Indian Journal of Poultry Science (2024) 59(2): 117–121, Research Article
https://doi.org./10.56093/ijps.v59i2.165158

Efficacy of dietary phytosome conjugated cinnamaldehyde supplementation on performance and economics in broilers

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(Received on December 11, 2023; accepted for publication on July 20, 2024)

ABSTRACT

Kondhare, A.A., Kadam, M.M., Bhaisare, D.B., Chopade, S.V., Patil, A.R. and Nagre, G.K. 2024. Efficacy of dietary phytosome conjugated cinnamaldehyde supplementation on performance and economics in broilers. Indian Journal of Poultry Science, 59(2): 117-121.

The present research was designed to assess the efficacy of dietary supplementation of phytosome conjugated cinnamaldehyde essential oil as a feed additive on growth performance and economics of broiler production. A total of 180 commercial broiler chicks (Vencobb-430) at one-day-old age were randomly divided into three groups of four replicates in each (60 chicks/group). The control group received the basal diet, while the other two groups received the basal diet supplemented with Bacitracin Methylene Disalicylate (BMD) @500gm per tonnes and phytosome conjugated cinnamaldehyde essential oil @ 100g/ton of feed, respectively for 42 days. The data obtained demonstrated that, in comparison to other groups, the group that received phytosome conjugated cinnamonaldehyde essential oil at a rate of 100 g/t of feed exhibited significantly ($P<0.001$) higher live body weight (LBW), body weight gain (BWG), enhanced feed conversion ratio (FCR), and production efficiency index (PEI); furthermore, there was a zero-mortality rate during entire experiment in all the groups. In comparison to supplementing the antibiotic and control diet, which ultimately results in the highest profit per bird, supplementing phytosome conjugated cinnamon aldehyde essential oil yields a higher profit per kg weight. It can be concluded that dietary supplementation of phytosome conjugated cinnamaldehyde essential oils has the potential to improve growth performance of broiler chickens. However, for greater productivity and optimal health, broiler chickens may benefit from consuming 100 g/ton of phytosome conjugated cinnamon aldehyde essential oil as an alternate growth promoter.

Keywords: Broiler, Economics, Essential oil, Growth performance, Phytosome conjugated cinnamaldehyde.

INTRODUCTION

The total poultry population in the country is 851.81 million in 2019, increased by 16.8% over previous census out of which backyard poultry contributes 317.07 million (Dept. of AHD 20th Livestock Census). About 95.22 billion of eggs are produced with 8% annual growth rate and 4.8 million tons of poultry meat is produced with 7% growth rate per annum in India (Dept. of AHD Annual report 2019-20).

The developments in genetics and nutrition in poultry has made it possible to achieve better growth in broiler chicken. To further enhance growth of broiler chickens different growth promoter like antibiotics is utilized but residual effect of antibiotics growth promoter (AGP) has health hazards in human population which is because of some negative effects of few antibiotics in poultry which lead into commercially ban. Recent restrictions on the use of antibiotics as growth-promoters in poultry feeds have prompted researchers to explore healthy and safe alternatives to produce food of animal origin.

Among the most studied alternatives, prebiotics, antioxidants, probiotics, organic acids and essential oils (EOs) used in poultry production for better performance (Petrolli *et al*. 2012). Among the techniques used for protecting feed additives, microencapsulation has been widely applied. It has been common practice to encapsulate essential oils (EOs) in a delivery system in order to improve their storage stability, conceal their flavor, shield them from interactions with other nutrients, lower the risk of oxidation, allow for controlled release, avoid gastrointestinal irritation, and stop the volatile components from evaporating. (Gottschalk *et al.*, 2018). The entrapped compound's bioavailability and bioaccessibility are improved by encapsulation, which facilitates a controlled and sustainable release. The phospholipids phosphatidylcholine, phos-phatidylethano-lamine, and phosphatidylserine combine with natural bioactive substances (plant extracts or water-soluble phytoconstituents) to form phytosomes, also referred to as herbosomes (Reis *et al*. 2018). It has been demonstrated that phytosomes can improve the natural bioactive components stability, bioactivity, and bioaccessibility. Additionally, EO placed in phytosomes improves their performance by preventing EO breakdown during digestion and exposure to environmental stressors. The current study was carried out to evaluate the economics and growth performance of broiler chickens treated with dietary phytosome conjugated cinnamon aldehyde essential oil based on the previously reported data.

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MATERIALS AND METHODS

The feeding trial was conducted in the Poultry Research and Training Centre, Department of Poultry Science of Maharashtra Animal and Fishery Sciences University.

