

EFFECT OF DIETARY SUPPLEMENTATION OF BLACK PEPPER (*Piper nigrum*) ON THE PERFORMANCE AND HEALTH OF VANARAJA BIRDS

ABSTRACT

The investigation of Vanaraja birds on a diet supplemented with black pepper (*Piper nigrum*) powder” was carried out to study the productive performance, carcass traits, mortality, performance index, blood parameters, and economics of vanaraja birds. A total of one hundred and fifty (150) day-old vanaraja chicks were randomly divided into five treatment groups of thirty birds each, namely T₁ (control), T₂, T₃, T₄, and T₅, with 5 replications per treatment having 6 birds in each replicate following a randomized block design. Standard broiler diet (0–28) days and finisher ration (29–63 days) were provided to the birds. Black pepper powder was supplemented at the rates of 0, 0.25, 0.5, 0.75, and 1 g/kg feed in T₁, T₂, T₃, T₄, and T₅, respectively. Body weight, weight gain, and feed conversion efficiency were recorded on a weekly basis, while feed intake was noted on a daily basis. 5 birds from each treatment were killed on the 63rd day in order to evaluate the carcass, and 5 birds from each treatment were selected for collecting blood samples for hematological and biochemical blood analysis. Black pepper supplementation at 0.25 g/kg of basal diet resulted in significantly (P<0.05) higher body weight. Feed intake was significantly (P<0.05) higher in T₂ (black pepper @ 0.25%). The dressing and liver weight were better in the T₂ group. The performance index was better in the T₃ group. Also, blood constituents of cholesterol, HDL, LDL, and triglycerides were found to be lower in T₂ groups. The net profit per kg live weight of vanaraja was highest in T₁ compared to treatment groups. Based on the above findings, dietary supplementation of black pepper powder at the rate of 0.25 g/kg feed can be recommended under the agro-climatic condition of Nagaland.

Keywords: Vanaraja bird, black pepper powder, Blood constituents, net profit.

INTRODUCTION

In India, total poultry production is 851.81 million, and it increases at the rate of 16.81% during the Livestock Census 2019. In India, backyard poultry population is 317.07 million, and commercial poultry population is 534.74 million. Overall, 45.78% increase in backyard poultry and commercial poultry has increased 4.5% in India. Tamil Nadu had the highest poultry population in India. The vanaraja bird, or officially (*Gallus gallus domesticus*), is an important poultry farming animal because of its distinctive genetic makeup and contributions to sustainable farming. The vanaraja is a hybrid of native Indian breeds that have been carefully cultivated to perform better under different climates and to be more tolerant of regional farming methods. The origins of this breed can be traced to attempts made in the middle of the 20th century to improve native chicken breeds in India. The main goals of the breeding program were to improve features

like overall adaptability to rural farming situations, disease resistance, egg production, and meat quality.

Vanaraja birds are distinguished genetically by a varied lineage that combines features from native Indian breeds with contemporary breeding methods, leading to variations in plumage color, body size, and egg-laying capacity. Their genetic variety facilitates their adaptability to various management techniques and durability, making them suitable for a wide range of agricultural systems. The socioeconomic circumstances in rural communities are improved since they are affordable and require little upkeep, making them available to farmers with little resources.

Patel *et al.* (2018) explained that vanaraja is a dual-purpose multi-colored bird for poultry production. The color and feather pattern of vanaraja closely match that of jungle fowl, which is raised in backyards in communities and tribal habitations. Some spices and herbs, including turmeric, hot red pepper, ashwagandha, cinnamon, oregano, garlic, rosemary, and ginger, are the well-investigated phytobiotics in the diet of vanaraja. (Kostadinovic and Levic, 2012), (Puvaca *et al.* 2013)

Black pepper (*Piper nigrum*) is also known as 'king of spices,' and 'black gold' is native to India within the family Piperaceae, genus Piper, and species nigrum. This woody perennial vine clings to trees, trellises, and other structures. Black pepper's main ingredient, piperin, is what gives it its pungent and stinging properties. Three categories of chemicals can be found in black pepper (*Piper nigrum*). The components in the first group determine how sharp black pepper is; the compounds in the second group determine how fragrant black pepper is; and the compounds in the third group include fiber, starch, polyphenols, mineral salts, and lipids, among other compounds. (Aleksandra *et al.*, 2021).

