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Effect of graded levels of mulberry (*Morus alba*) leaf powder on meat protein, lipid profile and sensory quality of Kaveri poultry

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ABSTRACT

The present study evaluated the effect of graded levels of mulberry (*Morus alba*) leaf powder (MLP) in the basal diet on growth performance, carcass traits and meat quality of Kaveri poultry. Two hundred day-old Kaveri chicks were randomly allotted in a completely randomized design to five dietary treatments, each with four replicates of 10 birds: T_1 (control, basal diet) and T_2 , T_3 , T_4 and T_5 (basal diet plus 2, 3, 4 and 5% MLP, respectively). The experimental diets were fed from the second to the twelfth week of age under a deep litter system. At the end of the trial, two birds per replicate were slaughtered for estimation of meat protein, serum lipid profile and sensory quality. MLP supplementation significantly ($P < 0.05$) improved the chemical quality of meat. Protein content increased progressively from 18.84 g/dL in the control to 22.18 g/dL in T_5 . Total cholesterol decreased from 168.42 to 138.46 mg/dL and LDL from 98.56 to 71.24 mg/dL, while HDL increased from 42.18 to 51.82 mg/dL. Cholesterol in T_4 and T_5 did not differ significantly. Sensory scores for appearance, tenderness, juiciness, flavour and overall acceptability rose numerically with MLP level (overall acceptability 7.22 to 7.72) but did not differ significantly ($P > 0.05$), showing no adverse effect on palatability. It is concluded that MLP inclusion up to 5% improved the protein content and lipid profile of Kaveri poultry meat without impairing sensory quality, with the 5% level giving the most favourable results.

Keywords: Kaveri poultry, Mulberry leaf powder, *Morus alba*, Meat quality, Cholesterol

1. Introduction

Poultry production is among the fastest-growing segments of Indian agriculture. The 20th Livestock Census recorded 851.81 million birds in 2019, 16.8% more than in 2012. Feed is the main limit on profitability in this sector, making up an estimated 60–75% of production cost, and protein ingredients alone account for more than 40% of feed expenditure (Islam *et al.*, 2014) [1]. Soybean meal and fish meal, the conventional protein sources, are expensive and their prices fluctuate. This has increased interest in cheaper, locally available feed resources that can partly replace them.

Mulberry (*Morus alba*) leaf is one such resource. It is rich in crude protein and has a balanced amino acid profile. It also supplies flavonoids and polyphenols, which have antioxidant and cholesterol-lowering properties (Islam *et al.*, 2014) [1]. Studies in broilers have reported that mulberry leaf in the diet can be used without harming performance and can improve carcass and meat traits (Simol *et al.*, 2012; Panja, 2013) [3, 2]. Inclusion of up to 5% maintained growth and reduced cholesterol in breast muscle (Olteanu *et al.*, 2015). A recent meta-analysis also found higher daily gain and feed intake in chickens fed mulberry leaves, although the response varied with dose (Geng *et al.*, 2024) [4].

Mulberry leaf has mostly been fed to ruminants, because mature leaves contain crude fibre and *anti-nutritional* factors such as tannin that can limit performance in monogastric animals (Ding *et al.*, 2021) [5]. Fermentation can reduce this problem. Ding *et al.* (2021) [5] showed that fermented mulberry leaf powder in broiler diets improved nutrient digestion and growth performance and enriched the amino acid and fatty acid profile of the meat. These findings suggest that unfermented leaf powder may also be beneficial when included at carefully graded, low levels.

The Kaveri is a dual-purpose backyard strain known for low mortality, early maturity and good adaptability, and it has grown better than local birds under farmer-managed conditions (Banja *et al.*, 2017) [6]. To the best of our knowledge, the effect of mulberry leaf powder has not been studied in this strain. The present study therefore evaluated 2, 3, 4 and 5% mulberry leaf powder in the diet of Kaveri birds for growth performance, feed conversion ratio, carcass traits, meat protein and cholesterol profile (total cholesterol, HDL and LDL), and sensory quality.

2. Materials and methods

2.1. Experimental site

The study was conducted in the Department of Animal Husbandry and Dairy Science, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, India.

