/ j.edurev.2020.10032

Kleemans, T., Peeters, M., Segers, E and Verhoeven, L. 2012. Child and home predictors of early numeracy skills in kindergarten. Early Childhood Research, Quarterly. 27 (3): 471–477. DoI: 10.1016/ j.ecresq.2011.12.004

Koponen, T., Aunola, K and Nurmi, J.E. 2019. Verbal counting skill predicts later math performance and difficulties in middle school. Contemporary Educational. Psychology. 59: 82-85. Doi:10.1016/ j.cedpsych.2019.101803

Koponen, T., Salmi, P., Torppa, M., Eklund, K., Aro, T and Aro, M. 2016. Counting and rapid naming predict the fluency of arithmetic and reading skills. Contemporary Educational. Psychology. 44(45):83–94. Doi:10.1016/ j.cedpsych.2016.02.004

Nelson, B.B., Dudovitz, R.N., Coker, T.R., Barnet, E.S., Biely, C., Li, N., Szilogyi, P.G., Larson, K., Halfon, N., Zimmerman, F.J and Chung, P.J. 2016. Predictors of poor school-readiness in children without developmental delay at age 2. Pediatrics. 38(2): 1-12

Psyridou, M., Eklund, K., Poikkeus, A. M and Torppa, M. 2018. Reading Outcomes of children with delayed early vocabulary: A follow-up from age 2-16. Research in Developmental Disabilities. 78: 114–124. Doi:10.1016/ j.ridd.2018.05.004

Schneider, M., Beeres, K., Coban, L., Merz, S., Susan, S and Stricker, J. 2017. Associations of non-symbolic and symbolic numerical magnitude processing with mathematical competence: a Meta-Analysis. Developmental. Science. 20(3): 67-70. Doi:10.1111/desc.12372.

Torppa, M., Lyytinen, P., Erskine, J., Eklund, K and Lyytinen, H. 2010. Language development, literacy skills, and predictive connections to reading in finnish children with and without familial risk for dyslexia. Journal of learning difficulties. 43 (4): 308–321. Doi:10.1177/0022219410369096

Watts, T. W., Duncan, G. J., Siegler, R. S and Davis-Kean, P. E. 2014. What's past is prologue: Relations between early mathematics knowledge and high school achievement. Educational. Research. 43:352–360. Doi:10.3102/0013189X14553660

Zhang, X., Koponen, T., Räsänen, P., Aunola, K., Lerkkanen, M. K and Nurmi, J. E. 2014. Linguistic and spatial skills predict early arithmetic development via counting sequence knowledge. Child Development. 85 (3): 1091–1107. Doi:10.1111/cdev.12173

Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A and Faísca, L. 2010. Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. Psychology. Science. 21:551–559. Doi:10.1177/ 0956797610363406

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STANDARDIZATION AND EVALUATION OF QUALITY OF THE JACKFRUIT PULP INCORPORATED ICE CREAM

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ABSTRACT

Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the most underutilised fruit containing high amounts of vitamins, minerals, phytochemicals, proteins, carbohydrates and other nutrients. During the flush season, jackfruit is inexpensive and readily available in large quantities.An infinite number of raw fruits are wasted each year, as the fruit is perishable and there are only few value added products.Ice cream is one of the most popular dairy products that is enjoyed by people of all ages. The experiment was conducted at the Department of Community Science, College of Agriculture, Kerala Agricultural University, Vellanikkara, Kerala in the year 2022.The organoleptic evaluation of the standardised ice creams was conducted in order to select the best treatment. The revealed that the selectedice cream had incorporation of 10 percent jackfruit pulp securing the highest mean score in terms of parameters like appearance (8.89), taste (8.82) and overall acceptability (8.81). These scores were significant when statistically evaluated using Kendall's Coefficient of Concordance. The selected ice cream was subjected to physico-chemical analysisusing standard procedures along with control. The jackfruit incorporated ice cream is a nutritious delicacy with novel taste.

Keywords: Ice cream, Jackfruit pulp ice-creams, Organoleptic evaluation, Physico-chemical analysis

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam.) is a widely available tropical fruit. The jackfruit, which is regarded as the world's largest edible fruitisshown to contain significant amounts of vitamins, minerals, phytochemicals, proteins, carbohydrates and other nutrients. The phytonutrients included in jackfruit, are known to have a variety of positive health effects such as anti-aging, anti-cancer and anti-hypertensive characteristics. In spite of having nutritional benefits,the jackfruit is an underutilised crop in the tropicaltosubtropical climate where most of the fruits get discarded owing to ignorance. Ripe jackfruit's edible bulbs are typically eaten fresh or converted into canned foods.Additionally, the jackfruit is used to create a variety of products, including jackfruit candy, juice, jam, jelly, finger

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chips, fruit bars, fruit leather, *halvah*, pickles, papad, ready-to-serve beverages, wine, toffee, cake and milk-based *shrikhand, rasogolla, basundi* and kulfi.

Ice cream is a frozen product and the popularity of ice cream is attributed to their refreshingly cool and delightfully sweet characteristics unanimously enjoyed by people of all ages.Ice cream is a frozen product prepared from cow or buffalo milk or a combination there of or from cream and or other milk products with or without the addition of cane sugar, eggs, fresh fruits, fruit juice, preserved fruits, nuts, chocolate, edible flavours and permitted food colours. Ice cream is a wholesome, delectable, relatively balanced, and easily digestible food.Ice cream is a particularly appealing food for growing kids and people who need to gain weight because these ingredients are virtually entirely digested. Ice cream's nutritional value and energy content are influenced by the food value of the ingredients used to make it. From unripe, ripe and raw fruits and seeds, many dishes have been created. The consumer trend nowadays is toward foods with more natural antioxidants, dietary fibres, natural colourants, minerals, and vitamins as well as foods that are low in calories, low in cholesterol, low in fat and devoid of artificial additives, among other things.In recent years, fruit based ice cream has attracted attention due to presence of different functional properties.The development of ice cream using jackfruit pulp has been attempted in light of the demand for ice cream and the fruit's nutritional value. The initiative of this study was started with the following goals because there is very less evidence of systematic research on jackfruit ice cream. Hence, this study was conducted with an aim to develop jackfruit incorporated ice creams and to evaluate the physico-chemical properties of the ice cream with best concentration of jackfruit pulp addition.

MATERIALS AND METHODS

Collection of ingredients

The experiment was conducted at the Department of Community Science, College of Agriculture, Kerala Agricultural University, Vellanikkara, Kerala in the year 2022. Fresh cow's milk required for the study was procured from College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Mannuthy. The jackfruit variety "*varikka"* was selected for the study and it was procured from the local households. The other ingredients used for the preparation of ice cream were skimmed milk powder, sugar, vanilla flavour and cream which were purchased from the local market.The stabilizers used were guar gum, xanthan gum, carrageenan, sodium alginate and dextrose which were also purchased from the local market.

Standardization of jackfruit pulp (JP) incorporated ice cream

For the standardisation of JP incorporated ice creams, the pulp was prepared from fresh jackfruit. For this the jackfruit was first washed in running tap water to remove dirt and dust, then cut with sharp knife to get bulbs after removal of seed. The bulbs or carpel was ground to paste form in grinder for three minutes at medium speed and passed through one mm stainless steel sieve in order to get uniform pulp. The pulp

thus obtained was stored at refrigeration temperature and used as and when required.

The pulp was added at various concentrations ranging from 5 - 30 percent in different treatments (T1 - T6),respectively. Plain ice cream without the addition of pulp served as control(T0). The experiment was conducted in a completely randomised design (CRD) and was replicated thrice.

Preparation of JP incorporated ice cream

Table 1. Composition of ice cream

S. No.	Ingredient	Quantity
1	Cow's milk (ml)	45
2	Cream (ml)	15
3	Skimmed milk powder (g)	7.4
4	Sugar (g)	15
5	Stabilizer (g)	0.5 (0.1 each)
6	Vanillin (ml)	0.1
7	Water (ml)	10

The composition for the preparation of ice cream is illustrated in Table 1. To the milk, the skim milk powder, sugar and water, were added and pasteurized at 85 ºC for one minute. This mix was homogenised and allowed to cool to 40 ºC to which cream was added. The homogenised mix was kept for ripening at 4 °C for 24 h. After ripening, the JP was added and then kept for storage in freezer (Figure 1).

Standardisation of level of JP in ice cream

The jackfruit pulp from the jackfruit variety "*varikka"* was added to ice creams at 0, 5, 10, 15, 20, 25 and 30 percent level for the treatments

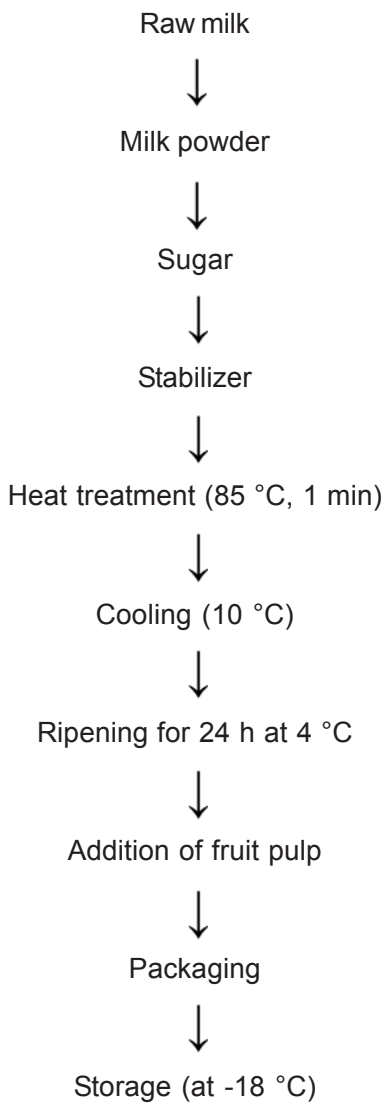

Figure. 1. Flow diagram for the preparation of the jackfruit ice cream

T0 to T6, respectively (Table 2) and is compared with plain icecream (without adding the JP).

The ice cream prepared with these formulations was evaluated for sensory qualities and level of addition was standardised on the basis of sensory qualities of ice cream with three replications and the physico-chemical analysis of best treatment selected were analysed.

Table 2. Treatments for the stadardisation of jackfruit incorporated ice cream

S.No.	Treatment	Composition
1	T0	Ice cream
2	T1	Ice cream + 5 % JP
3	T2	Ice cream + 10 % JP
4	T3	Ice cream + 15 % JP
5	T4	Ice cream + 20 % JP
6	T5	Ice cream + 25 % JP
7	T6	Ice cream + 30 % JP

Organoleptic evaluation

The organoleptic evaluation of the jackfruit incorporated ice creams were carried out by a panel of selected 20 judges using a nine-point hedonic scale with the replications in the College of Agriculture, Vellanikkara. The judges were asked to indicate their opinion on a nine-point hedonic scale (9 for like extremely to 1 for dislike extremely). The experts analysed each treatment for their appearance, colour, texture, taste,flavour and overall acceptability of the product. The scale of likeness used for the study was: 1 - Disliked extremely, 2 - Disliked very much, 3 - Disliked moderately, 4 - Disliked slightly, 5 - Neither liked nor disliked, 6 - Liked slightly, 7 - Liked moderately, 8 - Liked very much and 9 - Liked extremely.

Physico-chemical analysis

The physico-chemical qualities such as moisture, protein, fat,sucrose, TSS acidity and pH of the selected jackfruit pulp incorporated ice cream were estimated using the standard procedures.

Statistical analysis

The observations recorded during organoleptic evaluation, were tabulated and data was analysed by using Completely Randomized Design (CRD). The scores obtained for the organoleptic evaluation were evaluated by Kendall's Coefficient of Concordance (W).

