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Evaluation of bee pollen as a feed additive on nutrient digestibility of broiler finisher ration

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Abstract

The present study was conducted to assess the effect of supplementation of bee pollen (BP) in broiler chicken on nutrient utilisation. A feeding trial was conducted on one hundred and twenty-eight, day-old Vencobb 430Y broiler chicken at Instructional Livestock Farm Complex (ILFC), Pookode for a period of 42 days. Bee pollen was purchased from Khadi Village Industries Corporation. Broiler chicks were grouped into four treatments, each with four replicates having eight birds. The birds were fed with iso-caloric and iso-protein diets observing BIS 2007 specification. The T1 group was fed with basal diet and T2, T3, T4 groups were fed with 0.25, 0.5 and 0.75 per cent BP incorporated basal diet respectively. One bird from each replicate was caged in a metabolism cage, to study nutrient utilisation and apparent digestibility coefficients. Results showed that the digestibility of dry matter, crude protein and organic matter significantly increased in BP-supplemented groups compared to the control group. Hence it can be inferred that supplementation of BP at 0.25, 0.5 and 0.75 per cent levels can be recommended for improved nutrient digestibility in broilers.

Keywords: *Bee pollen*, *poultry, digestibility, feed additive*

Bee pollen, propolis, royal jelly, bees wax and bee venom are the commonly obtained honey bee products. One of the widely used bee products in animal and human nutrition is bee pollen (BP). Bee pollen is the pollen obtained from botanical plants mixed with bee saliva and nectar. Bee pollen has a rich supply of nutrients and energy, including protein, fat, carbohydrates (sugar and starch), essential amino acids, fatty acids and minerals (Attia *et al.,* 2014). The predominant amino acids in bee pollen include leucine, lysine, valine, alanine, aspartic acid, glutamic acid, and proline. The main fatty acids present in BP are palmitic acid, stearic acid, oleic acid, linoleic acid, and linolenic acid (Hsu *et al.,* 2021). Enzymes and coenzymes required for healthy digestion and cell growth of the intestine are also present in bee pollen (Wang *et al.,* 2007).

Total meat production in India is 9.77 million tonnes and India has the eighth position in the world in terms of meat production. Poultry meat contributes 51.14 per cent of the total meat production in the country. The per capita availability of meat in India was 6.82 Kg/Annum in 2021-22 which then increased to 7.10 Kg/Annum in 2022-23 (BAHS, 2023). Poultry meat plays a crucial role in meeting the meat demands of a growing population. Therefore, it is essential

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Table 1. Experimental diets of broilers maintained on four dietary treatments

Treatment	Experimental diets
T1	Basal diet
T2	Basal diet + 0.25per cent BP
T3	Basal diet + 0.5per cent BP
T4	Basal diet + 0.75per cent BP

Table 2. Ingredient composition of broiler finisher ration (per cent)

Ingredient	per cent composition			
	T1	T2	T3	T4
Maize	59.00	59.00	59.00	59.00
SBM	32.00	32.00	32.00	32.00
DCP	1.90	1.90	1.90	1.90
Calcite	1.02	1.02	1.02	1.02
Salt	0.38	0.38	0.38	0.38
Vegetable oil	5.70	5.70	5.70	5.70
Total	**100**	**100**	**100**	**100**
Trace Mineral Mix[1]	0.10	0.10	0.10	0.10
Vitamin Premix[5]	0.08	0.08	0.08	0.08
Lysine[1]	0.06	0.06	0.06	0.06
Methionine[2]	0.20	0.20	0.20	0.20
Choline[3]	0.10	0.10	0.10	0.10
Toxin Binder[6]	0.10	0.10	0.10	0.10
Liver powder[7]	0.03	0.03	0.03	0.03
Coccidiostat[8]	0.05	0.05	0.05	0.05
Bee pollen	0.00	0.25	0.50	0.75