Black pepper is medicinally used for a variety of conditions, such as antibacterial, antifungal, antiapoptotic, antidepressant, antidiarrheal, anti-inflammatory, antimutagenic, antioxidative, antipyretic, antispasmodic, antitumor, enhancing appetite and digestive function, treating dyspnea, colds, coughs, throat infections, treating intermittent fever, treating colic, treating dysentery, and getting rid of worms and piles. (Ahmad *et al.*, 2012), (Islam *et al.*, 2015). Glutathione peroxidase and glucose-6-phosphate dehydrogenase have been demonstrated to be abundant in black pepper (Karthikeyan and Rani, 2003).

Piperine, the active ingredient of black pepper, increases absorption of serum, vitamin B, beta-carotene, and other nutrients, favorably stimulating the digestive enzymes of the pancreas, enhancing the digestive capacity, and significantly reducing the gastrointestinal food transit time (Srinivasan, 2007). Black pepper is also used for culinary as well as medicinal purposes around the world. It increases digestion through digestive enzymes of the stomach and eradication of infectious bacteria (Hosseini, 2011). Toghiani *et al.* (2010) explained that piperine had biomolecular functions similar to various compounds, including vitamin K, to reduce the use of phytogenic substances presenting active biomolecular compounds with similar functions to synthetic compounds. They have the potential to boost poultry production by assisting in the control of certain metabolic processes.

According to Moorthy *et al.* (2009), piperine affects the neurological system, aiding in digestion and boosting the body's absorption of minerals including beta-carotene, vitamin complex, and selenium. Feed additives serve as catalysts in the digestion and metabolism of nutrients. It also improves digestibility (Acker, 1983). Piperine has an antiache effect (Mahady *et al.*, 2008). The bioactive compound in pepper aids in digestion and has a significant pharmacological effect on neurons and the neuromuscular system (Great, 2003). Being a natural commodity, black pepper may be produced at a minimal cost and in large numbers.

2. MATERIALS AND METHODS

2.1. Location of the study

The research was conducted at Nagaland University's Instructional Livestock Farm, Department of Livestock Production and Management, School of Agricultural Sciences, Medziphema Campus, Nagaland. The farm's coordinates are 93.20° E to 95.15° longitude, 25.6° N latitude, and a height of 310 meters above sea level (MSL).

2.2. Materials

A total of 150 commercial vanaraja chicks from a single hatch were obtained from the ICAR Medziphema, Nagaland. When the birds arrived, they were individually weighed and randomly assigned to one of the dietary treatment groups, with 30 birds in each group. The dietary treatments comprised feeding a basal diet as a control, while the other treatment groups were fed varied quantities of black pepper powder at rates of 0.25, 0.5, 0.75, and 1 g per kg of feed. Vanaraja chicks were fed a normal diet. The feeding was divided into two phases: normal starter ration (0–28 days) and finisher ration (29–63 days). The standard ration was obtained from a reputed commercial feed manufacturer in Dimapur, Nagaland. A precise amount of black pepper at 0.25, 0.5, 0.75, and 1 g/kg feed was added and held in separate bags as T₁ (control) and T₂, T₃, T₄, and T₅ as treatment groups, respectively. To guarantee *ad libitum* feeding, the chicks received a weighed amount of feed from each treatment group on a daily basis. The birds were provided with fresh and clean water throughout the trial. The birds were nurtured in a deep litter system during the brooding period, and subsequently, on the fifth week, they were transferred to cages. Black pepper powder was obtained from the Dimapur new market in Nagaland. The purchased black pepper was pounded into powder using an industrial blender and then kept in airtight containers until required.