Cost of production

Cost of production of the most acceptable combination of the jackfruit incorporated ice cream was computed considering the material cost, labour charges, fuel and electricity costs.

RESULTS AND DISCUSSION

The results of the organoleptic evaluation and the results of the physico-chemical analysis of the selected best treatment in jackfruit incorporated ice creams are given in this section.

Organoleptic evaluation

Sensory evaluation is used to quantify, analyse and evaluate how a product's attributes are experienced by consumers. The human senses of sight, hearing, taste, smell and touch are employed to quantify these sensory properties, which are a mixture of traits that together create a sensory experience (appearance, texture, taste, colour and flavour). The jackfruit incorporated ice creams developed under different treatments were evaluated for higher acceptability through sensory analysis. Jackfruit contributes to the desirable appearance, flavour and sensory properties of desserts and confectioneries. In the study, the suitability of JP in ice-cream was assessed.

The mean score obtained for the organoleptic qualities of each treatment were

Table 3. Mean scores for organoleptic evaluation of jackfruit pulp incorporated ice cream

Treatments	Sensory attributes						
	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability	Total score
T_0	8.60 (4.17)	8.46 (4.87)	8.46 (5.67)	8.60 (6.00)	8.67 (4.83)	8.56 (5.67)	51.33
T_1	8.56 (3.97)	8.51 (5.07)	8.44 (5.33)	8.24 (4.33)	8.80 (5.27)	8.52 (5.43)	51.08
T_2	8.89 (5.73)	8.73 (5.80)	8.76 (6.67)	8.82 (6.70)	8.84 (6.13)	8.81 (6.73)	52.85
T_3	8.60 (4.20)	8.11 (3.47)	7.49 (3.37)	7.73 (4.03)	8.22 (4.10)	8.03 (3.97)	48.19
T_4	8.60 (4.07)	7.89 (2.97)	7.42 (3.27)	7.56 (3.43)	8.04 (2.87)	7.90 (2.53)	47.41
T5	8.44 (3.20)	7.89 (2.93)	6.91 (1.73)	7.16 (2.13)	7.78 (2.40)	7.64 (1.77)	45.81
T6	8.33 (2.67)	7.89 (2.90)	6.84 (1.77)	6.91 (1.37)	7.78 (2.40)	7.62 (1.90)	45.37
Kendall's W value	**0.249****	**0.346****	**0.878****	**0.840****	**0.578****	**0.864****	

Values in parentheses are mean rank scores based on Kendall's W (**significant at 1 % level)

statistically analysed using Kendall's coefficient of concordance and the mean scores were determined (Table 3).

In the study based on sensory evaluation, the treatment T2 (10% jackfruit pulp) was selected as the best combination securing highest scores in all the organoleptic parameters such as appearance, colour, flavour, taste, texture and over acceptability.

The average sensory scores presented in Table 3 revealed that the incorporation of jackfruit pulp in the ice cream significantly enhanced the overall sensory scores compared to the control ice cream. The sensory evaluation scores revealed that acceptability was highest for the ice cream mix incorporated with 10 percent (T2) jackfruit pulp.The highest total score of 52.85 was noticed in T2 followed by 51.08 (T1), 48.19 (T3), 47.41 (T4), 45.81 (T5) and 45.37 (T6), respectively. Kendall's value showed that there was significant agreement between the judges at 1% level.

The maximum sensory score for appearance (8.89) and for colour (8.73) was

obtained to the ice cream containing 10 percent JP (T2). The ice cream prepared using 30 percent JP (T6) scored the lowest score for both appearance and colour. It was found that as the level of JP increased the score of appearance increased,upto addition of 10 percent pulp and then the scores declined. This is mainly because of lower the concentration of JP the colour of the ice cream was lighter and higher concentration of the JP, the darker and less appealing was the ice cream.

It was observed that the obtained score for flavourof the ice cream prepared by addition of JP at the rate of 0, 5% and 10 percent were 8.46 (T0), 8.44 (T1) and 8.76 (T2), respectively. The maximum score (8.76) was recorded to the sample containing 10 percent (T2) JP. The scores reduced with further addition of JPand minimum score (6.84) was to the product prepared with 30 percent JP (control). Similar observations were found in terms of taste as well. The scores improved with the addition of JP when compared with control and then decreased when JP was added more than 10 percent. The strong pungent flavour of jackfruit is the reason for such an observation.

The score for texture ranged from 7.78 to 8.84 (Table 2). The maximum score was recorded for treatment T2 (8.84) and minimum score for both T5 and T6 (7.78). The reduction in texture of JP incorporated ice cream might be because of the carpel of jackfruit which was fibrous, soft and mushy as reported by Swami *et al*. (2019), which supports the finding of the study.

The overall acceptability score for T0 and T2 were 8.56 and 8.81, respectively. The icecream prepared using 10 percent JP was yellow in colour, had optimum firmness and pleasing sweet and sour jackfruit flavour. The ice creams prepared using 5 percent JP were light yellow in colour, lightly hard body and lacked in flavour on the other hand, the ice creams prepared using more than 10 percent JP were dark yellow in colour, lacking firmness and pungent in flavour and taste. On the basis of these results, T2 (10% JP) was selected and used for further study.

Gaikwad *et al.* (2020) prepared ice cream using jackfruit pulp and concluded that the best quality ice cream could be prepared by addition of 15 percent JP of *Barka* type, 15 percent sugar and 0.1 percent carrageenan stabilizer.The results obtained in this study were on par with the study conducted by Haque *et al.* (2015) where fruitcakes containing upto 10 percent jackfruit pulp were most acceptable concerning sensory evaluation. The higher amount of jackfruit pulp was not accepted by the consumer in terms of overall internal and external appearances.

Physico-chemical analysis of the ice creams

The ice cream which was selected as best in the organoleptic evaluation (T2) was evaluated for nutritional value along with control (Table 4). The moisture content of the selected ice cream was observed to be 61.67 percent and for control was 60.82 percent.Nadelman *et al*. (2017) reported that the moisture content of ice cream developed from conventional sheep milk was 67.61%. According to Deosarkar *et al.*(2016) the recommended moisture content for ice cream is 61.7% which is on par with the study.

The TSS of the selected ice cream was found to be 38.33% which was slightly higher than

Table 4. Physico-chemical analysis of ice creams

S.No.	Quality Parameters	Control Ice cream	Jackfruit Ice cream
1	Moisture (%)	60.82	61.67
2	TSS (%)	37.18	38.33
3	Protein (%)	3.61	3.57
4	Fat (%)	4.79	3.59
5	Acidity (%)	0.14	0.18
6	pH	6.62	6.46
7	Sucrose (%)	18.96	19.27

the control (37.18%).Shelke *et al*. (2020) studied the utilisation of jamun pomace as functional ingredient to enhance the physico-chemical and sensory characteristics of ice cream, the TSS content of ice cream was found to be in the range of 29 to 39 percent. According to Jayatilake *et al.* (2020), there was a gradual decrement of TSS in synbiotic icecream incorporated with arrowroot during frozen storage period from 31.75 % to 28.65%.

The air interface in ice cream is stabilised in part by milk proteins, which is crucial for overall structure and stability. Protein content of the control was 3.61% and the developed jackfruit ice cream was 3.57%. Similar observation was found in vanilla ice cream 3.78% protein prepared by Patel *et al.* (2016). Remya *et al.*(2019) prepared bioyoghurt incorporating jackfruit pulp and the protein content ranged between 3.00 g to 3.05 g/ 100 g in both "*koozha"* and *"varikka"* varieties of jackfruit.

In a conventional ice cream, the microstructure formed throughout the ageing, freezing and aeration processes is significantly influenced by the fat. The fat also aids in flavour release and serves as a vehicle for lipid-soluble flavours (Underdown *et al*., 2018). The developed jackfruit ice cream had fat content of 3.59% and for control ice cream was 4.79%. As per FSSAI (2016), if the fat content is more than 2.5 and less than 10.0%, the ice cream is categorised into medium fat ice cream. Hence, the developed ice cream is a medium fat ice cream.Total fat contents in the ice creams developed by Espinoza *et al*. (2020) showed almost similar values in all formulations analysed ranging from 4.2 to 6.4 percent.

To achieve the ideal pH, acidity is a crucial consideration.When the mixture is pasteurised, the presence of excessive amount of acid may cause the mixture to curdle. Acidity of the control ice cream was 0.14 with a pH 6.62 and developed jackfruit ice cream was slightly higher than the control 0.18 percent with a pH of 6.46 which isoptimum. Shinde *et al*.(2021) developed ice cream incorporating jackfruit seed flour, the acidity (%) was increased from 0.21 percent to 0.24 percent during five weeks of storage period.

Although a variety of sugars, including glucose, fructose, sucrose and sugar alcohols, are utilised in the manufacturing of ice cream, sucrose is the primary sweetener which gives

taste to the ice-cream. In this study, the sucrose content of control ice cream was 18.96% and the developed jackfruit ice cream contains 19.27 percent sucrose, which was slightly higher compared to the sucrose content when ice cream was developed by Mansour *et al*. (2021) with date fibre powder (15%).

Cost of the products

The cost of production of the jackfruit incorporated ice cream was Rs. 50/100 g. The cost of commercially available premium ice creamsis in the range is Rs. 55-80/100 g. Gaikwad *et al*. (2020) reported average cost of production for jamun juice incorporated at level of 5%, 10% and 15 percent and control ice cream samples was Rs. 50.91, Rs. 54.06, Rs.57.09 and Rs.48.04, respectively.

CONCLUSIONS

Addition of 10 percent jackfruit pulp to the ice cream enhanced the overall acceptability of the product when compared to the control (plain ice cream). When jackfruit pulp, above 10 percent was added, the overall acceptability of the product decreased due to increase in intensity of appearance, pungent colour, flavour and taste. The texture was also negatively affected when concentration of pulp was more than 10 percent. The scores obtained in organoleptic evaluation were significant when evaluated statistically using Kendall's coefficient of concordance.The physico-chemical analysis was conducted for the selected best treatment which showed results that are in accordance with similar studies. Hence, jackfruit could be judiciously used for the development of ice cream which could serve as a delicious and nutritious delicacy for people of all ages.

REFERENCES

Deosarkar, S. S., Kalyankar, S. D., Pawshe, R. D and Khedkar, C. D.2016. On ice cream: Composition and health effects. In: Encyclopedia of Food and Health. Academic press. pp. 385-390.

Espinoza, L. A., Purrinos, L., Centeno, J. A and Carballo, J.2020. Chemical, microbial and sensory properties of a chestnut and milk ice cream with improved healthy characteristics. International Journal of Food Properties. 23(1): 2271-2294.

FSSAI. 2016. Food Safety and Standards Authority of India. FSSAI notifies revised standards for milk and milk products. Retrieved from website (https://foodsafetyhelpline.com/fssai-notifies-revised-general-standards-milk-milk-products/.) on 08.01.2022.

Gaikwad, S. B., Kamble, D. K and Jaybhay, V. B. 2020. Development of ice cream by using jackfruit pulp. Journal of Pharmaceutical Innovation. 9 (9): 533-539.

Haque, M. A., Begum, R., Shibly, A. Z., Sultana, M. M and Khatun, A. 2015. Influence of jackfruit pulp on the quality and shelf life of jackfruit cake. Journal of Environmental Science and Natural Resources. 8(1): 59-64.

Jayatilake, S., Priyadarshana, D. G. C. E and Kumarage, P. M. 2020. Evaluation of efficacy of Arrowroot (*Marantaar-undinacea*) extract incorporated synbiotic ice-cream. International Journal of Psychosocial Rehabilitation. 24(04):16-21.

Mansour, A. I., Ahmed, M. A., Elfaruk, M. S., Alsaleem, K. A., Hammam, A. R and El Derwy, Y. M. 2021. A novel process to improve the characteristics of low fat ice cream using date fibre powder. Food Science and Nutrition. 9 (6): 2836-2842.

