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RESEARCH ARTICLE

Study on sensory characteristics of *paneer* for process standardization from buffalo milk

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Abstract: Buffalo milk was utilized with the process variables for standardization of processes of manufacturing of *paneer*. The sensory evaluation study was under taken to investigate the effects of treatments on sensory scores for standardizing the manufacturing process. Effect of treatments on flavour score, and body and texture score were significant at $p<0.01$ and $p<0.05$, however, the effect of replication of sensory evaluations by Judges was non-significant. Effect of treatments on colour and appearance score was significant at $p<0.05$.It meant that at 95% level of confidence only, the treatments of colour and appearance was significant i.e. different. It was observed that the *paneer* manufactured from buffalo milk of 6% milk fat and 9% SNF and chilled in 1% NaCl solution was most suitable in regard of good body and texture of *paneer* at the preheating temperature of milk at 80-82°C for 5 minutes.

Keywords: Body and Texture; Colour & appearance; Flavour; *Paneer;* Sensory Evaluation

Introduction

There exist a great potential of entrepreneurship development in dairying including indigenous dairy products for rural youths and dairy farmers. Looking into the status of Bihar in regard of profession in dairying, Bihar has secured ninth position with annual production of 9.818 MMT and per capita availability of milk as 251 g/day in the year 2018-19 (NDDB, 2022).As per the recent statistics, milk production in India reached at 210 million tonnes in the year 2020 (Dwivedi, 2022). The per capita availability of milk in India is projected to rise to 428 g per day in the year 2020-21 from 394 g/day in 2018-19(NDDB, 2022).

The indigenous milk products including *paneer* (i.e. Cottage cheese) plays a great role in the development of Indian economy. *Paneer* is one of the most widely consumed dairy products which have occupied a very important place in various types of Indian cuisines (Kanawjia and Singh 2016). It is generally used after frying to replenish the proteins in vegetarian dishes in place of non- vegetarian proteins. Due to its excellent sensory attributes like cohesiveness and chewiness, the *paneer* is regarded as good replacement of meat for predominantly large vegetarian population of India (Agrawal and Sinha 2014). Apart from its huge domestic market, a large segment of international market also exists. One of the sources of growth of Indian economy may be the export of *paneer* but the main problem is low shelf-life of *paneer*. Even in frozen condition, its shelf-life is reported as 21 days and in vacuum packaging condition, it is 30 days. Besides, a number of indigenous dairy products can also be exported to the ethnic populations settled in North America, Middle East and South East Asia.

Shelf-life extension for a longer period storage and mechanization of *paneer* production process would make its marketing possible at distant places as well as for export (Rajorhia et al. 1984). At ambient temperature, its shelf-life is only 3 to 4 days due to presence of high moisture content and high water activity. Transportation, distribution and storage of *paneer* under frozen condition become difficult task and uneconomical. The sterilization of *paneer* in normal condition produces *paneer* of

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hard body and texture and also causes discolouration. The needs of cold chain for distribution to consumers cannot be omitted even after optimizing the hygienic parameters of processing. The available literature indicated that the *paneer* in the market has variable composition and high load of microbes. *Paneer* has short shelf-life and there is a need of enhancement of shelf-life by hygienic production and process standardization of *paneer*. Therefore, aim of this study was to standardize the manufacturing process of *paneer* from buffalo milk of Bihar origin which will facilitate the transportation and distribution without freezing and enhance the shelf-life of *paneer*.

Materials and Methods

Method of manufacturing the *Paneer*

The experiments of process standardization were carried out during 2018-20 at SGIDT, Patna with the process variables as per plan of study. The methodology for preparation of *paneer* from buffalo milk was used as per standard method (Sachdeva and Singh, 1988; Badshah et al. 2022) with slight modification as per process variables. The buffalo milk was procured from cattle farm of BASU, Patna. The milk were divided in two parts and standardized to 6.0% fat and 9.0% SNF and 4.5% fat and 8.5% SNF for preparation of experimental samples. The experimental samples of *paneer* were prepared as per details given below:

Treatment-T_1- The *paneer* samples prepared from buffalo milk standardized to 6.0% fat and 9.0% SNF with preheating at 90°C for 5 minutes and the fresh *paneer* cubes dipped in plain chilled distilled water for half an hour after pressing at 1 kgf/cm^2 for 30 minutes.