2.3. Treatment and Feeding

Completely Randomized Block Design (CRD) was followed in the execution of the experiment. A total of 150 chicks were randomly assigned to five (5) distinct groups (referred to as T₁, T₂, T₃, T₄, and T₅), with each group consisting of thirty (30) chicks that each had five replicates of six (6) birds. The chicks were raised in deep litter systems until they were 28 days old, after which they spent 35 days in cages in the finisher house. Standard starter was fed to the chicks from 1-4 weeks of age, while finisher was provided from 5-9 weeks of age. The basal diet was given to Group 1 (T₁), which was the control group. The chicks in the other five

treatment groups were also provided with the same basal diet as in T₁ but supplemented with different levels of black pepper powder. The details of the distribution of chicks and their treatment are summarized below.

Table 1. Details of the distribution of chicks and their treatment.

Group	Total no. of birds	Quantity of black pepper to basal diet
T1 (control)	30	Basal diet
T2	30	Basal diet + 0.25g black pepper /kg feed
T3	30	Basal diet + 0.5g black pepper /kg feed
T4	30	Basal diet + 0.75g black pepper /kg feed
T5	30	Basal diet + 1g black pepper /kg feed

The body weights of chicks were taken on the first day of arrival. Thereafter, on a weekly basis, the average body weight was taken in the morning prior to feeding and watering. A digital weighing balance having a maximum capacity of 10 kg was used for the entire experiment for weighing the birds. During the first four weeks, the average weight of the chicks was recorded in groups. This was done by placing 5–10 chicks each in a pre-weighed carton box. From 5th weeks onwards, the birds were weighed individually at weekly intervals till they attained nine weeks of age, i.e., 63 days of age. This information was used to determine the average daily and weekly feed intake, reported in grams, for each bird in each group. The formula below was utilized to calculate the feed conversion efficiency (FCE) of the various experiments. At the end of the feeding trial, two birds were randomly selected from each treatment for the blood collection. The blood was collected from the wing veins of the birds by sterilizing and rubbing an area with disinfectant and cotton wool and then collecting about 2 ml of blood with the use of sterile needles into well-labeled, heparinized sterilized tubes. Samples were used for measurement of various blood parameters, including HDL, LDL, cholesterol, and triglyceride, and the sample to be used for measurement of WBC, RBC, hemoglobin (Hb), and PCV was collected in a sterilized tube containing Heparin as an anticoagulant. Mortality was recorded daily during the period of investigation and was expressed in percentage. Mortality was calculated by using the following formula: The liveability percentage was calculated by subtracting the mortality percentage from 100. Performance index (PI) was calculated by adopting the formula of Bird (1955). Following the trial, three birds were chosen at random for carcass evaluation studies from each group. Prior to slaughter, the live weight of each individual bird was noted. Using the Standard Method, slaughtering was carried out. After the bird was completely bled and its feathers removed, its dressed weight was determined. The average weight of the heart, liver, spleen, and (empty) gizzard was noted for each of the five groups. These organs were also weighed separately. The following calculation was used to get the percentage of dressed weight.

3. RESULT AND DISCUSSION

3.1. Body Weight

The average body weights of dayold chicks for T₁, T₂, T₃, T₄, and T₅ groups were 31.66, 31.40, 30.40, 32.20, and 32.20 g per bird, respectively. The corresponding body weight for the various treatment groups was 1695.20, 1738.20, 1719.60, 1717.60, and 1714.20 g per bird at the end of the ninth week. The overall mean of the body weight was 800.54, 830.43, 816.63, 822.80, and 822.54 g/bird/week for T₁, T₂, T₃, T₄, and T₅ groups, respectively. From the statistical analysis, it had been revealed that supplementation with black pepper had a significant effect on the final body weight. The treatment group T₂ had significantly ($P < 0.05$) higher body weight, followed by T₃, T₄, and T₅ the least in the control group. However, the difference among T₃, T₄, and T₅ was found to be non-significant. The results of the present study were well corroborated with the findings of Al-Kassie *et al.* (2011), Tazi *et al.* (2014), and Aikpitanyi *et al.* (2019), who had also reported significantly higher body weight due to supplementation of black pepper as compared to the control group. Higher body weight in the black pepper supplemented group might be due to the presence of piperine, the active ingredient of black pepper, which caused increased absorption of serum, vitamin B, beta-carotene, and other nutrients, favorably stimulating the digestive enzymes of the pancreas, enhancing the digestive capacity, and significantly reducing the gastrointestinal food transit time (Srinivasan 2007). In addition, it may be due to increased enzymes in the stomach and the eradication of infectious bacteria (Hosseini, 2011).