Nadelman, P., Frazao, J. V., Vieira, T. I., Balthazar, C. F., Andrade, M. M., Alexandria, A. K., Cruz, A. G., Fonseca-Goncalves A and Maia L. C. 2017. The performance of probiotic fermented sheep milk and ice cream sheep milk in inhibiting enamel mineral loss. Food Research International. 9(7): 84-190.

Patel, M. R., Baer, R. J and Acharya, M. R. 2016. Increasing the protein content of ice cream. Journal of Dairy Science. 89(5): 1400-1406.

Remya, P. R., Sharon, C. L., Aneena, E. R., Panjikkaran, S. T and Shahanas, E. 2019. Standardization and quality evaluation of jackfruit based low fat yogurt. Asian Journal of Dairy and Food Research. 38 (2): 93-97.

Shelke, G., Kad, V., Yenge, G., Desai, S and Kakde, S. 2020. Utilization of jamun pomace as functional ingredients to enhance the physico chemical and sensory characteristics of ice cream. Journal of Food Processing and Preservation. 44 (10): 4736 -4737.

Shinde, V. L., Pawar, C. D., Warang, O. S., Dandekar, V. S., Kulkarni, M. M., Josiya, J and Joshi, M. S. 2021. Studies on preparation of ice cream from jackfruit (*Artocarpus heterophyllus*) seed powder. International Journal of Chemical Studies. 9(1): 2710-2712.

Swami, S. B., Thakor, N. J., Haldankar, P. M and Kalse, S. B. 2019. Jackfruit and its many functional components as related to human health: a review. Comprehensive Reviews in Food Science and Food Safety. 11 (6): 565-576.

Underdown, J., Quail, P. J and Smith, K. W. 2018. Reducing saturated fats in foods. Woodhead Publishing, New Delhi, India. pp.350-369.

Rajeesha, C. R., Sharon, C. L., Panjikkaran, S. T., Aneena, E. R. and Lakshmy P. S. 2023. Standardization and evaluation of quality of the jackfruit pulp incorporated ice creams. The Journal of Research ANGRAU. 51(2): 125-133. https://doi.org/10.58537/jorangrau.2023.51.2.14

DoI: https://doi.org/10.58537/jorangrau.2023.51.1.15

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FACTORS INFLUENCING MENTAL AND PSYCHOLOGICAL HEALTH DURING PREGNANCY

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ABSTRACT

The study aimed to evaluate maternal mental and psychological health throughout the pregnancy based on age, religion, and occupation. In this cross-sectional study, a total of 66 pregnant women from govt. and private hospitals in Coimbatore city who were admitted between December 2019 and January 2020 were selected as respondents.Purposive sampling method was applied to select the samples. A self-constructed tool on Pregnancy Psychological Status Scale (which assesses mental health) was developed and used to collect data from pregnant women. Results revealed that significant differences in mental and psychological health based on religion (p=0.005) and occupation (p<0.001). The overall level of psychological status (Mental health) among Hindu pregnant women was found better as compared to Muslims and Christians. Regarding occupation, housewives reported higher mental and psychological health followed by private and government employees. However, no significant differences could be seen among various age groups of pregnant women.

Keywords: Mental Health, Pregnancy, Psychological Health

INTRODUCTION

Pregnancy is an exceptional period for every woman, which is a particular and complex time with various physical and psychological changes that a pregnant woman experiences during the nine months (Bjelica *et al.,* 2018; Isaacs and Andipatin, 2020). It is a remarkable and vital period in a woman's life because the mother-to-be prepares herself for her new role as a mother(Lindsay, 2019).Thus, this period is generally ûlled with feelings of excitement and happiness; yet, stress, anxiety, and otherundesirable emotions and sentimentscould be seen during pregnancy (Lindsay, 2019). The psychological stress of pregnant mothers is generally believed to influence pregnancy, and it may increase the risk of fetal death in different ways (Relier, 2001). Stress during the prenatal period has also been shown to impair the regulation of the hypothalamic-pituitary-adrenal axis, and likely the effects of stress on birth

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outcomes are a consequence of the fetus being exposed to higher levels of cortisol (Weinstock, 2005).

Most of the prevailing studies showed that if the mother during pregnancy is anxious, worried, and distressful, the probability of the newborn weight loss and encountering unpleased results after birth such as emotional problems and the symptoms of hyperactivity disorders as well as problems in cognitive development will increase (Parcells, 2010).

Nayak *et al*. (2015) reported that physical changes could be seen throughout the pregnancy along with mood swings and other psychological or emotional reactions. The study added that during the advanced stage or third trimester of pregnancy, women experience various psychological problems, namely depression, somatization, anger hostility, interpersonal sensitivity, phobic anxiety, sleep disturbance, appetite, psychoticism etc.; these symptoms may relate to their current age and duration of pregnancy.

Based on the existing evidence,stress, depression, or anxiety in pregnancy has been associated with increased obstetric complications, including stillbirth and low birth weight infants(Dole, 2003; Maina *et al*., 2008). Pregnancy is a crucial time to care for the mothers' minds and mental attitudes (Donegan, 2015). Hence,the researcher decided to conduct a pilot study to evaluate maternal mental health and psychological status. Thus, the study aimed to assess mental and psychological health of the pregnant women; to analyze mental and psychological health of pregnant women based on age; to examine mental and psychological health of pregnant women based on religion and to know the mental and psychological health of pregnant women based and occupation.

MATERIAL AND METHODS

Area of the study and study sample

This pilot study was conducted between December 2019 and January 2020 in Coimbatore city of Tamil Nadu. The target groups of this study were pregnant women from various govt. and private hospitals. A total of 66 pregnant women were selected through the purposive sampling method. Prior permission/consent was obtained frompregnant women, theirfamilies,and the three hospitals of two Primary Health Centres (PHCs) and one private hospital. Inclusion and exclusion criteria were applied for sample selection; inclusion criteria involved pregnant women of the first trimester, between the age group of 18-40 years, and first/second/third pregnancies. In exclusion criteria, the points considered wereunwillingness to participate, below 18 years and above 40 years.

The data were collected with the help of a self-constructed tool named 'Pregnancy Psychological Status Scale'.This tool consisted of two parts: a sociodemographic profile and Pregnancy Psychological Status Scale(mental health). The socio-demographic profile was specially designed to gather information about sample characteristics and variables: name, age, education, income, religion, occupation, types of family, size of family, stages of pregnancy, etc.

Procedure of the study and research design

The Pregnancy Psychological Status Scale (PPSS) was constructed to measure the mental health and psychological status of pregnant women (Fig. 1). It was designed by referring to

various available tools based on mental health and psychological conditions during pregnancy. The tool consisted of 50 items in seven dimensions, namely anxiety (8 items), stress (10 items), depression (7 items), emotions (7 items), socialization (5 items), personal relationships (7 items), and in-law-family relationships (6 items). Item analysis and analyses of internal consistency, parallel form reliability, content validity, construct validity and criterion validity were performed to meet out standardization requirements. The alpha Cronbach value for reliability is 0.71 which got the accepted value to measure the same. Out of 50 items, 12 are true-keyed,and the rest 38 are false-keyed. A5-point Likert scale was adopted to respond to each statement: Always, Often, Sometimes, Rarely, and Never and the scoring for true-keyed items were 5, 4, 3, 2, 1 and for false keyed, the items were scored as 1, 2, 3, 4, 5 respectively. Total scores obtained range between 50-250, thus indicating thatthe higher the score better the mental health and psychological status, the lower the score,the poorermental health, and psychological status among pregnant women. The categories are as follows:

S.No.	Scale Score	Level of mental & psychological health
1	184-250	Good
2	117-183	Average
3	50-116	Poor

All the data were normally distributed, descriptive, and inferential statistics were applied. In inferential statistics, ANOVA, independent, t-tests were performed to assess

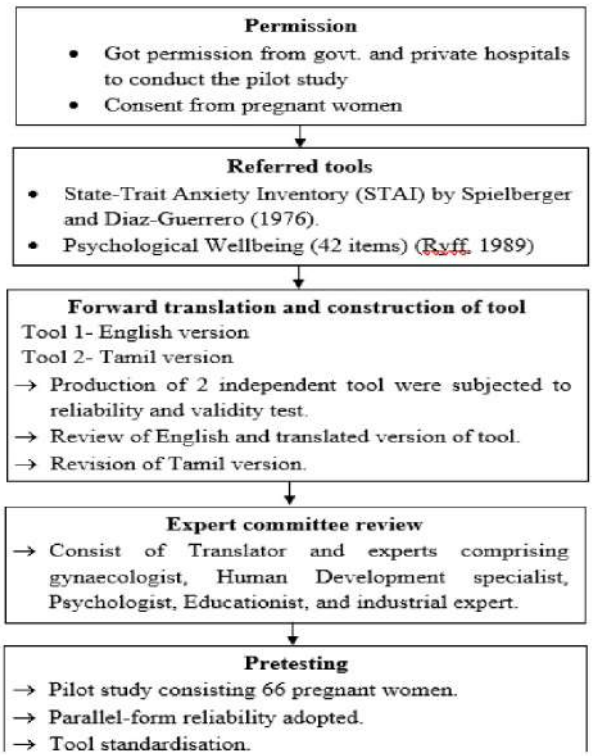

Fig.1. The process of developing the Pregnancy Psychological Status Scale and assessment of mental and psychological health

the mental and psychological health among selected pregnant women.

RESULTS AND DISCUSSION

Demographic profile of the respondents

Demographic factors such as age, religion, and occupation were represented as follows: Table 1 illustrates the descriptive statistics for all variables. The researcher selected total respondents of 66 pregnant women from Coimbatore. These participants were categorized under age, religion, and occupation. Most respondents (69.7%) were between 20 and 30 years of age, and a few, *i.e.,* 30.3 percent fell under the age group of 31-40.

Table 1. Descriptive statistic for all variables (n=66)

S..No.		Variables	Frequency	Percentage
1.	Age	20-30 years	46	69.7
		31-40 years	20	30.3
2.	Religion	Hindu	48	72.7
		Muslim	9	13.6
		Christian	9	13.6
3.	Occupation	Housewives	37	56.1
		Govt. employee	16	24.2
		Private employee	13	19.7

Table 2. Distribution of respondents based on mental and psychological health (n=66)

S..No.	Psychological status	Frequency	Percentage
1.	Good	45	68.2
2.	Average	21	31.8
3.	Poor	0	0

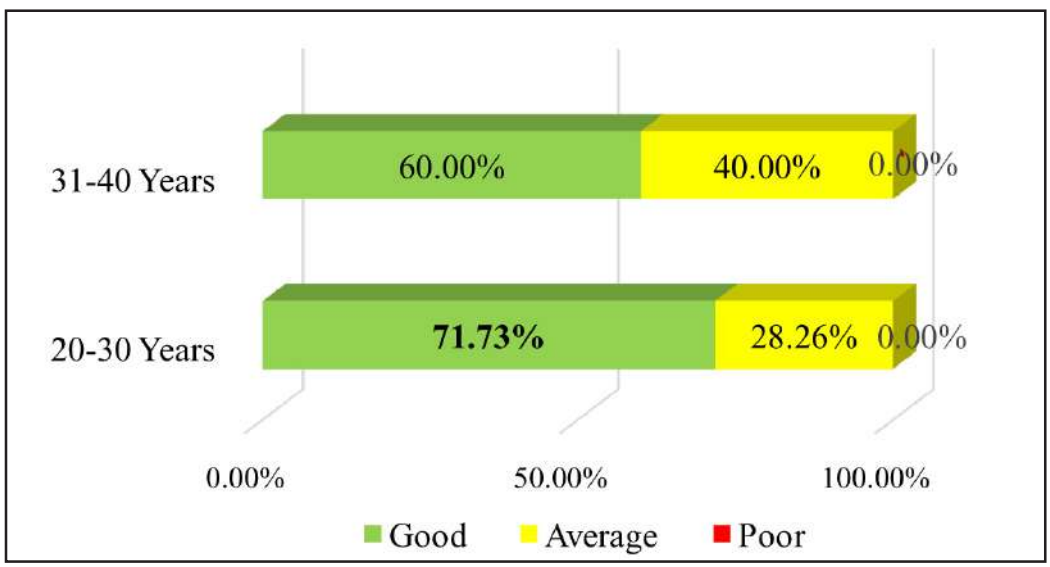

Fig. 2. Level of mental and psychological health among pregnant women in relation to age

Regarding religion, majority of the respondents, *i.e.,* 72.7 percent were Hindu and an equal number of respondents, i.e., 13.6 percent, were distributed under Muslim and Christian, respectively.