Treatment-T_2- The *paneer* samples prepared from buffalo milk standardized to 6.0% fat and 9.0% SNF with preheating temperature of 90°C for 5 minutes and further the *paneer* cubes dipped with 1% NaCl solution of chilled distilled water for an hour after pressing at 1 kgf/cm^2 for 30 minutes

Treatment-T_3-The *paneer* samples prepared from standardized buffalo milk (4.5% fat and 8.5% SNF) with preheating temperature of 82°C for 5 minutes and the fresh *paneer* cubes dipped in plain chilled water for cooling for half an hour after pressing at 1 kgf/cm^2 for 30 minutes

Treatment-T_4 - The market sample of fresh *paneer* from Patna market.

Physico-Chemical analysis of *Paneer*

The moisture content in samples was estimated by the gravimetric method (AOAC, 2005).Acidity was determined as per method of IS-10484 (1983). The fat content was measured by the Gerber method using Cheese butyrometer as described in AOAC, 2005.The protein of *paneer* was determined by Kjeldahl method (AOAC, 2005). The ash content of *paneer* was estimated by the method of IS-10484 (1983). The lactose content of *paneer* was estimated by the difference of sum total of the major constituents like moisture content, protein, fat and ash from 100 as described by AOAC (2005).

Sensory Evaluation of *Paneer*

The sensory evaluation of samples was done using a BIS score card IS 6273 (Part I) of 100 points recommended by De (1982) for *paneer*. The sensory evaluation of *paneer* samples were carried out by a panel of judges. Each block of *paneer* was cut into one inch small cubes. The *paneer* samples were tempered to room temperature before judging the samples in Petri dishes. The general conditions for sensory evaluation of *paneer* were kept as given in IS 6273 (Part I). Nine panellists were employed in the evaluations to arrive at consistent and valid results.

Statistical Analysis

Data were analyzed using the software Statistical Package for Social Sciences (SPSS) at the 0.05 and 0.01 level of significance following the procedure of Snedecor and Cochran (1994). Data were subjected to one way analysis of variance and Duncan's Multiple Range Test (DMRT) for comparing means of treatments to find the effects between treatments.

Results and Discussion

Chemical characteristics of *paneer*

The chemical characteristics of different treatment of *paneer* (T_1, T_2, T_3 and T_4) are presented in the Table 1.

The experimental samples of T_2 had maximum yield i.e. 191±1.02 g/litre of buffalo milk and the minimum yield was found with the samples of treatment T_3 (160±0.94). The moisture content of sample T_1 was found maximum (53.48±0.48%). The moisture content of *paneer* in treatment T_3 was 52.8±0.61% and the moisture content in treatment T_2 i.e. after chilling in 1% NaCl solution of T_1 sample was 53.47±0.62 %. It indicated that reduction in moisture content will occur with increasing the salt concentration and will result in high preserving quality due to low moisture and reduced water activity. It was observed that the moisture content decreased with decrease in fat content and preheating temperature. The fat content of treatment T_2 was found maximum (28.07±0.21%) while the fat content of *paneer* prepared with treatment T_3 was observed minimum (20.37±0.15%). The protein content of treatment T_1 was 14.97±0.15% and while the protein content of *paneer* prepared from standard buffalo milk i.e. treatment T_3 was found maximum (22.1±0.20%). The lactose content of treatment T_1 was observed maximum (3.29±0.45%) but lactose content of treatment T_2 was found minimum (1.2±0.43%). The decrease in lactose content is higher in T_2 due to cooling period of 1 hour causing higher solubility of lactose in water in