3.2. Gain in Body Weight

From Table 2, it was observed that average weight gain during the first week for Vanaraja birds was 49.97, 48.95, 53.88, 53.97, and 48.10 g per bird for T₁, T₂, T₃, T₄, and T₅ groups, respectively. The corresponding weight gain of the birds on the 9th week of age was 255.80, 247.20, 253.20, 251.20, and 243.80 g/bird. From the perusal of the data, the values for gain in weight were significantly higher ($p < 0.05$) in the T₁ group, followed by the T₃, T₄, T₂, and T₅ groups, who had the lowest weight gain values. However, there was no significant difference between the T₄ and T₅ groups. The results were in close agreement with the findings of Ndelekwute *et al.* (2015), Sindhu *et al.* (2018), and Dozo *et al.* (2023), who had also reported a non-significant effect of black pepper on body weight gain. On the other hand, the findings of the present study were contradictory to the observations of Abou-Elkhair *et al.* (2014), Tazi *et al.* (2014), and Aikpitanyi *et al.* (2019), who observed increased weight gain when supplemented with black pepper.

3.3. Feed Intake

From the data given in Table 2, it was perused that the total feed intake during the experiment was 4075.40, 4192.93, 4125.21, 4132.00, and 4139.80 g/bird for T₁, T₂, T₃, T₄, and T₅ groups, respectively. The corresponding mean feed intake was recorded as 452.82, 465.88, 458.36, 459.11, and 459.98 g/bird/week, respectively. From the perusal of data, it was observed that the average value of feed intake was significantly ($P < 0.05$) highest in T₂, followed by T₅, T₄, and T₃, and lowest in the T₁ group. However, the difference amongst T₁, T₃, and T₄ was found to be non-significant. The present findings were well corroborated with the reports of Al-Kassie *et al.* (2011) and Tazi *et al.* (2014), who had observed increased feed intake as a result of black pepper supplementation. Contrary to the present findings, Ndelekwute *et al.* (2015) and Dozo *et al.* (2023) had reported that supplementation of black pepper did not show any significant effect on feed

intake. It may be due to increased regulation of various metabolic functions, which might have increased intake and productivity of the animal, Toghyani *et al.* (2010).

3.4. Feed Conversion Efficiency

From the table 2, it was observed that the average value of feed conversion efficiency of vanaraja birds during first week was 0.80, 0.77, 0.88, 0.88 and 0.83. At the end of ninth week, the values were recorded as 0.33, 0.31, 0.32, 0.31 and 0.30 for T₁, T₂, T₃, T₄ and T₅ groups, respectively. The overall mean feed conversion efficiency of vanaraja birds was 0.48, 0.48, 0.48, 0.49 and 0.49 for T₁, T₂, T₃, T₄ and T₅ groups, respectively. From the perusal of data, it was observed that there was no significant difference amongst T₂, T₃, T₄ and T₅ groups. The present findings were well corroborated with the reports of Ndelekwute *et al.* (2015) who also observed that inclusion of black pepper did not show any significant effect on feed conversion efficiency. Contrary to the present findings, Al-Kassie *et al.* (2011) and Shahverdi *et al.* (2013) observed that feed conversion efficiency was better in group fed with black pepper as compared to control group.

3.5. Mortality and Morbidity

The mortality, liveability percentage, and performance index (PI) from day old to nine weeks old for the different treatment groups are shown in Table 2. The mortality percentages at 9th week for T₁, T₂, T₃, T₄, and T₅ are 6.66, 6.66, 3.33, 0.00, and 3.33 percent, respectively. The values of mortality were within the standard limit. However, the mortality was not due to black pepper feed supplementation but to external forces. And as a result, liveability percentages were recorded to be 93.34, 93.34, 96.67, 100.00, and 96.67, respectively. The highest performance of vanaraja birds was observed in T₃, followed by T₄, T₁, T₅, and the lowest in the T₂ group. Rahimian *et al.* (2016) had reported similar findings that the supplementation of black pepper powder had good effects on the performance of chickens compared to the control group. However, variation in the observation might be due to differences in species of birds, level of black pepper powder, inclusion, and agro-climatic condition.