Regarding occupation, 56.1 percent were homemakers, 24.2 percent were govt. employees and 19.7 were engaged in private jobs. Table 2 represents the level of the psychological status of pregnant women.From the above table, it was

Table 3. Mental and psychological health of pregnant women based on age (n=66)

Sl. No.	Age	Mean	SD	t	p-value
1.	20-30years(n=46)	198.10	30.30	1.705	0.093NS
2.	31-40 years(n=20)	183.10	38.26		

NS-Not significant

observed thatmajorityof the respondents, *i.e.,* 68.2 percent had good mental and psychological health, and the remaining 31.8 percent had moderate mental and psychological health. There was no one with poor mental and psychological health. Findings showed that most (71.73%) of respondents under the 20-30 age group had good mental and psychological health, while 28.26 percent had average mental and psychological health.

Regarding respondents belonging to 31-40 years, 60 percent had good mental and psychological health, 40 percent were unde r-averageand no respondents were found under poor mental and psychological health in the age groups.

Table 3 describes mental and psychological health of pregnant women based on age. But the result did not show any significant difference.Thus, age groups have no significant difference in their psychological status.The reasons observed by the study were due to individual experiences that may vary, similar expectations and preparedness for their pregnancies, pregnant women of both age groups accessed to have similar support networks comprising partners, family members, friends, or healthcare professionals, and adequate social support.

The study conducted by Ulfah *et al.* (2021) which contradictsthe results of the study revealed that the effect of stress on psychological well-being with age was found significant (p<0.01).

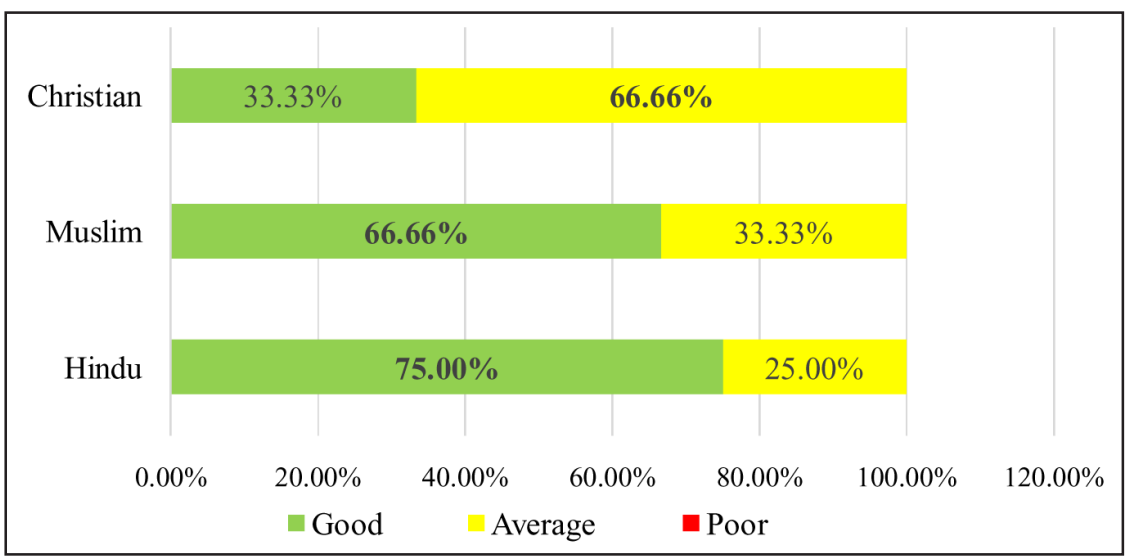

Fig.3. Level of mental and psychological health among pregnant women based on religion

Table 4. Mental and psychological healthof pregnant women based on religion (n=66)

S..No.	Religion	Mean	SD	F	p-value
1.	Hindu (n=48)	200.95	28.08	5.832	0.005**
2.	Muslim (n=9)	183.44	36.16		
3.	Christian (n=9)	164.22	41.02		

**Significant at 1% level

Thus, there was an effect of maternal characteristics such as age, gestational age,and parity on psychological well-being.

Regarding Hindu religion, majority of respondents, *i.e.,* 75.00 percent had good mental and psychological health during pregnancy, while only 25 percent fell under average mental and psychological health. No one was found in poor mental and psychological health.

In case of Muslims, 66.66 percent of the total respondents were in good mental and psychological health, whereas only one-third of the respondents *i.e.,* 33.33 percent were found to have average mental and psychological health. Likewise, for Hindus, none of the respondents fell under the poor category.

Regarding Christian religion, majority of respondents (66.66%) had average mental and psychological healthduring pregnancy and the rest 33.33 percent had good mental and psychological health. However, no respondent was found under poor mental and psychological healthamong Christian respondents.

Table 4 describes the Mean, SD, and F-values of the mental and psychological healthof pregnant women based on religion.

Findings showed that mental and psychological health had significantdifferences based on religion. Regarding religion, the observed mean and SD values among Hindus were 200.95 and 28.08, respectively. In the case of Muslims, the mean value was 183.44, and SD was 36.16. Regarding Christian, it was 164.22, and SD was 41.02, respectively. The observed p-value was 0.005, which is significant at 1% level. From this, it could be stated that respondents from the Hindu religion had better mental and psychological health than Muslims and Christians. However, it is inappropriate and incorrect to generalize about the psychological status of pregnant women based on their religious affiliations. But in this study, the variations of psychological status among different religions were observed based on cultural factors, individual differences, support from in-laws, small family size, and financial security. Hence, Hindu pregnant women tended to have better mental and psychological health than others.

Kumari *et al.*(2013) also support the findings and explored the relationship between religiosity, anxiety, and pregnancy outcomes. The results indicated that higher levels of religiosity were associated with lower anxiety levels and improved pregnancy outcomes.

Regarding occupation, it was observed that many housewives, *i.e.,* 83.7 percent had good mental and psychological healthwhile only very few, *i.e.,* 16.21 percent, were under the

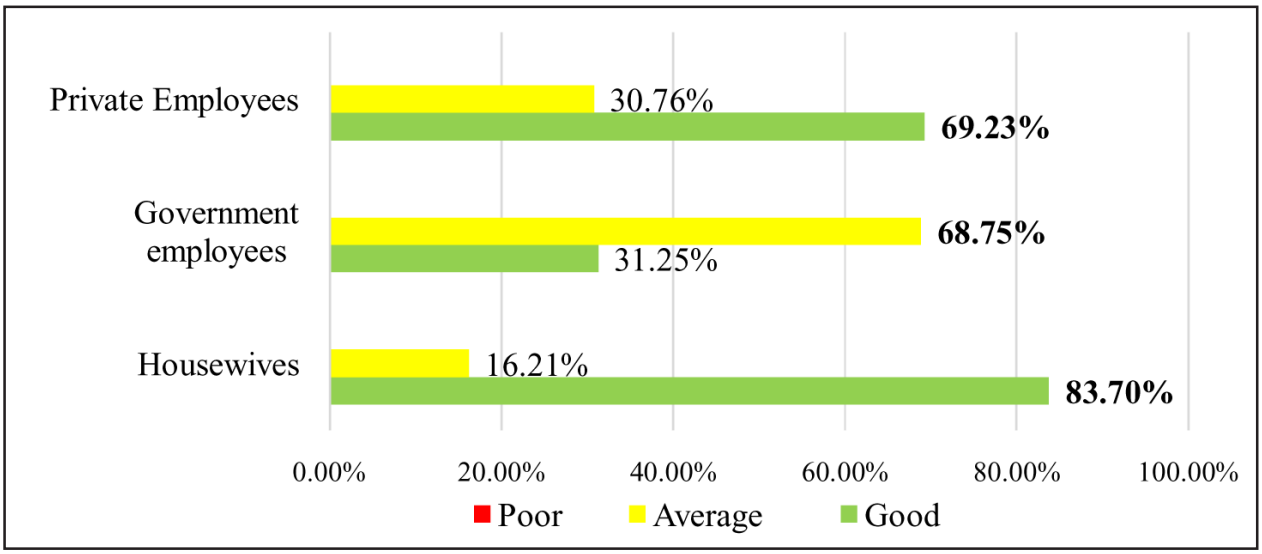

Fig. 4. Level of mental and psychological health among pregnant women based on occupation

category of average mental and psychological health. On the other hand, no one was observed under poor mental and psychological healthduring pregnancy.

In the case of governmentemployees, it was found that 68.75 percent of respondents showed average mental and psychological health, and the remaining 31.25 percent had good mental and psychological health, while no one was found with poor mental and psychological health.

Regarding women working in a privateorganization, 69.23 percent of total respondents had good mental and psychological health, and the rest, 30.76 percent of respondents, showed average mental and psychological health. In contrast, no respondents were observed with poor mental and psychological health.

Table 5 describes the Mean, SD, and F-values of the mental and psychological healthof pregnant women based on occupation. Findings showed that occupation was significantly related to mental and psychological health of pregnant women. Regarding Housewives, the observed mean value was 204.94, and SD value was 25.41. In case of pregnant mothers belonging to government occupation, mean and SD were 164.00 and 32.66, respectively. In case of private employees, the observed mean value was

Table 5. Mental and psychological healthof pregnant women based on occupation (n=66)

S. No.	Occupation	Mean	SD	F	p-value
1.	Housewives(n=37)	204.94	25.41	11.216	0.001**
2.	Government employee (n=16)	164.00	32.66		
3.	Private employee (n=13)	197.53	34.22		

**Significant at 1% level

197.53, and SD was 34.22. The observed p-value was <0.001, which is highly significant at 1% level. From this result it was observed that housewives have better mental and psychological health compared to government and private employees. In addition, private employees are good in mental and psychological healththan government employees. The reasons observed and sighted by the study were due to better family and social support for housewives and they had more time and flexibility to seek help from family members/friends, also reduced work-related stress than those of government and private sectors. As per the literature housewife pregnant women generally have greater autonomy in managing their daily routines and pregnancy-related decisions than working women.

The study contradicts the findings which examined the psychological status of pregnant women based on their employment status and found that working pregnant women exhibited more positive attitudes, a sense of purpose, and higher self-esteem thannon-working women (Bulgakov *et al.*, 2018).

CONCLUSIONS

The study aimed to assess pregnant women'smental and psychological health from govt. and private hospitals in Coimbatore. The results revealed that pregnant women's overall mental and psychological health was good to moderate. The study identified that Hindu housewives were found to have better mental and psychological health than other groups. However, we did not observe any significant difference among age groups. Additionally, these results also revealed that no respondents had poor mental and psychological health during pregnancy. The study suggested that more attention should be paid to identifying the psychological risk factors during pregnancy and providing suitable interventions to improve the lifestyle of pregnant women. Influential factors for psychological status determined in the present studyare to provide additional facilities in the health care sector in relation to public mental health in developing preventive strategies to improve their overall psychological health.