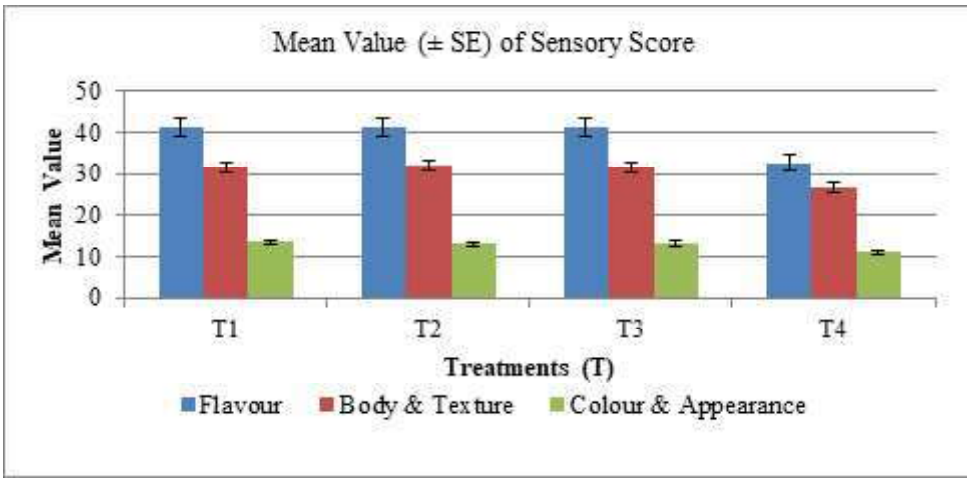

Fig 1. Sensory Scores of *Paneer* of different Treatments

comparison to 30 minutes in T_1 and T_3. The ash content treatment T_1 was maximum (1.23±0.15%), while the *paneer* cubes dipped in 1% salt solution i.e. in treatment T_2 had higher ash content than T_1 due to absorbed content of Nacl during cooling at a temperature less than 4°C. The ash content of *paneer* of treatment T_3 was measured as 1.94±0.27%, which was higher than that in treatment T_1. The factors affecting ash contents are temperature of preheating and coagulation temperature. Higher the preheating temperature resulted in lower values of ash content in T_1.

Sensory characteristics of *Paneer*

The sensory characteristics of different treatment of *paneer* (T_1, T_2, T_3 and T_4) are presented in the Table 2. The numerical score was an indication of the quality of *paneer* prepared from treatments given as per process variables.

The graph depicting the relation among mean values of BIS sensory score is shown in Fig. 1. The statistical analysis of the sensory evaluation data has been performed to have more effective results. The analysis of variance (ANOVA) for the scores of Flavour, Body and Texture and Colour and appearance are shown in Tables 3, 4 and 5, respectively.

Effect of various treatments on flavour of *Paneer*

Table 2 reveals that the mean values of flavour score in treatments T_1, T_2, T_3 and T_4 were found to be41.11±1.51, 41.11±1.96, 41.11±3.02 and 32.67±5.5, respectively. Highest value of flavour score was recorded in T_3 and lowest in T_4.

It was observed from the result of ANOVA in Table 3 that the effect of treatments on flavour score was significant at $p<0.01$;

Table 1 Chemical quality of *paneer* of different treatments*

Items (%)	Treatment- T_1	Treatment-T_2	Treatment-T_3	Treatment-T_4
Yield (g per litre of milk)	186±0.95	191±1.02	160±0.94	-
Moisture	53.48 ± 0.48	53.47± 0.62	52.80± 0.61	52.25±1.07
Acidity	0.36± 0.01	0.39± 0.05	0.57± 0.05	0.60± 0.05
Fat	27.03± 0.15	28.07± 0.21	20.37± 0.15	25.63± 0.15
Protein	14.97± 0.15	15.4 0± 0.10	22.10± 0.20	18.42± 0.49
Lactose	3.29± 0.45	1.20± 0.43	2.79± 0.38	1.40±0.63
Ash	1.23± 0.15	1.87± 0.43	1.94± 0.27	2.27±0.66

*Data presented in table are average of 3 replicates ± SD.