3.6. Carcass yield, dressing percentage and organ weight

The mean carcass weight of vanaraja birds in different experimental groups was 1057.80, 1125.00, 1073.00, 1135.40, and 1142.60 g/bird for T₁, T₂, T₃, T₄, and T₅, respectively. The highest carcass weight was in T₅, followed by T₄, T₂, T₃, and T₁ groups. However, from the statistical analysis, the carcass weight was significantly ($P < 0.05$) higher in T₅ and lowest in T₁. The average dressing percentage at the end of the 9th week of different treatment groups T₁, T₂, T₃, T₄, and T₅ were recorded as 67.51, 72.17, 71.11, 66.41, and 69.30 percent, respectively. The dressing percentage was found to be higher in T₂, followed by T₃, T₅, T₁, and T₄ groups. From the statistical analysis, the dressing percentage was significantly ($P < 0.05$) higher in T₂ (72.17%), but there was no significant

difference between T₄ and T₅. The average liver weight was 37.60, 43.40, 43.40, 41.20, and 40.80 for T₁, T₂, T₃, T₄, and T₅ groups, respectively. The highest liver weight was recorded in T₂, followed by T₃, T₄, and T₅, and the lowest in the T₁ group. The average weight of spleen for T₁, T₂, T₃, T₄, and T₅ groups was 2.08, 2.14, 2.16, 3.00, and 2.78 gram, respectively. The spleen weight was higher in T₄, T₅, T₃, T₂, and T₁, respectively. Statistical analysis revealed that T₄ was significantly ($P < 0.05$) higher than T₁. In T₁, T₂, T₃, T₄, and T₅ groups, respectively, the average gizzard weight was 26.00, 30.60, 31.00, 30.80, and 27.80 gram. A higher gizzard weight was observed in the T₃ group, followed by T₄, T₂, T₅, and T₁, respectively. Statistical analysis revealed that the gizzard weight was significantly ($P < 0.05$) higher in T₃ and lowest in T₁, but there was no significant difference between T₂, T₃, and T₄. The average heart weight for the T₁, T₂, T₃, T₄, and T₅ groups was 8.40, 8.60, 9.60, 10.60, and 9.80 g. The highest heart weight was found in T₄ and subsequently T₅, T₃, T₂, and least in T₁ group. Statistical analysis revealed that the heart weight was significantly ($p < 0.05$) higher in T₄, but there was no significant difference between T₁, T₂, T₃, and T₄. The present findings were well collaborated with the reports of Mansoub (2011), Tazi *et al.* (2014), Singh (2014), Rahimian *et al.* (2016), and Puvaca *et al.* (2019), where observations of carcass yield, dressing percentage, and organ weights increased after black pepper was supplemented into the feed.

3.7. Haematological and Biological parameter

i. Total leucocytes count

From the table 3, it was revealed that the values of the average TLC concentration of Vanaraja birds at 9th week in T₁, T₂, T₃, T₄ and T₅ groups were 222.51, 225.90, 233.30, 231.05 and 225.62 cumm, respectively. The values of TLC was significantly ($P < 0.05$) higher in T₃ and the least in control group

ii: Haemoglobin

The average values of haemoglobin (Hb) on the 9th week of age were 14.40, 15.05, 15.85, 15.30, and 13.85 g/dl for T₁, T₂, T₃, T₄, and T₅ groups, respectively. The value of haemoglobin in the T₃ group was significantly ($p < 0.05$) higher than the other groups. However, the haemoglobin levels did not show significant differences among the treated groups and control group. This finding was similar to Al-Kassie *et al.* (2011), who also observed no significant increase in Hb level in the treated group as compared to the control group. On the contrary, Ndelekwute *et al.* (2017) found significant increases in haemoglobin concentration when supplemented with black pepper powder.

iii. Red blood cell.