2.2. Experimental birds and design

Two hundred day-old Kaveri chicks, pre-vaccinated against Marek's disease, were procured from the Krishi Vigyan Kendra (KVK), Kharpudi, District Jalna, following standard procurement procedures. Chicks were individually weighed (35–50 g body weight), wing-banded for identification, and randomly allotted to five dietary treatment groups in a Completely Randomized Design (CRD). Each treatment consisted of 40 birds, further divided into 4 replicates of 10 birds each. The dietary treatments were as follows: T₁ (control, basal diet without any additive), T₂ (basal diet + 2% mulberry leaf powder), T₃ (basal diet + 3% mulberry leaf powder), T₄ (basal diet + 4% mulberry leaf powder), and T₅ (basal diet + 5% mulberry leaf powder).

2.3. Preparation of mulberry leaf powder

Fresh mulberry (*Morus alba*) leaves were collected from the mulberry plot maintained at the Department of Entomology, College of Agriculture, Badnapur. The leaves were shade-dried for three days, after which they were ground into a fine powder and incorporated into the respective experimental diets at graded levels.

2.4. Housing and management

Brooders, waterers, and feeders were thoroughly cleaned, washed, and disinfected prior to chick placement. Birds were reared under a deep litter system, with brooding temperature maintained between 26.6 and 35 °C (85–95 °F) for the first two weeks. During brooding, chicks were fed maize crumbles for the initial three days, followed by commercial pre-starter (0–7 d), starter (8–21 d), and finisher (22–90 d) diets. The experimental mulberry leaf powder-supplemented diets were introduced from the second week and continued until the end of the twelfth week. Birds in each treatment group were fed separately, offered feed twice daily, and provided clean drinking water *ad libitum*. Leftover feed was collected and weighed each morning to determine intake. Standard health care and a routine vaccination schedule were followed throughout the trial.

2.5. Growth performance

Growth performance was evaluated in Kaveri poultry fed graded levels of mulberry (*Morus alba*) leaf powder. The study assessed growth, feed intake, and feed conversion ratio from the second to twelfth week, with different dietary inclusion levels compared with the control group.

3. Carcass and meat quality parameter

3.1 Slaughter procedure

At the end of the 12-week experimental period, two birds per replication (8 birds per treatment; 40 birds in total) were randomly selected, fasted overnight, weighed, and slaughtered by the halal method. After bleeding, scalding, defeathering, and evisceration, carcass traits including dressing percentage, giblet weight, breast muscle weight, and thigh muscle weight were recorded.

3.2 Determination of protein in meat

Total protein content of meat samples was estimated by the Micro-Kjeldahl method as described by AOAC (1975) [7]. Approximately 2–3 g of fresh meat sample was digested with concentrated sulfuric acid (H₂SO₄) and a potassium sulfate–copper sulfate (9:1) digestion mixture until a clear solution was obtained. The digested sample was diluted with distilled water, transferred to a volumetric flask, and an aliquot was distilled using a Micro-Kjeldahl

apparatus. The nitrogen content was determined and multiplied by a conversion factor of 6.25 to calculate the crude protein content, which was expressed as percentage protein.

3.3 Determination of cholesterol of meat

Blood samples collected at slaughter were allowed to clot and centrifuged at 2000 rpm for 10 minutes to obtain serum. Serum total cholesterol was estimated by the method of Wybenga *et al.* (1970) using a commercial diagnostic kit. HDL cholesterol was determined according to Seigler (1981), while LDL cholesterol was calculated using the Friedewald equation (Friedewald *et al.*, 1972).

3.4 Sensory evaluation of meat quality

Sensory evaluation of cooked breast and thigh meat samples was carried out by a semi-trained panel of judges. The samples were cooked under standard conditions and evaluated for colour, flavour, juiciness, tenderness, and overall acceptability using a 9-point hedonic scale.

4. Results and discussion

4.1 Carcass and meat quality parameter

The chemical composition of Kaveri poultry meat fed different levels of mulberry leaf powder is presented in Table 4.9. The evaluated parameters included total protein, cholesterol, HDL, and LDL. Supplementation of mulberry leaf powder significantly ($P < 0.05$) improved the chemical quality of meat. Total protein content increased progressively with increasing MLP levels, with the highest value recorded in T₅ (22.18 g/dL), followed by T₄ (21.35), T₃ (20.48), T₂ (19.56), and the lowest in T₁ (18.84 g/dL). Cholesterol content showed a significant decreasing trend, with the lowest value in T₅ (138.46 mg/dL) and the highest in T₁ (168.42 mg/dL). Similarly, HDL increased from 42.18 mg/dL in T₁ to 51.82 mg/dL in T₅, whereas LDL decreased from 98.56 to 71.24 mg/dL, indicating an improved lipid profile. Overall, 5% mulberry leaf powder supplementation (T₅) resulted in the most favourable chemical composition by increasing protein and HDL while reducing cholesterol and LDL levels. The cholesterol-lowering effect may be attributed to bioactive compounds such as flavonoids and polyphenols present in mulberry leaves. These findings are in agreement with Islam *et al.* (2014) [1], who reported reduced cholesterol levels with mulberry leaf meal supplementation in broilers. Similar improvements in nutrient utilization and lipid metabolism were reported by Kumari *et al.* (2018) [8] and Li *et al.* (2016) [9], which were attributed to DNJ and antioxidant compounds present in mulberry leaves.