Table 2 Sensory quality of *Paneer* of different treatment*

Characteristics	PerfectScore	Treatment-T_1	Treatment-T_2	Treatment-T_3	Treatment-T_4
Flavour	45	41.11±1.51	41.11±1.96	41.11±3.02	32.67±5.5
Body and Texture	35	31.56±1.88	31.89±1.90	31.67±2.87	26.89±5.21
Colour and appearance	15	13.44±1.42	12.89±1.54	13.11±1.54	11.00±1.58
Package	5	-	-	-	-

*Data presented in table are average of 3 replicates ± SD.

however, the effect of replication of sensory evaluations was non-significant. That indicates the treatments are different with each other. The difference in mean value of T4with other three treatments mean values was found higher than CD (1%) level; this means the treatment T_4 was quite different from other three treatments. The difference in means of first three treatments were less than CD (5%) value, thus all the three treatments are non-significant. The maximum flavour score was found with T_3, however, the flavour score of T_1 and T_2 were also closer to the maximum value. But, the flavour score of market samples T4 was lowest and this may be due to improper delivery and transport condition or high microbial count. Singh (2022) observed that the flavour score of *paneer* was affected significantly by different temperature of coagulation, coagulants used, fat percentages and different storage period used for preparation and storage of *paneer*. The highest flavour score (8.5) was found in the sample which was coagulated at the temperature of 80°C by lactic acid with 4.0% milk fat at 0 day while lowest score (5.0) was found with coagulation temperature of 70°C using Aonla extract with 4.0% milk fat at 12 days of storage. It is indicated that the temperature of coagulation and preheating should not be kept above 80-82°C during manufacture of *paneer* with buffalo milk of Bihar origin.

However, the *paneer* samples of treatment-T_2 also resulted a flavour score of 41.11±1.96, which was closer to treatment-T_3. Therefore use of milk fat of 6 % and SNF of 9 % was also favourable in regard of flavour score.

Effect of various treatments on body and texture of *Paneer*

The mean values of body and texture score of treatments T_1, T_2, T_3 and T_4 were found to be31.56±1.88, 31.89±1.90, 31.67±2.87and 26.89±5.21, respectively (Table 2). The highest mean score of body and texture was observed31.89 ± 1.90 with *paneer* cubes of treatment-T_2. However, the body and texture scores of *paneer* samples of T_3andT_1 were 31.67±2.87 and 31.56±1.88, respectively which shows similar values.

The result of ANOVA is depicted in Table 4. The body and texture score of market *paneer* was found with value 26.89 ± 5.21, which was lowest as judged by panellist. The effect of treatments on body & Texture score was significant at $p<0.01$ and $p<0.05$, however, the effect of replication of sensory evaluations by judges was non – significant (Table 4). The differences between the mean values of treatment- T_1 to treatment- T_2 and T_3 were lower than CD (5%) value, which indicated that these three were not exhibiting much difference but the difference of mean value of treatment-T_4 with all the three mean values of treatments was higher than CD (1%) which indicated that the means of treatment$T_4$was actually different from all other treatments.The treatment-T_2 was better in regard of body and texture score. As

Table 3 ANOVA of flavour score

Source	D.F.	SS	MSS	Cal. F	TAB F(5%)	TAB F(1%)
Treatment	3	469.42	156.47	13.79	S	S
Replication (No. of Judges)	8	119.00	14.88	1.31	NS	NS
Error	24	272.33	11.35			
TOTAL	35	860.75				
S.EM=	1.12	CD(5%)=	3.28		TAB. F(5%)=	3.01
SE.d=	1.59	CD(1%)=	4.44		TAB. F(1%)=	4.72
CV	8.66					

Table 4 ANOVA of body and texture score

Source	D.F.	SS	MSS	Cal. F	TAB F(5%)	TAB F(1%)
Treatment	3	157.00	52.33	4.99	S	S
Replication (No. of Judges)	8	88.50	11.06	1.06	NS	NS
Error	24	251.50	10.48			
TOTAL	35	497.00				
S.EM=	1.08	CD(5%)=	3.15		TAB. F(5%)=	3.01
SE.d=	1.53	CD(1%)=	4.27		TAB. F(1%)=	4.72
CV	10.61					