Experimental plan

The experiment was carried out on one hundred and eighty (n=180) day-old straight run "Vencobb-430" commercial broiler strain which were procured from Sri Rajeshwara Hatcheries Private limited, Nagpur. The experimental birds (n=180) were distributed into three groups and each group was further sub-divided into four replicates having 15 birds in each reared up to 6 weeks. The control/basal diet were free from any antibiotics, whereas second group feed was prepared along with treatment of Bacitracin Methylene Disalicylate (BMD) @500g per ton. The third group was supplemented with phytosome conjugated cinnamaldehyde @ 100g/ton of feed. During the entire experiment the birds were not exposed to any antibiotic as prophylactic or treatment measures. The feed was formulated as per the commercial broiler strain Cobb nutrient requirement (Broiler management guide, Venkateshwara Hatcheries Pvt. Ltd.). The composition of experimental diet and proximate analysis are presented in table 1and table 2 respectively.

Prestarter feed:- salt-2.5 kg, sodium bicarbonate- 1 kg, vitamin premix- 600 gm, MM ORG- 250 gm, DLM- 3.1 kg, Lysine- 2.6 kg, Threonine- 1 kg, Robinidine- 350 gm, Enzyme- 200 gm, Phytase- 125 gm, Antioxidant- 100 gm, emulsifier- 300 gm, choline chloride- 1.4 kg, toxin binder- 1 kg, MCP- 11.5 kg, LSP- 13 kg, MM INORG- 750 gm, Protease- 400 gm, probiotic- 250 gm, liver tonic- 1 kg.

Starter feed:- salt-2.5 kg, sodium bicarbonate- 1 kg, vitamin premix- 500 gm, MM ORG- 250 gm, DLM- 2.9 kg, Lysine- 2.9 kg, Threonine- 500 gm, Diclazuril- 200 gm, Enzyme- 200 gm, Phytase- 125 gm, Antioxidant- 100 gm, emulsifier- 300 gm, choline chloride- 1.4 kg, toxin binder- 1 kg, MCP- 11 kg, LSP- 14 kg, MM INORG- 750 gm, Protease- 300 gm, probiotic- 250 gm, liver tonic- 1 kg.

Finisher feed:- salt-2.5 kg, sodium bicarbonate- 1 kg, vitamin premix- 500 gm, MM ORG- 250 gm, DLM- 2.7 kg, Lysine- 1.45 kg, Threonine- 500 gm, Madura- 500 gm, Enzyme- 200 gm, Phytase- 150 gm, Antioxidant- 100 gm, emulsifier- 500 gm, choline chloride- 1.4 kg, toxin binder- 1 kg, MCP- 10 kg, LSP- 15 kg, MM INORG- 750 gm, Protease- 300 gm, probiotic- 200 gm, liver tonic- 1 kg.

The experimental broiler birds were fed pre starter diet till first 14 days of age. The starter diet was offered from 15 to 28 days and finisher feed was given from 29 to 42 days of experiment. During the experiment standard

Table 1: The composition of experimental diets (per 1 ton)

Ingredients	Experimental diet		
	Prestarter(0-14 d)	Starter(15-28 d)	Finisher(29-42 d)
Maize	580 kg	600 kg	630 kg
Soyabean meal	380 kg	345 kg	310 kg
Soyabean oil	10 kg	25 kg	30 kg
Premix*	40 kg	40 kg	40 kg
Bacitracin Methylene Disalicylate (BMD)	Treatment 1- Nil	Treatment 2- 500 g	Treatment 3- nil
	Treatment 1- Nil	Treatment 2- 500 g	Treatment 3- nil
	Treatment 1- Nil	Treatment 2- 500 g	Treatment 3- nil
Phytosome conjugated cinnamaldehyde	Treatment 1- nil	Treatment 2- nil	Treatment 3- 100 g
	Treatment 1- nil	Treatment 2- nil	Treatment 3- 100 g
	Treatment 1- nil	Treatment 2- nil	Treatment 3- 100 g

*Premix

MM ORG- Mineral Mixture Organic; DLM- DL Methionine; MCP-Mono Calcium Phosphate; MM INORG- Mineral Mixture Inorganic; LSP- Limestone Powder

Table 2: Proximate analysis of the experimental diets (% dry matter basis)

Nutrients (%)	Pre starter	Starter	Finisher
Dry matter	88.9	89.3	90.2
Crude protein	23.4	21.8	20.1
Ether extract	4.09	5.20	6.30
Crude fibre	3.68	3.50	3.32
Nitrogen Free Extract N.F.E.	64.5	64.84	64.89
Total ash	6.22	6.32	6.49
Metabolizable Energy ME (Kcal/kg)	3154	3252	3300

management practices were followed for the entire groups. The birds were reared on litter system and similar conditions were maintained for each group throughout the study period (0-42 days). The birds were offered weighed quantity of feed and *ad*-libitum water supply. Mortality record was maintained and the mortality corrected FCR was calculated accordingly. At the end of each phase the live body weight of birds and feed refusal were weighed to calculate the performance data of each replicate. The production cost of rearing broilers for complete experimental period was calculated by considering cost of the chicks, feed, antibiotic, essential oils, vaccine, and other miscellaneous items. The net profit per bird or per kg was calculated considering average selling price of the year on live body weight basis as per the local market.