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REFERENCES

Bjelica, A., Cetkovic, N., Trninic-Pjevic, A and MIadenovic-Segedi, L. 2018. The phenomenon of pregnancy - A psychological view. Ginekologia Polska. 89 (2): 102–106.

Bulgakov, A.V., Babieva, N.S., Levanova, E.A., Gridyaeva, L.N. Erofeeva, M.A., Sokolovskaya, I. E andDavidyan, L. Y. 2018. Specific features of psycho-emotional states of working women during pregnancy. Electronic Journal of General Medicine. 15 (6):em86.

Dole, N. 2003. Maternal stress and preterm birth. American Journal of Epidemiology.157 (1):14–24.

Donegan, T. 2015. Mindfulness: An intervention for improving the health of mothers and babies. Midwifery today with international Midwife. 113: 62–63.

Isaacs, N. Z and Andipatin, M. G. 2020. A systematic review regarding women's emotional and psychological experiences of high-risk pregnancies. BMC Psychology. 8 (1):45.

Kumari, S., Joshi, S and Jain, M. 2013 . Religiosity, anxiety and pregnancy outcomes in indian women. journal of The Indian Academy of Applied Psychology. 39 (1): 110-116.

Lindsay, K.L., Buss, C., Wadhwa, P. D and Entringer, S. 2019. The interplay between nutrition and stress in pregnancy: Implications for fetal programming of brain development. Biological Psychiatry. 85(2):135–149.

Maina, G., Giolito, M. R., Danelon, D., Bogetto, F., Todros, T and Saracco, P. 2008. Impact of maternal psychological distress on fetal weight, prematurity, and intrauterine growth retardation. Journal of Affective Disorders. 111 (2–3): 214–220.

Nayak, S., Poddar, R and Jahan, M. 2015. Psychological problems during advance stage of pregnancy. The International Journal of Indian Psychology. 2 (2):103–113.

Parcells, D.A. 2010. Women's mental health nursing: depression, anxiety, and stress during pregnancy. Journal of Psychiatric and Mental Health Nursing. 17 (9): 813–820.

Relier, J.P. 2001. Influence of maternal stress on fetal behavior and brain development. Biology of the Neonate. 79 (3-4):168–171.

Ulfah, M., Ediyono, S and Apriliyani, I. 2021. The effect of the characteristics of pregnant women and stress on the psychological well-being. International Journal of Health Science and Technology. 3(2): 43-49.

Weinstock, M. 2005. The potential influence of maternal stress hormones on the development and mental health of the offspring. Brain, Behaviour, and Immunity. 19(4): 296–308.

Sharanoor, H and Priya, M. 2023. Factors influencing mental and psychological health during pregnancy. The Journal of Research ANGRAU. 51 (2):. 134-142.
DoI: https://doi.org/10.58537/jorangrau.2023.51.2.15

DoI: https://doi.org/10.58537/jorangrau.2023.51.2.16

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ASSESSMENT OF HAEMATOLOGICAL PARAMETERS OF PUNGANUR CATTLE

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ABSTRACT

The study was undertaken with the objective of establishing the normal reference values of certain haematological parameters in Punganur cattle maintained at Livestock Research Station, Palamaner in Andhra Pradesh. Twenty-four healthy Punganur cattle in different physiological stages (calves, bulls and lactating cows) during the month of August, 2022 were selected for the study. Blood samples were collected from jugular vein during morning hours before feeding. Hematological profile such as total red blood cells (RBC), haemoglobin (HB), total white blood cells (WBC), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) etc. were estimated with automatic blood analyser. The range of values for haematological parameters such as RBC (6.77 ± 0.60 to 9.59 ± 0.59 million/ìl), WBC (8.20 ± 1.10 to 10.33 ± 1.23 thousands/ìl), haemoglobin content (8.51 ± 0.52 to 10.50 ± 0.49 g/dl), PCV (28.75 ± 2.36 to 32.25 ± 2.05 %), MCV (31.30 ± 0.38 to 42.90 ± 1.42 fl), MCH (8.79 ± 0.12 to 14.07 ± 0.45 pg), MCHC (28.27 ± 0.33 to 33.93± 0.18 g/dl) and the cells in differential leukocyte count (Lymphocytes: 3.88 ± 0.49 to 4.98 ± 0.93 thousands/ìl, Monocytes: 0.75 ± 0.08 to 1.35 ± 0.13 thousands/ìl and Granulocytes: 0.37 ± 0.10 to 0.50 ± 0.10 thousands/ìl) were recorded for different stages. The normal haematological values established in the study could be helpful in the diagnosis of different ailments in Punganur breed of cattle at different physiological stages and the values can also useful for academic purposes.

Keywords: Haematological profile, Punganur cattle, Reference values

INTRODUCTION

India is blessed with 41 registered diversified genetic groups of cattle which are adopted for different agro-climatic region of the country. Extensive work has been carried out on various aspects of different breeds of cattle under local climatic conditions. In recent years, preservation and conservation of local germ plasm has gained priority and several attempts were being made to improvise the indigenous cattle breeds due to their production potential (Sripad *et al.,* 2014). Many of the indigenous breeds of cattle in India are giving way to the exotic and cross-bred animals. This has led to a situation, where exotic breeds like Holstein Friesian, Jersey and their cross-breeds are

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predominant in many parts of India, while the indigenous breeds like Haryana, Hallikar, Killari, Gir, Punganur, Ongole and Sahiwal have been reduced to small herds. Among the different local cattle breeds, Punganur breed belongs to native tract of Rayalaseema region (Chittoor) of Andhra Pradesh. Punganur is a dwarf, dual purpose breed of cattle with an adult body weight of 240 kg for male and 170 kg for female and the milk yield ranges between 200-1100 kg per lactation with an average of 550 kgs, for lactation length of 153 ± 24 days (Ekambaram *et al.,* 2014). They are resistant to many bacterial, viral, and parasitic diseases and have good capacity of heat tolerance. They require less care, management and can thrive well under the poor feed stuffs available in the state.

In Andhra Pradesh, most of the grazing area is subjected to decline day by day as well as occurrence of periodic drought, seasonal dry periods, low-nutrition winter grazing, common livestock diseases (Trypanosomiasis, Haemorrhagic septicaemia, brucellosis etc.) and other major environment related stress. Numerous studies have proved that indigenous cattle are able to survive in such harsh environmental conditions in comparison to exotic breeds. Now-a-days the farmers are realizing that despite of low productivity of indigenous breeds; they have the potential for higher yields provided better management conditions and selective breeding rather than cross-breeding from exotic ones. The importance of determining the haematological and biochemical indices of domestic animals have been well documented and acknowledged (Opara *et al*., 2006). Hematological values can provide baseline valuable information and help in realistic evaluation of management practice, nutritional and physiological status of animal and diagnosis of health condition (Radostits *et al*., 2006 and Mir *et al*., 2008). To the best of our knowledge there is paucity of information in the literature regarding the haematological values of Punganur breed of cattle.

Keeping these points in view, the study was undertaken at Livestock Research Station, Palamaner, Andhra Pradesh with the objective of determining the reference values for haematological parameters for Punganur breed of cattle.

MATERIALS AND METHODS

Study area

Livestock Research Station, Palamaner is in Chittoor district of Andhra Pradesh at a height of 683 meters above sea level, with longitude - 13.20 N and latitude - 78.75 E coordinates and belongs to hot and humid agroclimatic zone. The average temperature of Palamaner ranges from 260 ^{0}C to 350 ^{0}C, rainfall of 36.08 mm and average humidity of 65% to 70%.

Study animals

The study was carried out on Punganur cattle belonging to different physiological stages. Twenty-four animals from each stage *i.e.,* calves (3 to 6 months age), bulls and lactating cows were selected during the month of August 2022. The animals were maintained under isolateral management conditions at the LRS, Palamaner. The experimental animals were fed daily with *adlibitum* quantity of green fodder and concentrate feed was given as per the ICAR requirements.Fresh water was available throughout the day. The animals were separated from the herd only for the duration of blood collection.

Collection of blood samples

About 2 ml of blood was collected from jugular vein aspectic method in sterile vacutainers containing EDTA (ethylene diamine

tetra acetic acid) salt, twice from each animal at an interval of two weeks, prior to letting out of animals for grazing during early morning hours between 7.30 AM to 8.30 AM. Samples were immediately transported to the laboratory on ice.

Sample analysis

Whole blood analysis was carried out at department of Veterinary Physiology, College of Veterinary Science, Tirupati, using Mindray Vet 2800 Haematology analyser. The haematological parameters such as Total erythrocyte count (TEC), Total leukocyte count (TLC), Packed cell volume (PCV), Haemoglobin (Hb) content, Erythrocyte sedimentation rate (ESR), Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined.

Statistical analysis

Data recorded were subjected to statistical analysis using Microsoft office Excel 2019 software and values are presented as mean ± standard error.

RESULTS AND DISCUSSION

The study describes the blood composition of relatively genetically pure indigenous Punganur cattle of different physiological stages. The mean and standard error of Hematological (Hb, WBC, RBC, Platelet count, PCV, Lymphocytes, Monocytes, Granulocytes, MCH, MCHC and MCV) parameters are given in Table 1.

The Hb concentration ranged from 8.51 to 9.47 g/dl, with a slight variation among different stages. Blood Hb concentration could be used as an indicator of adaptability to the environment and the animal with higher Hb concentration have been found to be more adaptable than with lower Hb levels (Lankesh *et al.,* 2015). In the present study, lactating cows have comparatively higher Hb than bulls and calves, indicating long term adaptation to the environment. The changes in haematological values could also be dependent on the nutritional status of the animal.

The RBC count (x106 /µl) in calves, bulls and lactating cows was 9.59, 7.85 and 6.77, respectively. Reduced RBC count as age advanced may be due to increased destruction of erythrocytes and environment induced adaptative changes with increasing age (Mohan *et al.,* 2009).The PCV (%) ranged from 28.75 to 32.25 in different groups of cattle. The values are in concurrent to the statement that decreasing value of PCV as age progressed (Mirzadeh *et al.,* 2010).TheWBC count (x103 / µl) in calves, bulls and lactating cows was 9.02, 8.20 and 10.33, respectively. The counts of white blood cells at period of lactation and during pregnancy were comparatively higher than found at most of the otherages in cattle. The presence of higher WBC count during these stages could be due to lactation stress. Higher value of MCV, MCH and MCHC observed in lactating over non-lactating cows by Randhawa *et al*.(2009), agreed with the findings.

Knowledge on the haematological values is very much useful to diagnose the different pathological as well as the metabolic disorders, which are adversely or deleteriously affect the reproductive and productive performance of the cows. However, this requires for the establishment of normal reference values for different breeds. Pathological values are defined as those values deviating from the normal standard reference values. Evaluation, analysis and interpretation of the obtained results mainly depend on the standard reference values for different breeds in different regions as well as under existing environmental or climatic conditions. However, Factors such as breed, sex, age, seasonal variation, pregnancy, lactation,

Table 1. Haematological parameters in Punganur Calves, Bulls and Lactating cows

Parameter	Calves	Bulls	Lactating cows
Hb (g/dl)	8.51±0.52	10.50±0.49	9.47±0.73
WBC (x103 /µl)	9.02±0.76	8.20±1.10	10.33±1.23
RBC (x106 /µl)	9.59±0.59	7.85±0.41	6.77±0.60
Platelets (x105 /µl)	10.80±1.02	17.43±1.90	9.37±1.06
PCV (%)	32.25±2.05	30.56±1.42	28.75±2.36
Lymphocytes (x103 /µl)	4.43±0.37	3.38±0.40	4.38±0.87
Monocytes (x103 /µl)	1.35±0.13	0.80±0.11	0.75±0.08
Granulocytes (x103 /µl)	4.98±0.93	4.02±0.71	3.88±0.49
MCV (fL)	31.30±0.38	41.64±0.84	42.90±1.42
MCH (pg)	8.79±0.12	13.36±0.29	14.07±0.45
MCHC (g/dl)	28.27±0.33	32.36±0.22	32.93±0.18

Each value is the mean of 24 observations

Fig. 1. Punganur Bull

Fig. 2. Punganur Calf

Fig. 3. Punganur Cow

Fig. 4. Mindray Haematology analyser

nutritional and health status of the animal alter haematological attributes. Since the Punganur local cattle used in the study did not show any significant clinical signs or pathological symptoms, therefore they were believed as healthy animals and the result or data observed can serve as standard reference values for these animals in future veterinary science and animal husbandry.