The average values for red blood cells (RBC) obtained were 2.64, 2.53, 2.63, 2.35, and 2.29 10⁶/ul for T₁, T₂, T₃, T₄, and T₅, respectively. The value of RBC was numerically higher in the T₁ group, followed by T₃, T₂, T₄, and the lowest in the T₅ group. However, the values obtained showed that there was no significant difference amongst the groups. The findings were similar to Al-Kassie *et al.* (2011), who also observed no significant increase in RBC level in the treated group as compared to the control group. The results of the present study were contrary to the findings of Ndelekwute *et al.* (2017), who reported increased RBC count on diet supplemented with black pepper powder.

iv. Packed Cell Volume

The values of the average HCT (PCV) values of Vanaraja birds were 30.45, 29.40, 31.22, 29.15, and 29.65 for T₁, T₂, T₃, T₄, and T₅, respectively. The value of HCT was numerically higher in T₃ PVC level in the treated group as compared to the control group. In contrast, the findings observ, followed by T₁, T₅, T₂, and the lowest in T₄. However, the values obtained showed no significant difference amongst the group. Al-Kassie *et al.* (2011) also observed no significant increase in ed in the present study by Ndelekwute *et al.* (2017) reported that there was an increase in the PCV value of the treated group.

v. Total cholesterol

The average values of total cholesterol in the T₁, T₂, T₃, T₄, and T₅ groups were 183.30, 163.46, 173.49, 172.79, and 181.03 mg/dl, respectively. The value of total cholesterol was significantly ($P < 0.05$) higher in T₁, followed by T₅, T₃, T₄, and the least in T₂ groups. A similar finding was also observed by Al-Kassie *et al.* (2011), Rahimian *et al.* (2016), and Mansoub. (2011), who reported that supplementation of black pepper decreased cholesterol levels compared to the control group.

vi. High-density lipoprotein (HDL)

The average values of HDL cholesterol of vanaraja birds in different treatment groups were 38.64, 32.88, 33.29, 33.99, and 36.94 mg/dl for T₁, T₂, T₃, T₄, and T₅ groups, respectively. The value of HDL was significantly ($P < 0.05$) highest in T₁, followed by T₅, T₄, T₃, and the lowest in the T₂ group. However, the values obtained showed no significant distinction between the T₂, T₃, T₄, and T₅ groups. The present study's conclusion was strongly supported by the observations of Al-Kassie *et al.* (2011), who also reported a decreased level of HDL than the control group with a diet supplemented with black pepper.

vii. Low Density Lipoprotein (LDL)

The average values of LDL cholesterol were 125.56, 110.15, 105.29, 114.72, and 120.36 mg/dl for the T₁, T₂, T₃, T₄, and T₅ groups, respectively. The value of LDL was significantly (P<0.05) higher in T₁, followed by T₅, T₄, T₂, and the lowest in T₃ groups. The findings of the present study were strongly supported by the observations of Rahimian *et al.* (2016), who also reported a decreased level of LDL than the control group with a diet supplemented with black pepper.

viii. Triglyceride

It was observed that the average values of triglycerides in the T₁, T₂, T₃, and T₄ groups were 124.81, 118.79, 121.88, 122.41, and 123.22 mg/dl, respectively. The value of triglyceride was significantly (P<0.05) higher in T₁, followed by T₅, T₄, T₃, and the lowest in the T₂ group. The finding of the present study was well corroborated with the observations of Rahimian *et al.* (2016), who also reported that the triglyceride value decreased with feed containing a supplement with black pepper.