1. Each kilo gram of mineral mixture contains- Manganese-100 g, Zinc-85 g, Iron- 90 g, Copper-15 g, Iodine-1.8 g, Selenium-0.45 g, Organic chromium- 0.15 g.
2. Each kilo gram of vitamin premix supplement contains Vitamin A - 82,500 IU, Vitamin D 3 – 12000 IU, Vitamin B 2 – 50 mg, Vitamin K – 10 mg, Vitamin B 1 – 4.0 mg, Vitamin B6 – 8.0 mg, Vitamin B 12 – 40 mcg, Niacin 60 mg, Calcium pantothenate – 40 mg, Vitamin E – 40 mg
3. L-Lysine mono-hydrochloride 98.5per cent. (Feed grade)
4. DL-Methionine 99per cent. (Feed grade)
5. Choline chloride 60per cent. (Feed grade)
6. Toxin binder containing a blend of Hydrated Sodium Aluminosilicate, organic acids, activated charcoal and natural herbal Ingredients
7. Liver Tonic Powder- hepatic stimulant and production enhancer
8. Coccidiostat- Diclazuril-(0.5per cent)-each kg preparation containing 5g of diclazuril

to explore natural feed additives that can enhance the growth performance and meat production of broilers. The use of mustard bee pollen as a natural feed additive and its impact on nutrient utilisation in broilers is not exploited by the Indian broiler industry. Hence, the present study is envisaged to assess the effect of mustard bee pollen as a natural feed additive on the nutrient digestibility of broiler finisher ration.

Materials and methods

The present research was conducted by the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Pookode at Poultry Farm, Instructional Livestock Farm Complex, Pookode. The experimental protocols were approved by the Institutional Animal Ethics Committee of Kerala Veterinary and Animal Sciences University (Ref Number: IAEC/COVAS/PKD/22/6/2024)

Experimental animals

One hundred and twenty-eight, day-old Vencobb 430Y broiler chicks were purchased from a local hatchery and formed the experimental subjects of the study. Chicks were wing-banded and weighed. They were divided into four groups (T1, T2, T3 and T4), having four replicates with eight chicks per replicate in a completely randomised block design. The experimental pens were properly cleaned and disinfected with Kohrsolin-Th (Glutaraldehyde 10 g/100mL) at 10 mL/L of water one week before the commencement of the experiment. The feeder, waterer and other equipment were cleaned, disinfected with Kohrsolin-Th at the dilution rate of 5 mL/ L of water and sun-dried three days before the arrival of chicks. Birds were reared in a deep litter system for 42 days under standard management practices. Wood shavings were used as the litter material and spread to a thickness of five centimetres in each pen. The chicks were brooded using incandescent bulbs till they attained three weeks of age. Thereafter, light was provided only during night hours. All the experimental chicks were vaccinated against Ranikhet disease and Infectious bursal disease. Feed and clean drinking water was provided *ad libitum*.

Experimental diets

Bee pollen (mustard) was purchased from Shiv Gramoudyog Sansthan (Unit of Khadi Village Industries Commission) in Uttar Pradesh. Pre-starter, starter and finisher ration given during the feeding trial was isocaloric and isonitrogenous. Rations were prepared as per BIS (2007) recommendation, in mash form in the feed mixing plant of Revolving Fund Poultry Project, Centre for Advanced Studies in Poultry Science, Mannuthy. Details of experimental diets are given in Table 1. The ingredient composition of the experimental finisher ration offered is given in Table 2.

Feeding trial

The feeding trial was conducted for a period of 42 days in the Poultry farm, Instructional Livestock farm complex, Pookode.

Metabolism trial

The metabolism trial was carried out for three days during the finisher phase, after giving an adaptation period of two days. One bird from each replicate was randomly selected

and caged individually. They were fed with respective treatment diets. During the metabolism trial, records of feed offered and leftovers were maintained on a daily basis. All the excreta from each bird were collected on a polythene sheet over a period of 24 hours and excreta were processed for dry matter content. A representative sample ($1/10^{th}$) of excreta was taken for nitrogen estimation in a 10 per cent sulphuric acid solution to avoid nitrogen loss. The dried samples of three consecutive days were pooled and then thoroughly mixed, powdered and used for proximate analysis as per AOAC (2016).