CONCLUSIONS

The haematology values were the mean of 24 observations which were considered to be in the normal range in the cattle breeds. The findings of the study may serve as reference values in which alterations due to metabolic, nutrient deficiency, physiological and health status can be compared for diagnostic and therapeutic purpose in different age and physiological states of Punganur cattle breed, which are unique cattle breed adapted to existing climatic conditions.

REFERENCES

Ekambaram, B., Chakravarthi, M. K and Alexander, G. 2014. Performance of Miniature Punganur Cattle of Andhra Pradesh, India. Indian Journal Veterinary and Animal Science. 43(5): 382-385.

Lankesh P, Narayana Swamy M, Shrikrisha Isloor, Sudhakar M L and Pradeep N. 2015. Haematological profile in Hallikar cattle at the native tract. International Journal of Science, Environment and Technology 4(5): 1316–21.

Mir, M. R., Pampori, Z. A., Iqbal, S., Bhat, Z. I., Pal, M. A and Kirmani, M. A. 2008. Hemato-biochemical indices of crossbred cows during different stages of pregnancy. International Journal of Dairy Science. 3: 154–59.

Mirzadeh, K. H., Tabatabaei, S., Bojarpour, M and Mamoei, M. 2010. Comparative study of haematological parameters according strain, age, sex, physiological status and season in Iranian cattle. Journal of Animal Veterinary Advances. 9(16):2123-2127.

Mohan, N. H., Debasish Niyogi, Waghaye, J. Y and Singh, H. N. 2009. Age-related haematological changes in Murrah buffalo (*Bubalus bubalis*) calves. Indian Journal of Animal Science. 79(4):369-371.

Opara, M. N., Ike, K. A and Okoli, I. C. 2006. Haematology and plasma biochemistry of the wild adult African grass cutter (*Thryonomys swinderianus*). Journal of American Science. 2: 17–22.

Radostits, O. M., Gay, C. C., Hinchciliff, K. W. and Constable, P. D. 2006. Veterinary Medicine. 10th Edition., Elsevier Science Ltd., USA.

Randhawa, C. S., Heigo, Pal., Randhawa, S. S and Uppal, S. K. 2009. Influence of age, season, lactation on haematology and iron biochemistry of crossbred cattle. Indian Journal of Animal Science. 79(10):39-42.

Sripad, K., Kowalli, S and Metri, R. 2014. Hematological profile of Khillar breed of cattle in Karnataka, Veterinary World. 7(5): 311-314.

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POST-HARVEST LOSSES OF ONION CULTIVATION IN KALABURAGI, KARNATAKA

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ABSTRACT

The empirical field study was conducted during 2021to understand the Agri-logistics and Post-harvest Losses (PHLs) of crops in the Kalaburagi district of Karnataka.The findings of the study indicated that the loss due to logistics was more for the farmers compared to the field-level loss. In onion cultivation, there was only quantitative lossandno quality loss. The monetary loss of onions was around Rs.40,000 per acre—the loss of onions due to logistics to the farmer was around Rs. 34,000 per acre. After harvest, the loss wasdue to the lack of inefficient logistics compared to other factors. Post-harvest losses of agricultural produce indicatedthe inefficiency of post-harvest management. In mitigating PHLs, effective logistics services are desirable, and their sustainability is equally important.

key words: Agri-logistics, Food Scarcity, Onion Cultivation, Post-harvest Losses, Sustainable Agriculture

INTRODUCTION

Post-harvest losses (PHLs) and food security

To meet food targets, one essential and complementary factor often ignored is reducing the losses and wastes of food. The food systems approach proposes reducing food loss and waste as a potential solution to achieve food and nutritional security (Nuthalapati *et al.,* 2022). Throughout the supply chain, around 1/3rd of the food produced is lost before it reaches theendpoint of the supply chain. Reducing food losses and wastages through the supply chain is essential to availing food, alleviating poverty, and improving nutrition.

Moreover, reducing PHLs positively impacts the environment and climate by enhancing farm-level productivity and reducing the utilization of production resources or expanding into fragile ecosystems to produce food that will be lost and not consumed. The food loss and wastage volume are higher downstream of the food chain in high-income and low-income countries (Rolker *et al.,* 2022) . Food loss throughout the supply chain is a waste of productive resources. This, in turn, leads to the

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reduction of the food supply, which leads to additional pressure on scarce natural resources to meet the demand for food. So, the efforts to minimize food losses after harvesting in the supply chain are equally important as efforts to increase the total food supply in the economy. Food loss results from ineffective logistics services, *i.e.,* infrastructural incapacities, primitive technology, refrigeration facilities, lack of space, and other logistic issues.

On the other hand, as per the Committee on Doubling Farmers' Income (2019) estimates, at the all-India level, farmers cannot sell about 40 percent of the total fruits and vegetables produced in the market every year (Boss and Pradhan, 2020). The farmers have a market surplus; procurement was hampered by irregular collection from the farm due to scarce labor and logistics (Balkrishna *et al.,* 2022). They reduce food loss and waste and increase farmers' income (Chand, 2016). The main objective is to find the proportion of PHLs due to the logistics activities throughout the supply chain, *i.e.,* transportation, storage, material handling, packaging, etc. Empirical studies are related to the PHLs for reasons like insects, climate, etc. There are minimal studies related to PHLs due to ineffective logistics services and so far, no studies have been conducted in our study area.

MATERIALS AND METHODS

Study area

The district of Kalaburagi is situated in the north of Karnataka. Based on the area, Kalaburagi is the second biggest district in the state from the point of area and population, i.e., 8.49 percent and 5.9 percent in Karnataka state, respectively. Kalaburagiconsists of 11 talukas. The district covers 10,954 sq qmin area; the population density is 234, and the total population is 25,66326 (GoI,2011). The projected population for 2022 is 30,80,566. The Gross District Domestic Product of Kalaburagi at current prices (2018-19) is Rs. 31,76,440, and constant prices (The base year 2011-12) is Rs. 22,15,676 (Kalaburagi – Statistical Report, 2020).

The study is based on both secondary and primary data. The field study was conducted in 2021. Multistage and Random sampling methodsare used to select the samples for the primary data collection. The study used a structured interview schedule to collect data. The field study locationwaschosen from North-east Karnataka, *i.e.,* the Kalyana- Karnataka (HK) region of Karnataka. This region is chosen because this is the most backward region of Karnataka. In the first stage, the district of Kalaburagi is selected. In Kalaburagi, there are 11 Taluka. In the second stage, one Taluka is selected, *i.e.,* Aland, the biggest Talukas in the Kalaburagi district. In the third stage, two panchayats arechosen, *i.e.,* Kadaganchi and Patton. The two villages, *i.e.,* Kadaganchi and Patton, are specified in the fourth stage. The sample farmers for the study are the household farmers who directly sellonions soon after harvesting and those who store their produce to sell later. We have selected 60 samples randomly. The crop onion under the vegetables is determined based on the area, production, and importance of the produce in Aland. For this study, the data was collected in 2022 for 2021. Descriptive statistical tools like means, percentages, etc. have been used to analyze data. The PHL losses are estimated by tabular, percentage, and averages. The losses due to

Table 1. Profile of the Farmers of Kalaburagi and Aland

S. No.	Regions	Numbers	Area	Percentage to the Total Land Holders
Marginal agricultural landholder (Below 1 hectare) Panel (a)				
1	Aland	14241	8816.54	22.876
2	Kalaburagi	106374	60698.77	25.222
Small agricultural landholders (1-2 hectares) Panel (b)				
1	Aland	23 820	3 495 4.4	38.26
2	Kalaburagi	154 013	223 449 .21	36.52
Medium agricultural land holders (4-10 hectares) Panel (c)				
1	Aland	6976	40419.88	11.21
2	Kalaburagi	43 871	250641.58	10.4
Large agricultural land holders (More than 10 hectares) Panel (d)				
1	Aland	985	13497.31	1.58
2	Kalaburagi	5681	78423.83	1.35

Source: District at a Glance – Kalburgi – Statistical Report – FY 2020-21

the lack of inefficient logistics services are shown as a percentage share of all the factors contributing to the PHLs. The secondary sources of data are extracted from the Department of Agriculture and Horticulture, Government of Karnataka, and India; Various issues of Statistical Handbook, Karnataka; National Horticulture Board, etc.

RESULTS AND DISCUSSION

Status of agriculture in Kalaburagi

The primary occupation of the people in Kalaburagi is farming. As per the records of the 2011 censusof Govt. of India, 20.26 percent of the working population are cultivators, and 38.2 percent are agricultural Labourers. The net sown area (NSA)[1] of the district is 1156.7 (’000 hectares), the area sown more than once is 268.9 (’000 hectares), Gross Cropped Area (GCA) is 1425.6 (’000 hectares), and the cropping intensity is 123.2 percent. Thirty-fivepercent of the soil is deep black clayey soils, and 34 percent is shallow mixed black clayey and loamy soils. The major crops of the region are rice, jowar, bajra, maize, ragi, vegetables, and horticultural crops, etc. Agriculture land and the topsoil are significantly limited input endowed by nature. The land-holding profile of the farmers is given below in Table 1.

The area in the district of Kalaburagi in 2020 under the marginal landholders, small landholders, medium landholders, and large landholders are 223449.21 ha, 223449.21 ha, 250641.58 ha, and 78423.83 ha, respectively. The cold storage facilities for horticulture crops in Kalaburagi district in 2019-20 is 2, and the capacity is 9799 t. Both cold storage facilities are available in Gulbarga, Kalaburagi. While the

share of agriculture is dramatically reduced in the Gross Domestic Product (GDP), almost half of the country's population still depends on the agricultural sector for livelihood. The dominant feature that defines present-day farming in India is the preponderance of marginal holdings. Intergenerational subdivisions and land fragmentation mean people must cultivate on tiny pieces of land, creating a viability crisis (Yadu, 2016) . Landholding patterns and farm size are equally important when mechanizingfarms (Bagal *et al.,* 2016).The smaller the land size, the more difficult it gets to mechanize.

Area, production of horticulture in Karnataka – Kalaburagi

India is known to produce fruit and vegetables worldwide. India's position in cultivating vegetables is second in the world, whereas China is first. According to the National Horticulture Database of the National Horticulture Board, in (2020), the total production of fruits and vegetables produced in India was 102.48 Million Metric Tonnes (MMT) and 200.45 MMT, respectively. The area under cultivation of fruits and vegetables was 9.6 and 10.86 MillionHa, respectively. The main hindrance in India in cultivating horticulture is the high logistics costs. India can become a significant horticulture exporter if it reduces its high delivery costs. India's low agricultural production cost leads to its high share in global export. India's share in the total output of the world's vegetables is 11 percent and 15 percent of all fruits. However, its export share in the global vegetable market is only 1.7 percent and fruits 0.5 percent. Vegetable has three segments,*i.e.,* fresh, frozen, and processed. Onion includes in the Fresh. Thetop-producing states of onion in India are Maharashtra, Gujarat, Uttar Pradesh, and Karnataka. However, Orissa, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, and Bihar significantly contribute to India's total onion production. The state of Karnataka accounted for 20 percent of the area and 13 percent of the total output of onions in the country. North Karnataka is a significant contributor to total onion production in Karnataka. The primary onion markets in North Karnataka are Hubli and Belgaum markets. The onion produced in North Karnataka is distributed throughout the country. Most of the onion exported from India also originates from North Karnataka. There is great potential for the farmers in Karnataka to cultivate onion crops. Farmers often incur losses due to low prices, lack of market, and other infrastructure and services.