4.8 Cost of production

The average production cost of vanaraja birds in different treatment groups. The average cost of production per bird was 280.82, 301.82, 313.68, 328.78, and 344.15 rupees per bird for groups of T₁, T₂, T₃, T₄, and T₅, respectively. The comparable figures for the average production cost per kg of live bird were 166.16, 174.46, 183.43, 183.67, and 201.25 rupees. The net profit per bird was 145.01, 134.76, 116.15, 118.15, and 86.43 rupees for groups of T₁, T₂, T₃, T₄, and T₅, respectively, and the corresponding values for net profit per kg of live weight were 101.40, 90.44, 80.10, 80.92, and 58.79 rupees. The benefit cost ratio was calculated as 1.51, 1.44, 1.37, 1.31, and 1.25 for T₁, T₂, T₃, T₄, and T₅, respectively. The cost of production was maximum in T₅ (Rs. 344.15) and the least in T₁ (Rs. 280.82). The total cost of production per kg of live weight of bird was recorded to be highest in T₄ (Rs. 201.25) and lowest in T₁ (Rs. 166.16). The net profit per bird and net profit per live kg were observed to be higher in T₁ (Rs. 145.01 and Rs. 101.40, respectively) and lower in T₅ (Rs. 86.43 and Rs. 58.79, respectively). The benefit-cost ratio was highest in T₁, followed by T₂, T₃, T₄, and the lowest in the T₅ group. From the results obtained in the present study, it may be concluded that the birds in the control group had a better economical return as compared to the birds supplemented with black pepper. Contrary to present findings, Tazi *et al.* (2014) and Dozo *et al.* (2023) found that the birds supplemented with black pepper powder were found to be economical. The variation in the results might be due to differences in the species/strains and agro-climatic conditions.

Conclusion

The treatment group T₂ had significantly ($P < 0.05$) higher body weight, followed by T₃, T₄, and T₅ the least in the control group, and body weight gain in the T₁ group. It was observed that the average value of feed intake was significantly ($P < 0.05$) highest in T₂, followed by T₅, T₄, and T₃, and lowest in the T₁ group. However, the feed conversion was comparable irrespective of treatments. The performance index was better in the T₃ group. The carcass weight was comparable by supplementation of black pepper, while the higher dressing percentage and liver weight were found in the T₂ group. The values of hematological blood parameters were highest in T₃ for TLC, hemoglobin, and HCT (PVC). However, the values for RBC were highest in T₁. The values of blood constituents were highest in T₁ for cholesterol, HDL, and triglycerides. However, these values were lowest in the T₂ group. As for LDL, it was found higher in T₃ and lowest in T₂. From the present experiment on the basis of the above observations, it may be concluded that the performance of vanaraja birds in terms of body weight, feed intake, dressing percentage, liver weight, and biochemical constituents of blood were better in T₂ groups as compared to other treatments. Hence, on the basis of the above findings, dietary supplementation of black pepper (*Piper nigrum*) powder at the rate of 0.25 g/kg of basal can be advocated for better performance of vanaraja birds.

Future plans

1. Similar studies under different agro - climatic conditions and altitudes need to be carried out.
2. Additional research should be conducted on the inclusion of Paper Mulberry leaf meal in the diets of various pig breeds and age groups.
3. Further studies need to be carried out to evaluate the effect of Paper Mulberry leaves as feed supplementation at higher levels.
4. Further studies need to be carried out for a longer period of time to see results.
5. Additional studies are necessary to assess the impact of Paper Mulberry leaves on various other parameters, such as milk secretion and diarrhea, among others.

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Details of the AI usage are given below:

- 1.
- 2.
- 3.

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Table: 2. Production performance of broiler chicken with the supplemented black pepper on the different treatments groups of Vanaraja Birds.