Nutrient digestibility = ((Nutrient intake – Nutrient outgo)/ Nutrient intake) * 100

Nutrient intake was calculated using the matter intake of birds and the chemical composition of feed offered, while nutrient outgo was calculated using dry matter content and the chemical composition of excreta.

Statistical analysis

Data collected were analysed statistically using the one-way ANOVA method as per Snedecor and Cochran (1994) using the SPSS version 24.0 ® software.

Results and discussion

The chemical composition of bee pollen is presented in Table 3. The present study used bee pollen (BP), which had the following composition on a dry matter (DM) basis: 90.08 per cent DM, 25.01 per cent crude protein (CP), 8.18 per cent ether extract (EE), 4.88 per cent crude fibre (CF), 3.03 per cent total ash (TA), 0.22 per cent acid insoluble ash (AIA), 58.89 per cent nitrogen-free extract (NFE), 0.80 per cent calcium (Ca), and 1.14 per cent phosphorous (P).

The findings in the present study are similar to the reports of Bogdanov (2011), who stated that BP may contain 13-55 per cent carbohydrates, and 10-40 per cent protein. 1-13 per cent lipids, 0.3-20 per cent dietary fibre, 2-6 per cent ash, 200-3000 mg/Kg calcium, 800-6000 mg/Kg phosphorous in his book titled 'Pollen Book'. The findings of Al-Kahtani *et al.* (2022) are also similar to the observations of the present study. Al-Kahtani *et al.* (2022) obtained 90.5 per cent dry matter (DM), 67.6 per cent carbohydrate, 1.2 per cent crude fibre (CF), 3.7 per cent total lipids, 17.1 per cent crude protein (CP), 2.9 per cent total ash (TA) on chemical analyses of BP.

The chemical composition of broiler finisher ration is presented in Table 4 suggesting that the requirements as per BIS (2007) were fulfilled. The chemical composition of excreta of broiler chicks, maintained on four dietary treatments during the metabolism trial is presented in Table 5. Dry matter, CP, EE, CF and TA of excreta ranged from 20.45 to 21.09 per cent, 16.46 to 17.38 per cent, 3.95 to 4.12 per cent, 14.70 to 15.28 per cent, 14.00 to 15.57 per cent respectively. Acid insoluble ash (AIA), Nitrogen free extract (NFE) and organic matter (OM) were in the range of 1.4 to 1.62 per cent, 65.56 to 66.65 per cent, and 84.43 to 86.00 per cent, respectively.

Table 3. Chemical composition of bee pollen*, per cent

Attribute (per cent)	Bee pollen
Dry matter	90.08 ± 0.08
Crude protein	25.01 ± 0.64
Ether extract	8.18 ± 0.25
Crude fibre	4.88 ± 0.03
Nitrogen free extract	58.89 ± 0.39
Total ash	3.03 ± 0.02
Acid insoluble ash	0.22 ± 0.01
Organic matter	96.97 ± 0.02
Calcium	0.80 ± 0.02
Total phosphorous	1.14 ± 0.01

*Average of four values with SE

* On DM basis

Table 4. Chemical composition of broiler finisher* ration, per cent

Attribute (per cent)	T1	T2	T3	T4
Dry matter	89.05 ± 0.004	89.04 ± 0.002	89.04 ± 0.01	89.05 ± 0.01
Crude protein	20.29 ± 0.29	20.30 ± 0.01	20.32 ± 0.01	20.33 ± 0.02
Ether extract	6.32 ± 0.04	6.33 ± 0.01	6.33 ± 0.01	6.35 ± 0.01
Crude fibre	4.85 ± 0.01	4.85 ± 0.01	4.85 ± 0.00	4.86 ± 0.01
Nitrogen free extract	62.29 ± 0.25	62.27 ± 0.02	62.27 ± 0.02	62.23 ± 0.03
Total ash	6.26 ± 0.01	6.25 ± 0.00	6.24 ± 0.00	6.23 ± 0.00
Acid insoluble ash	0.40 ± 0.005	0.39 ± 0.01	0.38 ± 0.00	0.39 ± 0.01
Organic matter	93.74 ± 0.01	93.75 ± 0.00	93.76 ± 0.00	93.77± 0.00
Calcium	1.12 ± 0.00	1.12 ± 0.01	1.12 ± 0.00	1.13 ± 0.01
Total phosphorous	0.97 ± 0.01	0.99 ± 0.01	1.02 ± 0.02	1.04 ± 0.03