In a fully randomized block design, SPSS-21 was used to statistically analyse all the data gathered during the study period. Every parameter was subjected to a one-way ANOVA. Duncan's multiple range test (1955) was used to isolate the treatment means that showed significant differences. In experiments, probability values ≤0.05 were deemed significant.

RESULTS AND DISCUSSION

The broiler response to supplementation of phytosome conjugated cinnamaldehyde oil and antibiotic on live body weight, feed consumption and feed conversion ratio over the period of 42 days is summarized in Table 3.

At the end of pre starter stage (14 d) feed intake, the live body weight and FCR values among any of the treatment groups or control group were significantly not affected among themselves due to dietary cinnamaldehyde or antibiotic effect. In contrast, at the end of starter phase (28 d) the broiler birds which received supplementation of phytosome conjugated cinnamaldehyde (T3) recorded highest live body weight (1496 g), which was significantly (P<0.01) higher than the broilers birds supplemented with control (T1) or antibiotic fed group (T2). The broiler birds supplemented with BMD antibiotic recorded lowest (P<0.01) live body weight (1255 g) at the end of 28 day age. Similarly, BMD supplemented birds showed poorest FCR (P<0.01) compared to control and treatment groups. There was no significant change in the FI among any of the treatment groups. However, highest FI was observed in control group followed by the birds supplemented with phytosome conjugated cinnamaldehyde. Once the bird reached to liquidation (42 d) stage, the broiler birds supplemented with phytosome conjugated cinnamaldehyde recorded 36 g higher (P<0.001) LBW and significantly lower FI (3939 g) with the best FCR value (1.53) than the birds reared in control group. Surprisingly, though the LBW was lowest in BMD supplemented birds, but the FI and FCR value (1.66) was better than the control group (1.74). Herbs and phytogenic products have the potential to serve as antibiotics, limiting the growth and colonization of many pathogenic and non-pathogenic bacterial species in the gut. This could result in enhanced feed efficiency and growth due to more effective food consumption (Bedford, 2000). Since the improved FCR seen in all supplemented groups did not show up at slaughter age, the current study's findings indicate that the beneficial effects of feed additives on the digestive system and nutrient absorption are more noticeable in younger age groups. This is likely because older birds have better-developed digestive tracts and organs and their nutrient requirements decrease with age.

In accordance to our research findings, Bravo *et al.* (2014) concluded that supplementation of mixture containing 5% carvacrol, 3% cinnamaldehyde and 2% capsicum @ 100 g/t in the diet of broiler chickens showed improved (P=0.055) feed efficiency by 9.8%, increased (P=0.009) weight gain by 14.5% compared to control group at 21 days of age. Awaad *et al.* (2014) recorded that addition of specific combination (SC) of carvacrol and cinnamaldehyde at 100 ppm of ration significantly (P<0.05) increased final body weight and significantly (P<0.05) decreased final feed conversion ratio (FCR) in broiler chicken. Reis *et al.* (2018) observed that addition of phytogenic feed additive (PFA) based on essential oils such as carvacrol, thymol and cinnamic aldehyde at 0.5% level improved live body weight of broiler chicks compared to the control group at 35 and 42 days of age. Bosetti *et al.* (2020) observed significantly (P<0.001) improved feed conversion ratio, increased live body weight of broilers supplemented with mixture of microencapsulated carvacrol and cinnamaldehyde @100, 200 and 400 mg/kg compared to control at 42 days. Heydarian *et al.* (2020) concluded that broilers fed diet containing encapsulated thyme essential oil and oregano essential oil mixture with and without probiotic had significantly (P<0.05) higher body weight gain compared with control and non-capsulated thyme essential oil+ oregano essential oil mixture groups on day 42. Also, Nath *et al.* (2023) found better growth performance of broilers supplemented with cinnamaldehyde oil @100 mg/kg. These findings support results published by Petrolli *et al.* (2012) Reis *et al.* (2018) and Saied *et al.* (2022) and demonstrate the positive effects of essential oils on performance enhancement when used in place of growth boosters.

In contrast with present results, Symeon *et al.* (2014) and Chowlu *et al.* (2019) reported that cinnamon oil supplementation @0.5 and 1ml levels and @ 2.5, 5 and 7.5 g/kg did not affect feed intake and feed conversion ratio body weight of broilers respectively. Galli *et al.* (2020) determined no significant (P>0.05) difference in body weight and weight gain in Cobb 500 broilers supplemented with 50 mg/kg curcumin and 100 mg/kg of phytogenic feed containing encapsulated carvacrol, thymol, cinnamaldehyde and their combination. Lee *et al.* (2020) noted that dietary addition of encapsulated essential oils at 60 and 120mg /kg diet did not significantly change feed consumption and feed conversion ratio live body weight of broiler chicken. When essential oils were used, Petrolli *et al.* (2012) assessed the growth parameters at 1-41 days of age and showed that the alternative growth boosters were equally effective.