Parameter	Treatments					
	Week	T ₁	T ₂	T ₃	T ₄	T ₅
Body weight (gram/bird/week)	Onset	31.66	31.40	30.40	32.20	32.20
	9 th	1695.2 ^a	1738.2 ^c	1719.6 ^b	1717.6 ^b	1714.2 ^b
	Total	7204.88	7473.9	7349.7	7405.2	7402.89
	Overall mean	800.54	830.43	816.63	822.80	822.54
Body Weight Gain (gram/bird/week)	Onset	49.97	48.95	53.88	53.97	48.10
	9 th	255.8 ^b	247.2 ^{ab}	253.2 ^b	251.2 ^a	243.8 ^a
	Total	1649.92	1704.79	1630.86	1685.2	1673.56
	Overall mean	183.32	189.42	181.20	187.25	185.95
Feed Intake (gram/bird/week)	Onset	62.20	63.40	60.60	61.20	58.13
	9 th	785.2 ^a	815.2 ^b	798.2 ^a	801.2 ^a	807.6 ^{ab}
	Total	4075.40	4192.93	4125.21	4132.0	4139.8
	Overall mean	452.82	465.88	458.36	459.11	459.98
Feed Conversion Efficiency	Onset	0.80	0.77	0.88	0.88	0.83
	9 th	0.33 ^b	0.31 ^a	0.32 ^a	0.31 ^a	0.3 ^a
	Total	4.38	4.40	4.33	4.42	4.42
	Overall mean	0.48	0.48	0.48	0.49	0.49
Mortality	1 st -9 th	6.66	6.66	3.33	0.00	3.33
Liveability (%)	9 th	93.34	93.34	96.67	100.00	96.67
Performance index	9 th	471.7	451.94	479.76	472.02	465.36
Dressing (%)	9 th	67.5 ^{ab}	72.17 ^b	71.11 ^b	66.41 ^a	69.30 ^a
Carcass weight (gram)	9 th	1057. 8 ^a	1125.0 ^a b	1073.0 ^a b	1135.4 ^b	1142.6 ^c

Heart (gram)	9 th	8.4 ^a	8.6 ^a	9.60 ^a	10.6 ^b	9.8 ^a
Liver (gram)	9 th	37.6 ^a	43.4 ^b	43.4 ^b	41.2 ^{ab}	40.8 ^{ab}
Gizzard (gram)	9 th	26.0 ^a	30.6 ^b	31.0 ^b	30.8 ^b	27.8 ^{ab}
Spleen (gram)	9 th	2.08 ^a	2.14 ^{ab}	2.16 ^{ab}	3.00 ^c	2.78 ^b

a, b and c Mean bearing different superscripts in a column differ significant (P<0.05).

Table.3. Average blood biochemical constituents of vanaraja birds in different treatment groups.

Treatments	Biochemical Characteristics			
	Total Cholesterol (mg/dl)	HDL Cholesterol (mg/dl)	LDL Cholesterol (mg/dl)	Triglycerides (mg/dl)
(T ₁)	183.30 ^b	38.64 ^b	125.56 ^c	124.81 ^b
(T ₂)	163.46 ^a	32.88 ^a	110.15 ^{ab}	118.79 ^a
(T ₃)	173.49 ^{ab}	33.29 ^a	105.29 ^a	121.88 ^{ab}
(T ₄)	172.79 ^b	33.99 ^a	114.72 ^{ab}	122.41 ^{ab}
(T ₅)	181.03 ^b	36.94 ^a	120.36 ^b	123.22 ^b
<i>SEm</i> ±	3.53	1.41	2.65	0.97
CD (p=0.05)	13.88	5.55	10.41	3.82

a,b,c means bearing different superscript in the column differ significantly (P<0.05)

Table.4. Average haematological characteristics of Vanaraja birds in different treatment groups.

Treatments	Haematological Characteristics			
	Total Leucocytes Count (TLC) (Cumm)	Haemoglobin (gm/dl)	Red Blood Cells (RBC)(10 ⁶ /ul)	HCT (PVC) (%)
(T ₁)	222.51 ^a	14.40 ^a	2.64 ^a	30.45 ^a
(T ₂)	225.90 ^{ab}	15.05 ^a	2.53 ^a	29.40 ^a
(T ₃)	233.30 ^c	15.85 ^a	2.63 ^a	31.22 ^a
(T ₄)	231.05 ^b	15.30 ^a	2.35 ^a	29.15 ^a
(T ₅)	225.62 ^a	13.85 ^a	2.29 ^a	29.65 ^a
<i>SEm</i> ±	1.32	0.73	0.16	0.86
CD (p=0.05)	5.19	NS	NS	NS

a,b,c means bearing different superscript in the column differ significantly (P<0.05).