*Average of four values with SE

* On DM basis

Table 5. Chemical composition of excreta* of broilers maintained on four dietary treatments, per cent

Attribute (per cent)	T1	T2	T3	T4
Dry matter	21.05 ± 0.21	21.09 ± 0.18	20.73 ± 0.16	20.45 ± 0.21
Crude protein	17.38 ± 0.11	16.93 ± 0.11	16.46 ± 0.36	16.64 ± 0.22
Ether extract	3.95 ± 0.06	4.09 ± 0.12	4.00 ± 0.05	4.12 ± 0.01
Crude fibre	14.70 ± 0.30	15.20 ± 0.09	15.28 ± 0.23	15.23 ± 0.08
Total ash	15.57 ± 0.86	14.38 ± 0.03	15.16 ± 0.61	14.00 ± 0.06
Acid insoluble ash	1.59 ± 0.00	1.52 ± 0.00	1.62 ± 0.00	1.41 ± 0.00
Nitrogen free extract	65.79 ± 0.54	66.34 ± 0.15	65.56 ± 0.37	66.65 ± 0.06
Organic matter	84.43 ± 0.86	85.62 ± 0.03	84.84 ± 0.61	86.00 ± 0.06

*Average of four values with SE

*On DM basis

Digestibility of nutrients

The digestibility coefficient values of various nutrients are given in Table 6. On the statistical analysis of the data the dry matter, crude protein and organic matter digestibility were significantly higher (P<0.01) in BP-supplemented groups compared to the un-supplemented control group. Dry matter digestibility was significantly higher in T2 (76.22%), T3 (76.27%) and T4 (76.39%) compared to T1 (74.99%). Significantly higher (P<0.01) CP digestibility values of 80.17, 80.77 and 80.67 per cent were noticed in T2, T3 and T4, respectively compared to 78.58 per cent in the T1 group. Ether extract, CF and NFE digestibility ranged from 84.37 to 85.00 per cent, 24.27 to 26.03 per cent and 80.56 to 81.29 per cent respectively and were similar (P>0.05) among the groups. Organic matter digestibility was significantly higher (P<0.01) in T3 (78.54%) and T4 (78.35%) compared to T1(77.48%), while T2 (78.28%) was similar among the groups. The results of Zeedan *et al*. (2017), who observed significantly greater digestibility of DM, CP, EE, NFE, and CF in male New Zealand white rabbits supplemented with 200, 500, and 700 mg BP/Kg BW in comparison to the control group, partially align with our current investigation. They observed DM digestibility of 71.92 per cent in the control group, while it was 72.87, 77.65, and 79.95 per cent in groups supplemented with 200, 500, and 700 mg BP/Kg BW. Similarly, they noticed 59.61 per cent CP digestibility in the control group, which is significantly lower than the treatment groups' respective CP digestibility of 63.50, 66.42 and 70.63 per cent. Bee pollen is rich in a variety of nutrients, including vitamins, minerals, hormones, and amino acids. It also contains coenzymes and other enzymes that are essential for healthy digestion and cell division (Wang *et al.,* 2007). This might be the reason behind improved nutrient digestibility in broilers. Bee pollen supplementation improves the digestive system's absorption process because of increased mucosa surface and the volume of epithelium in the jejunum (Toman *et al.,* 2015). In addition to the increased length of intestinal villi, BP supplementation results in deeper crypts in duodenal intestinal villi, which is a definite sign of increased proliferative activity in the mucosa of those intestinal villi (Toman *et al.,* 2015). Increased mucosal proliferative activity results in improved digestibility and absorption of nutrients in broilers (Prakatur *et al*., 2019). Several studies have reported reduced feed intake on bee pollen supplementation (Farag and El Rayes, 2016; Rabie *et al*., 2018). Reduced feed intake results in increased digestibility of nutrients (Zeedan *et al.,* 2017). Bee pollen supplementation has an impact on both pathogenic and beneficial microorganisms' occurrence in broiler chicken gastrointestinal tracts (Krocko *et al*., 2012). Phenolic compounds including different flavonoids, phenolic acids, and their derivatives can shield the intestinal villi and boost nutrient absorption. Thus, the antibacterial and antioxidant property of BP positively affects nutrient digestibility (Prakatur *et al.,* 2019).