The broiler birds supplemented with phytosome conjugated cinnamaldehyde showed significantly highest live body weight (2581 g) compare to basal diet (2545 g) or antibiotic (2273 g) supplemented group. Similarly Feed conversion ratio value were found significantly better in the broilers birds supplemented with phytosome conjugated cinnamaldehyde (1.53) compare to basal diet (1.74) or antibiotic (1.66) supplemented group. Phytosome conjugated cinnamaldehyde @ 100 mg /kg feed supplemented group performed well in term of live body weight and Feed conversion ratio as compare to the antibiotic @ 500 mg/kg of feed. These findings confirm the beneficial effect of phytosome conjugated cinnamaldehyde essential oils in improving overall growth performance, as substitutes for antibiotic growth promoters and presented satisfactory growth performance indices mentioned in Table 3. No mortality was observed in any of the groups during entire experiment.

The phytosome conjugated cinnamaldehyde is commercially available in the market with approximate price 1200 ₹/kg. Similarly, antibiotics are available in the open market for livestock feeding as a preventive measure. The choice of antibiotic of present study was bacitracin methylene disalycilate (BMD) which is available at the price of approximate 280 ₹/kg. The used dose of conjugated cinnamaldehyde essential oil in this study was 100 g/ton of feed. The dose of antibiotic was 500g/ton of feed. The price of phytosome conjugated oil and antibiotic were calculated as ₹/bird and considered in Table 3. The commercial chick, feed & miscellaneous cost were considered similar in all treatment diets, whereas treatment (antibiotic and essential oil) price was considered additionally in respective treatment group.

At the end of experiment all input values and profit generated through rearing the broiler batch was analysed and depicted in the Table 3.

The birds received phytosome conjugated cinnamaldehyde showed highest net profit (₹10.39/kg LBW) followed by the birds which received antibiotic

Table 3: Overall zootechnical performance of broiler birds in response to supplementation of antibiotic and cinnamaldehyde (0-42 d age)

Sr. No.	Treatments Particulars	T1 Control (Basal diet)	T2 Basal diet + BMD Antibiotic @ 500 mg/kg feed	T3 Basal diet + Phytosome conjugated cinnamaldehyde @100 mg/kg feed
1	Chick cost (₹)	30.00	30.00	30.00
2	Feed cost (₹/kg)	40.00	40.00	40.00
3	Cost of BMD (₹/b)	0.00	2.00	0.00
4	Cost of plain cinnamaldehyde (₹/b)	0.00	0.00	0.00
5	Cost of phytosome conjugated cinnamaldehyde (₹/b)	0.00	0.00	0.90
6	Miscellaneous cost	5.00	5.00	5.00
7	Total feed intake (g/b)	4414	3767	3939
8	LBW (g)	2545	2274	2581
9	FCR	1.74	1.66	1.53
10	Corrected FCR for 2 kg LBW	1.61	1.60	1.39
11	Mortality (%)	0.00	0.00	0.00
12	Feed cost (₹/bird)	176.56	150.68	157.56
13	Cost of production per bird (₹)	211.56	185.68	192.56
14	Production cost (₹/kg)	86.21	81.65	74.60
15	Lifting rate (₹/kg/bw)	85.00	85.00	85.00
16	Gross income per bird (₹)(=8x15)	216.32	193.29	219.38
17	Net profit per bird (₹)(=16-13)	4.76	7.61	26.82
18	Net profit (₹/kg/bw)	1.87	3.34	10.39

recorded ₹3.34/ kg/LBW net profit which was higher than the birds reared on control diet ₹1.87/kg/LBW. The broiler birds supplemented with phytosome conjugated cinnamaldehyde generated minimum higher benefit of @ ₹4.65/kg LBW than the antibiotic supplemented group. These findings confirm the economically beneficial effect of phytosome conjugated cinnamaldehyde essential oils in generating more income, as substitutes for antibiotic growth promoters.

CONCLUSION

The broiler birds supplemented with Phytosome conjugated cinnamaldehyde essential oils is beneficial in term of achieving higher growth performance with highest profit compared to antibiotic and control group broiler birds. The Phytosome conjugated cinnamaldehyde essential oil can act as alternative to replace dietary antibiotics (@ 500g/T) supplementation.

ACKNOWLEDGEMENT

The authors would like to acknowledge Maharashtra Animal and Fishery Sciences University, Nagpur, Maharashtra, India for funding and supporting the work.

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