The village merchant has a significant role in onion marketing throughout the supply chain, *i.e.,* linking production centers with the wholesale markets of vegetables. Especially the merchant has a unique position in the marketing of the product of the smaller produce by the farmers. In handling the vegetables, especially onions, of the smaller and marginal vegetable farmers, it is pivotal to encourage the village merchants. Simultaneously, it is required to bring the transactions under a proper system. Alternatively, farmer's markets may be developed with mandi to get the farmers in direct transactions with the consumers to benefit producers and consumers.

Table 2 shows the production of the horticulture crops in Kalaburagi is 4,39,403 million tonnes, worth 1,09,290 lakh. The contribution of vegetables to the total production of horticulture is 2,54,181 million tonnes which

Table 2. Details of the crops in Karnataka and Kalaburagi- 2020-21- (Unit: Area in ha; production in million tonnes; yield inmillion tons/ha; value in Rs. in lakhs)

Details of the horticulture crops					
S. No.	**Regions**	**Area**	**Production**	**Yield**	**Value**
1	Kalaburagi	24812	439403	17.71	109290
2	Karnataka	2620535	24150226	9.22	6626280
Details of the horticulture cropsPanel (a)					
1	Kalaburagi	24812	439403	17.71	109290
2	Karnataka	2620535	24150226	9.22	6626280
Details of Vegetable Panel (b)					
1	Kalaburagi	14353	254181	54334	
2	Karnataka	521183	10884759	1511903	
Details of Onion Panel (c)					
1	Kalaburagi	5284	102961	20592	
2	Karnataka	247942	4417725	600062	

Source:Department of Horticulture, Government of Karnataka, 2022

are worth 54,334 lakhs. At the same time, the contribution of onion production is 1,02, 961 million tonnes and worth 20,592 lakhs. Despite the unprecedented steps to increase food production, the world must be on track to meet its food needs. There are many remarkable causes behind this global problem. Most importantly, both quantitative and qualitative post-harvest losses contribute a significant proportion.

The post-harvest losses reduce the quantity available, leading to the increased cost of production and marketing and the price of the products. Ultimately, both the producer and the consumer would be affected negatively by the increase in the costs and price of the product. The PHLs of vegetables are incredibly high compared to the other horticulture crops due to their perishable nature. The PHLs of onion as a vegetable crop are very high. In Karnataka, the total horticulture production and onion loss during the post-harvest period is 30% to 35% of the total output.

Marketing channel of onion in the study area

Defining the marketing channel is the first step of supply chain analysis. Multiple factors are there in supply chain management. Mapping the market channels helps in determining the factors. Moreover, the mapping of the market channels helps to analyze the nature of the relationship among the chain factors along with the flow as well as the destination of the transition of the crop. Thus, it helps us visualize the produce flow from the farm to the form. The above makes it clear that direct actors of the

post-harvest periods are farmers and various market intermediaries. The indirect actors provide financial or nonfinancial support in the supply chain. These indirect or supporting actors play a significant role by providing critical support the supply chain management.

Four important marketing channels of Onion in the domestic market of North Karnataka have been identified. These are -

Seller (Farmer) — Village merchant — Wholesaler — Retailer — Consumer

Farmers — seller — Commission agent — Wholesaler — Retailer — Consumer

Seller (Farmer) — Commission agent-cum-Wholesaler - Retailer — Consumer

Seller (Farmer) — Consumer

The village merchant has a significant role in onion marketing throughout the supply chain, *i.e.,* linking production centers with the wholesale markets of vegetables. Significantly, the merchant has a unique position in marketing the product of the smaller produce by thefarmers. In handling the vegetables, especially onions of the smaller and marginalvegetable farmers, it is pivotal to encourage the village merchants. Simultaneously, it isrequired to bring the transactions under a proper system. Alternatively, farmer's markets maybe developed with mandi to get the farmers in direct transactions with the consumersto benefit producers and consumers.

The farmers cultivate onions two times annually. To avoid loss due to rain and weather, the farmers sell onions during rainy seasons soon after harvesting the crop. The farmers store onions in summer to earn more money selling the produce. Various types of onion storage structures are used to storeonions in different onion-growing areas of the country. Most of these are the traditional type made by the farmers as per their requirements the majority of them are improved to be properly, and storage losses are higher. The bottom-ventilated structures arebetter than conventional structures for storingonions. But these structures have some problems, such as improper ventilation and short roof span, and are costly and beyond the reach of small farmers (Tripathi and Lawande, 2016) .

Available infrastructural provisions in the study area

In this section, the available infrastructural provision in the study area has been explained. The infrastructural requirements regarding the general markets, road conditions, public transportation facilities, cold storage, and processing units have been examined. It also looks at the existence of some other provisions like the existence of farm-based organizations

Table 3. Particulars of the field studyof onion - (Unit: l and in acre; output in kg; price in INR)

S. No.	Land	Crop	Output	Storage of output	Sale after storage	Priceper quintal	Sale before storage	Price per quintal
1	1	Onion	12000	10000	8385	20	1755	15

Source: Author's Field Study, 2022

Table 4. Available infrastructural provisions in the study area

S. No.	Variables	Time/Distance/Facilities
1	Distance to the nearby market (km)	1
2	Distance to the urban market (km)	20
3	Distance to the major market of the specific (km)	230
4	Travel time to the nearby market (minutes)	10
5	Travel time to the urban market (minutes)	45
6	Mode of transportation	Mini Truck
7	Farm based orgainsation	0
8	Cold storages	0
9	Processing units	0

Source: Author's Field Study, 2022

and so on. The selected crop's requirements have been discussed as they represent both villages. The facts have been incorporated in the following Table 4.

The average distance to the nearby market for the onion is 1 km. The nearby markets are mainly the village assembly markets and are found to be dominated by the village-level collectors of the study area. The average distance to the urban market center is 20 km. The road infrastructure facility is suitable for the study area. The average travel time required to sell the produce in Gulbarga is approximately half an hour.

The road condition has been reported as satisfactory, but the cost discourages the growers from selling in distant major urban centers. Besides the urban and significant town markets, some small semi-urban markets have also been found surrounding the study area. But these markets are meant for something other than that specific crop. The average market distance for the significant market of the particular product is 230 km. These are considered major markets as a vast volume of the specific crop considered for the study has been traded in such markets. The percentage of the sample farmers having access to any farm-based organization could be better for the selected crop. The primary development focus for agricultural post-production infrastructure has been logistics, *i.e.,* warehousing, and cold stores, to store the products for extended durations. The improvement of the logistics services to connect the farmers with markets have yet to find strategically linked policy support. Due to that reason, in the study area, there are no cold storage or warehouse facilities.

The storage of the crop for a better price lead to weight loss. Table 4 and Table 5 state that this weight loss was due to the lack of proper storage facilities in the region. The study showed that the output of onion per acre was 12000 kg. On an average, farmers store 1000 kg of onion for a better price. The price of onion before storage was Rs. 15, whereas, the price after storage was Rs. 20. On an average, 240 kg of onionswas lost in the field after harvesting, *i.e.,*

Table 5. Post-harvest losses of onion per acre

S. No.	Particulars	Quantity (kg)	Percentage (%)
1	Output	12000	100
2	Loss in the field	240	2
3	Loss During Transportation and Packaging	15	0.1
4	Loss During Storage	1600	13.4
5	Sale after storage	8385	69.87
6	Sale before storage	1755	14.63

Source: Author's Field Study, 2022

2 percent per acre. The transportation and packing losswerean average of 15 kg per acre. The weight loss due to the storage was 1600 kg, *i.e.,* 13 percent per acre.

In onion cultivation, there was only quantitative loss, *i.e.,* quantity and no quality loss. The monetary loss of onions was around Rs. 40,000 per acre. The logistics loss of the farmer was around Rs. 34,000. This can be understood as follows – after harvest, the loss wasdue to the lack of inefficient logistics compared to other factors. Post-harvest losses of agricultural produce indicate the inefficiency of post-harvest management. Such losses lower the profit margin of the farmers and other agents involved in the supply chain (Boss *et al.,* 2020). Besides, it reduces the per capita output availability and thus increases the price of the produce. These losses also have an opportunity cost of production as the resources sacrificed could have been utilized for other productive purposes. This indirectly lowers the profit margin of the agents involved in the supply chain.

CONCLUSIONS

The leading cause of the high magnitude of post-harvest loss in developing countries was ineffective logistics services. The post-harvest losses reduce the quantity available, leading to the increased cost of production and marketing and the price of the products. Ultimately, both the producer and the consumer would be affected negatively by the increase in the costs and price of the product. In addressing the world's food challenges, mitigating post-harvest losses (PHLs) is essential. The loss due to logistics was more for the farmers than the field-level loss. In onion cultivation, there was only quantitative lossandno quality loss. The monetary loss of onions was around Rs. 40,000 per acre of land. The loss of onion due to logistics to the farmer was around Rs. 34,000. After harvest, the loss was due to the lack of inefficient logistics compared to other factors. Post-harvest losses of agricultural produce indicate the inefficiency of post-harvest management. It lowers the farmer's income.

In mitigating PHLs, effective logistics services are desirable, and their sustainability is equally important. Ease of PHLs will lead to the minimization of food losses and hunger, leading to the development of the economy. Globalization, technological advancement and changing world trade environment in the modern era enhance the productivity of crops. It is

improving the productivity of the horticulture sector as well. To maintain the adequate flow of those products to the market without losses, an efficient logistics infrastructure facility is required. Establishing marketing facilities, providing funds for logistics services, better information, advertisement, and publicity of the products is necessary.

The loss of onions due to the logistics services was prevalent in the study area. An efficient logistics infrastructure facility was required to maintain the adequate flow of products to the market withoutlosses. Establishing marketingfacilities, providing funds for logistics services, better information, advertisement, and publicity of the products is necessary, especially in North Karnataka. India's agriculture sector is leading to the growth of all sectors. If the Agriculture sector goes wrong, there is no other sector that can be right. The post-harvest loss is a long-persisting problem in farming in India. The Government should implement programs and policies to overcome the problem, especially in the study region.

REFERENCES

Bagal, Y.S., Sharma, L.K., Singh, L., Kour, P., Sharma, D and Gupta, A. 2016. Factors affecting the productivity of wheat crop in Jammu region. Indian Journal of Ecology. 43(1): 592–595.

Balkrishna, A., Arya, V., Joshi, R., Kumar, A., Sharma, G and Dhyani, A. 2022. Doubling farmers' income in India: Progress, gaps, and futuristic approaches. Indian Journal of Ecology. 49(3):1044-1050. DOI: https://doi.org/10.55362/IJE/2022/3632.

Boss, R and Pradhan, M.2020. Post-harvest management and farm outcomes - storage facilities matter. Economic and Political Weekly. 55(16):24-27.

Chand, R. 2016. Doubling farmers' income: strategy and prospects. Presidential address delivered at the 76th Annual Conference of the Indian Society of Agricultural Economics. Assam Agricultural University, Jorhat (Assam). November 21-23, 2016.

GoI. 2011. Census of India reports - 2011. Retrieved from the website www.censusindia.gov.in on 03.02..2023.

Nuthalapati, C. S. R., Mahendra Dev, S and Sharma, R. 2022. Supply-side problems in food loss and waste issues in mitigation through cold chain. Economic and Political Weekly. 57(14):51-61.