Table 5 ANOVA of colour and appearance score

Source	D.F.	SS	MSS	Cal. F	TAB F(5%)	TAB F(1%)
Treatment	3	32.56	10.85	4.49	S	NS
Replication (No. of Judges)	8	16.06	2.01	0.83	NS	NS
Error	24	57.94	2.41			
TOTAL	35	106.56				
S.EM=	0.52	CD(5%)=	1.51		TAB. F(5%)=	3.01
SE.d=	0.73	CD(1%)=	2.05		TAB. F(1%)=	4.72
CV	12.32					

the highest means of treatment-T_2 which was superior treatment and chilling in 1 % Nacl solution of distilled/pasteurized water if occur in treatment-T_3also, it would have given the most significant result in improving the body and texture.

Singh (2022) found that the highest mean body and texture score (7.11) of *paneer* with temperature of coagulation of 80°C and lowest mean score (6.38) was observed with coagulation temperature of 70°C. Percent fat in milk also affected the body and texture score. Singh (2022) reported that the highest score (7.12) was found in 4.0% milk fat, while it was observed as minimum score (6.46) with 3.5 % milk fat in respect of body and texture. Therefore, buffalo milk of 6.0 % milk fat and 9.0 % SNF chilled in 1% Nacl solution was most suitable in regard of good body and texture of *paneer* that can be observed from highest score of treatment-T_2 but the preheating temperature should be kept to 80-82°C similar to treatment-T_3 with coagulation temperature of 70°C.

Effect of various treatments on colour and appearance of *Paneer*

The mean value of colour and appearance score in Treatments T_1, T_2, T_3 and T_4 were found to be13.44 ±1.42, 12.89 ±1.54, 13.11±1.54 and 11.00±1.58, respectively (Table 2). The effect of treatments on colour and appearance score was significant at $p<0.05$ and not significant at $p<0.01$. However, the effect of replication of sensory evaluations by Judges was non-significant (Table 5).The colour and appearance score of control samples (TreatmenT_1) was highest i.e. 13.44 ± 1.42.

However, there was no mark difference in colour and appearance score except lowest value of 11.00±1.58 in market *paneer* sample (treatment-T_4). The difference between means of sample of T_1 and T_4 was higher than the critical difference (CD 1%) that indicated the treatment-T_1 and treatment-T_4 were significantly different. The colour and appearance score of treatment-T_1 was highest with maximum fat content. Singh (2022) reported that the colour and appearance score of *paneer* was significantly affected by temperature of coagulation, types of coagulants and fat percentage at 0.1 % level of significance. The highest mean score (7.08) was found with 80°C coagulation temperature in place of lowest score (6.45) at 70°C coagulation temperature. The mean maximum score (7.01) and minimum score (6.47) were observed in case of *paneer* prepared from 4.0% and 5.5% milk fat, respectively.

The effects of fat content and coagulation temperature and cooling with salt solution have been found significant in controlling the sensory scores. It has been found that use of treatment-T_2 with preheating temperature of 82°C instead of 90°C showed better result in giving high flavour, body and texture and colour & appearance score along with low bacterial counts and all chemical characteristics as per the FSSAI (2006) standards.

Conclusions

The *paneer* manufactured from buffalo milk of 6.0% milk fat and 9.0% SNF and chilled in 1% NaCl solution was found most suitable in regard of good flavour, body and texture and colour and appearance scores of *paneer*. It can also be observed that the highest sensory scores was found with treatment-T_2 but the preheating temperature should be kept to 80-82°C similar to treatment-T_3 with coagulation temperature of 70°C.The buffalo milk with preheating temperature of 82°C and coagulation temperature of 70°C with citric acid (2%) coagulation and cooling in 1-3% NaCl solution of distilled/ pasteurized chilled water was found as best parameter.

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