In contrast to our present study, comparable DM and CP digestibility was observed by Nemauluma *et al*. (2023) in both male and female broiler chickens in

Table 6. Digestibility coefficients of nutrients* in maintained on four dietary treatments, per cent

Attribute	T1	T2	T3	T4	F-Value (P- Value)	SEM
Dry matter	74.99^{b} ± 0.26	76.22^{a} ± 0.32	76.27^{a} ± 0.25	76.39^{a} ± 0.17	6.614** (0.007)	0.186
Crude protein	78.58^{b} ± 0.18	80.17^{a} ± 0.24	80.77^{a} ± 0.61	80.67^{a} ± 0.39	6.728** (0.006)	0.286
Ether extract	84.37 ± 0.20	84.65 ± 0.36	85.00 ± 0.23	84.67 ± 0.13	1.089^{ns} (0.391)	0.124
Crude fibre	24.27 ± 0.79	25.51 ± 0.80	25.29 ± 0.42	26.03 ± 0.52	1.279^{ns} (0.326)	0.336
Nitrogen free extract	80.56 ± 0.09	81.12 ± 0.32	81.29 ± 0.05	81.02 ± 0.08	3.241^{ns} (0.060)	0.104
Organic matter	77.48^{b} ± 0.04	78.28^{ab} ± 0.29	78.54^{a} ± 0.10	78.35^{a} ± 0.15	7.295** (0.005)	0.130

*Average of four values with SE

*On DM basis

ns non-significant ** Significant at 0.01 level(P<0.01)

Means having different letters as superscripts differ significantly within a row

the experimental groups that were fed 4g, 8g, and 12g BP per Kg DM and control group. In male broiler chickens, Nemauluma *et al.* (2023) reported DM digestibility of 82.45 per cent in the control group and 81.80, 82.29, and 82.10 per cent in the BP4, BP8, and BP12 groups, respectively. In female broiler chickens, dry matter digestibility varied from 81 per cent in the control group to 81.20 per cent, 80.33 per cent and 80.98 per cent in the BP4, BP8, and BP12 groups, respectively. They found that the CP digestibilities of male broiler chickens in the BP0, BP4, BP8, and BP12 groups were 79.97, 80.21, 80.49 and 80.92 per cent, respectively, and that the CP digestibilities of female broiler chickens were 79.73, 79.85, 79.77 and 78.95 per cent, respectively. Crude protein digestibility values were similar among groups.

The nutritional value of pollen collected by bees varies greatly depending on the type of flower and its geographical origin (Hsu *et al*., 2021). Hence this difference in chemical composition might be the reason for not getting increased digestibility in the present study.

Conclusion

Results of the present study show that dry matter and crude protein digestibility increased significantly in 0.25, 0.5 and 0.75 per cent bee pollen-supplemented broilers compared to un-supplemented broilers. Organic matter digestibility was also significantly higher in 0.5 per cent and 0.75 per cent BP-supplemented broilers compared to the control group, while 0.25per cent BP-supplemented broilers had a value which is similar to both the control group and other treatment groups. The ether extract, crude fibre and nitrogen-free extract digestibility values were statistically similar among all the experimental groups. Hence it could be inferred that supplementation of BP at 0.25, 0.5 and 0.75 per cent levels could be recommended for improved nutrient utilisation in broilers.

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Conflict of interest

The authors declare that they have no conflict of interest.

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