Rolker, H., Eisler, M., Cardenas, L., Deeney, M and Takahashi, T. 2022. Food waste interventions in low-and-middle-income countries: A systematic literature review. Resources, Conservation and Recycling. 186 (106534).(https://doi.org/10.1016/j.resconrec.2022.106534)

Tripathi, P. C andLawande, K. E. 2016. Designing and evaluation of onion storage structures for Indian conditions. International Journal of Agricultural Sciences. 6(2): 918-924.

Yadu, C. R. 2016. Agrarian question in India indications from NSSO's 70th round. Economic and Political Weekly. 51(16): 20-23.

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KNOWLEDGE ACQUISITION OF ENTREPRENEURSHP AFTER A TRAINNING PROGRAMME FOR MIDDLE-INCOME HOMEMAKERS

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Nirmala Sitaraman, India's finance minister, defined the country's middle-income group as people who earn more than the poverty level but less than Rs. 18 lacs a year ($2,000 per month) in income. (Sunday Guardian, 2020). The middle-income class refers to individuals and households that, on a socio-economic scale, often sit between the lower and upper classes. (Baviskar and Ray, 2020). In the upcoming ten years, the number of middle-class citizens in the nation is projected to rise. (Indian Express, 2022). After China and the United States, India is currently the third-largest market for the middle class; in another twelve years, it is predicted to overtake them. (Pandey, 2016). Losses of income affected all types of households during the COVID-19 pandemic, notably during the lockdown in March 2020. Nonetheless, studies revealed that the upper middle- and middle-income groups were the most severely affected. (Statista Research Department, Sep 12, 2022). The Middle-Income population outside of those who work for the government or the huge organised sector has been devastated by the lockdown. (WHO, 2020). McKinsey Global estimates that by increasing women's labour force participation, India may boost the global GDP by $700 billion. Compared to men, women have a higher likelihood of working in industry and agriculture. These industries are frequently credited with assisting families in escaping poverty and raising household income. Also, women's knowledge rates increased by 8.8% in FY21, underscoring the nation's promising future. (Times of India, 2022). According to Bosch Consultancy Group, start-ups with female founders or innovators make 10% more money overall over the course of five years. These start-ups have a more inclusive workplace atmosphere and hire three times as many women as men. (Globe News Wire, 2018.)

Studies revealed that the middle-income groups were the most severely affected during COVID-19 pandemic. There is a need to look for an alternative to cope up the situation post pandemic. Women's participation in the workforce has created jobs and helped millions of families escape poverty. The growing number of women entrepreneurs in India has had a big impact on the social and economic demography of the nation. Entrepreneurship education and training help entrepreneurs develop the creativity, innovativeness, and ability needed to launch a business. (Byun *et al.,* 2018).

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Table 1. Effect of training programme about entrepreneurship among selected 50 middle-income homemakers

(n-50)

S.No.	Criteria	Effect of Training Programme on Entrepreneurship					
		Before		After			
		Mean	SD	Mean	SD	t-value	signifi-cance
1	The motivation level will be higher when compared to working for others	3.0000	1.37024	4.6200	.94524	6.344	**
2	Entrepreneur tend to learn lot	2.6600	1.23899	4.6800	.55107	10.259	**
3	Entrepreneurs face lots of risk	2.0800	1.25909	3.8000	1.49830	5.765	**
4	Financial pressure can be enormous	2.4800	1.26556	3.4000	1.56492	3.496	**
5	Entrepreneurs can manage their own company's profit	2.8800	1.20611	4.1000	1.03510	6.276	**
6	Entrepreneurs can follow their passion	2.7200	1.44335	4.4000	.98974	7.006	**
7	The most important skill that can be developed as an entrepreneur is leadership.	2.8600	1.14304	4.4200	.88271	7.352	**
8	Being an entrepreneur means they can directly improve the lives of others	2.4000	1.22890	4.4000	.90351	8.427	**
9	Entrepreneurs have the potential to earn a lot of money	2.6800	1.20272	4.3200	.95704	6.683	**
10	Entrepreneur have a great deal of freedom and flexibility	2.5200	1.29741	4.5000	.99488	7.822	**
11	Entrepreneurs have to rely on their business partners	3.3600	1.10213	2.4600	1.26507	3.100	**
12	Entrepreneurs have total control over the business	2.3600	1.22491	4.5000	.76265	9.436	**
13	Employees will mess things up	2.2200	1.18304	3.5000	1.63195	3.899	**
14	More responsibility sometimes means more personal stress	2.2200	.97499	3.3200	1.54444	4.245	**
15	Only few people have luck in starting their own business.	2.3800	1.32311	3.8000	1.48461	4.758	**
16	Entrepreneurship can imply more stress	2.2800	1.10730	3.5400	1.50116	5.355	**
17	Competition with other established businesses	2.7200	1.24605	2.9200	1.15776	1.121	NS
18	Time can be used as efficient as possible	3.3400	1.25536	4.5800	.73095	5.671	**
19	Requires greater sacrifices, longer working hours	1.6800	.81916	3.6600	1.25536	8.374	**
20	Requires a professional network	2.4600	.81341	2.6000	1.24540	0.747	NS

** - Significant at 1% level; NS – Not Significant

According to Ori and Theuri (2016), developing entrepreneurial education and training is seen as a potential strategy to encourage entrepreneurship because entrepreneurial skills are acquired via education and training programme. Therefore, in this study an attempt was made to analyse the effect of the training programme conducted on entrepreneurship among the selected 50 middle-income homemakers through purposive sampling in the year 2022. The homemakers were contacted personally one at a time, at their convenience. Rapport was developed by explaining the purpose of the study. The data was collected using 5-point Likert scale. Both positive and negative responses has been collected from the selected middle income homemakers and the collected data before and after the training programme was transferred into Microsoft Excel version 10 and coded, and then statistically analysed using SPSS Version 20 software to assess the knowledge gained about entrepreneurship. Inferential Statistics such as the one-way analysis of variance, independent t test and correlation were performed.

Socio-demographic profile of the selected homemakers

The socio-demographic profile revealed a clear picture on the age, educational status, occupation, family life cycle, size of the family, annual Income, type of family, type of house, of the selected 50 middle-income homemakers. Homemakers were aged more than 25 years and no one is illiterate. 34% of the homemakers are graduated. The type of family is equally divided as nuclear family and joint family. 50% of the family are in expanding stage.16% of the family's annual income is less than 6,00,000. Majority of the homemakers are in rental house (78%)and majority ofthe heads of their family work in a private company (42%), only 10% in business 20% works as Govt. employee and remaining 28% in other fields. Experts had been invited personally from various sectors to deliver speech about entrepreneurship for the training programme imparted by us as a part of research and to improve knowledge in this particular field.

Comparative analysis of the effect of training programme on entrepreneurship among selected middle-income homemakers

In this study paired sample t-test has been applied to examine whether the training and knowledge acquired about entrepreneurship among selected 50 middle income home makers is significantly different ornot.Thus, providing the effectiveness of the training programme. The statistical procedure of thet-test was used to assess the efficiency of the knowledge given to the homemakers as a part of the intervention. Descriptive analysis was done before and after, the scores wered one before applying aparametrictest, and followed by that the t-test was performed to measure the difference between the knowledge among homemakers before and after giving knowledge about entrepreneurship.

Null Hypothesis H0: There is no significant difference in themean scores on the knowledge acquisition on entrepreneurship among the homemakers before and after the training programme.

Alternative Hypothesis H1: There will be a significant difference in the meanscores on the knowledge acquisition on entrepreneur ship

among the homemakers before and after the training programme.

The Table 1 portrays the knowledge gained by the home makers before and after the training programme. Before training programme, the homemakers were not aware of the importance of entrepreneurship. After the training programme the knowledge score of the homemakers have increased. The training programme also enhanced knowledge among the selected middle-income home makers in some areas that were kept as false beliefs by the respondents. Statement 17th and 20th are not significant and the critical value is 2.010. From the above table there exist a significant difference in the meanscores of the knowledge provided on entrepreneurship among the home makers before and after thetraining programme. It was also revealed that the "p" value or value of significance is found to be 1% ($p < 0.01$) level of significance rejecting the null hypothesis(H0)and accepting the alternative hypothesis (H1), stating that there is a significant difference among thehomemakersafter providing knowledgeon entrepreneurship. In a similar study conducted by Kalpana (2017) in Chennai for college going girls, it has been found that 79% of the students gained knowledge in entrepreneurship through training programme and concluded that the training given to them had brought an insight in entrepreneurship among those students. The words of Shane's theorysupports the findings of this present study that the training is the process of obtaining the skills required for the profession (Santosa *et al.,* 2021). Enhancing a homemaker's entrepreneurial efficacy allows them to put in more effort over a longer period of time, preserve through setbacks, and build plans and strategies to attain greater entrepreneurial goals. Thus, the training programme has a positive effect on knowledge on entrepreneurship.

REFERENCES

Baviskar, A and Ray, R. (Eds.). 2020. Elite and everyman: The cultural politics of the Indian middle classes. Taylor and Francis. 20. 3-7.

Byun, C., Sung, C. S., Park, J. Y and Choi, D. S. 2018. A study on the effectiveness of entrepreneurship education programs in higher education institution: A case study of Korean Graduate Programs. Journal of Open Innovative: Technology, Market and Complexity. pp.1-14.

Globe News Wire. 2018. Women-owned startups deliver twice as much per dollar invested as those founded by men. Published on 6th June, 2018. Retrieved from the website from (https://www.globenewswire.com/news-release/2018/06/06/1517397/0/en/Women-Owned-Startups-Deliver-Twice-as-Much-Per-Dollar-Invested-as-Those-Founded-by-Men.html) on 04.2.2023.

Indian Express. 2022. India projected to surpass China as world's most populous country during 2023: United Nations Report, Article by Esha Roy. Published on 04.2 2023.

Retrieved from the website (https://indian express.com/article/india/india-to-be-most-populous-country-in-2023-8021711/) on 04.2.2023.

Kalpana,M. 2017. Inculcating Entrepreneurial Skills among College Students. Ph.D. Thesis submitted to Avinashilingam

Institute for Home science and Higher Education, Coimbatore.

Ori, G. N. K and Theuri, F. S. 2016. The role of entrepreneurship training and education in enhancing growth of small and medium enterprises in Kenya: A case study of Mombasa County. IOSR Journal of Humanities and Social Sciences. 21(4); 97-107.

Pandey, T. 2016. Shifting of economic power towards the Asian economies. International Journal of Pure and Applied Research. 3 (1): 65-75.

Santoso, R. T. P. B., Junaedi, I. W. R., Priyanto, S. H and Santoso, D. S. S. 2021. Creating a startup at a University by using Shane's theory and the entrepreneurial learning model: A narrative method. Journal of Innovation and Entrepreneurship. 10 (1): 21-22.

Statista Research Department. 2023. Statista company share of households by gross annual income across India in financial year 2021. Article by Manya Rathore. Published on 12th Sep,2022. Retrieved from the website (https://www.statista.com/statistics/482584/india-households-by-annual-income/) on 04.2.2023.

Sunday Guardian 2023. India's middle class: despondent, ignored, irrelevant and dumped? Published on 14th June, 2020. Article by Sanjit Paul Singh. Retrieved from the website (https://sundayguardianlive.com / news/indias-middle-class) on 04.2.2023.

Times of India. 2022. 'Entrepreneurship is tough, tougher for a woman in India' by Kunj Yadav. Published on 22nd Nov, 2022. Retrieved from the website (https://timesofindia.indiatimes.com/top-headlines/womens-entrepreneurship-day-entrepreneurship-is-tough-tougher-for-a-woman-in-india-says-kunj-yadav/articleshow/95624440.cms) on 04.2.2023.

WHO. 2020. Impact of COVID-19 on people's livelihoods, their health and our food systems. Published on 13th Oct, 2020. Retrieved from the website (https://www.who.int/news/item/13-10-2020-impact-of-covid-19-on-people's-livelihoods-their-health-and-our-food-systems) on 04.2.2023.

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