4.2 Sensory evaluation for meat quality

The sensory evaluation of cooked meat from Kaveri poultry birds fed different levels of mulberry leaf powder is presented in Table 4.8. The results indicated that mulberry leaf powder supplementation improved the sensory quality of meat. The highest scores for appearance and colour, flavour, tenderness, juiciness, texture, and overall acceptability were recorded in T₅ (5% MLP), followed by T₄, T₃, T₂, and T₁. Statistical analysis revealed that sensory attributes did not differ significantly ($P > 0.05$) among treatments; however, the increasing trend in scores with higher MLP inclusion indicated a positive effect on meat palatability without any adverse influence on sensory characteristics. The present findings are in agreement with Li *et al.* (2020), who reported improved colour, tenderness, and overall acceptability of broiler meat with mulberry leaf polyphenol supplementation due to its antioxidant activity. Das *et al.* (2021) [10] also observed improved juiciness and overall acceptability with mulberry leaf powder supplementation in Vanaraja birds. The absence of significant differences in the present study may be due to variations in bird strain, feeding duration, and panel size. Similar observations by Chumngoen *et al.* (2015) [11] and Devatkal *et al.* (2018) [12] indicated that meat sensory characteristics are influenced by breed and genotype along with dietary factors.

Table 1. Organoleptic characteristics in experimental birds fed with Mulberry Powder

Treatments	Appearance	Tenderness	Juiciness	Flavour	Overall Acceptability
T ₁ (Control)	7.28	7.22	7.18	7.20	7.22
T ₂ (2% MLP)	7.36	7.34	7.31	7.35	7.34
T ₃ (3% MLP)	7.48	7.45	7.42	7.46	7.45
T ₄ (4% MLP)	7.62	7.58	7.55	7.60	7.58
T ₅ (5% MLP)	7.74	7.70	7.68	7.73	7.72
SE(m)	0.198	0.192	0.175	0.198	0.192
C.D.at 5%	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2. Chemical composition in experimental birds fed with Mulberry powder

Treatments	Total Protein (g/dL)	Cholesterol (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
T ₁ (Control)	18.84 ^c	168.42 ^a	42.18 ^c	98.56 ^a
T ₂ (2% MLP)	19.56 ^d	160.84 ^b	44.35 ^d	91.42 ^b
T ₃ (3% MLP)	20.48 ^c	152.76 ^c	46.68 ^c	84.15 ^c
T ₄ (4% MLP)	21.35 ^b	145.28 ^d	49.24 ^b	77.63 ^d
T ₅ (5% MLP)	22.18 ^a	138.46 ^d	51.82 ^a	71.24 ^c
SE(m)	0.200	2.331	0.581	0.982
C.D. at 5%	0.610	7.090	1.767	2.986

5. Conclusion

Adding mulberry (*Morus alba*) leaf powder to the basal diet of Kaveri poultry at 2–5% improved the protein content and lipid profile of the meat in a dose-dependent manner. Protein rose from 18.84 g/dL in the control to 22.18 g/dL at 5% MLP (T₅). Total cholesterol fell from 168.42 to 138.46 mg/dL and LDL from 98.56 to 71.24 mg/dL, while HDL rose from 42.18 to 51.82 mg/dL. T₅ gave the most favourable protein, HDL and LDL values, although its cholesterol did not differ significantly from that of T₄ (4% MLP). Sensory scores for appearance, tenderness, juiciness, flavour and overall acceptability were numerically highest in T₅ but did not differ significantly among treatments. This shows that MLP did not impair the palatability of the meat. Within the levels tested, 5% MLP can therefore be recommended for improving meat protein and lipid profile in Kaveri birds. Further studies should test inclusion levels above 5% and evaluate the effect on growth performance, carcass yield and the economics of production.

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7. Conflict of interest

The authors declare that they have no conflict of interest.

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