Review Article

MULBERRY LEAF POWDER AS PROTEIN ALTERNATIVE FOR POULTRY- A REVIEW

Abstract

Poultry production is one of the most important livestock sectors as it provides the cheapest animal protein in the form of eggs and meat for human consumption in the shortest period. The poultry sector accounts for over 1% of total GDP, and about 13% of the livestock GDP and is recognized as one of the fastest growing sectors in India with an annual growth rate of 6-8% in egg production and 10-12% in broiler chicken production per annum.Feed cost typically accounts for 60-75% of the total cost of poultry production.However, feed availability is decreasing due to the increasing demands of an expanding human population and significantly increased levels of biofuel production. Finding economical, cost-effective, and locally available alternatives to conventional feed sources could be one way to reduce poultry feed costs.Mulberry leaves, which have a high nutritional value, can be added to the list of feed alternatives for poultry feeding.Mulberry is a prominent medicinal plant belonging to the *Moraceae* family. Mulberry leaf fodder can be employed successfully in the poultry diet. They are readily digestible (70-90 %) by herbivorous animals as well as monogastric and are found to contain little or no anti-nutritional factor or toxic compounds.It positively influences the growth performance and nutrient utilization in broiler and laying hens.It has been found that mulberry leaves contain a variety of active substances, including polysaccharides, flavonoids, and polyphenols, which can reduce blood glucose and triglycerides, and have the function of antioxidation and regulation of lipid metabolism. Mulberry leaf powder supplementation produces meat with longer storage life.The level of thiobarbituric acid (TBA) in the breast meat of all mulberry leaf powder supplemented groups have also been lower than the control groups.The yolk colour has been improved in the eggs of the birds fed with mulberry leaf powder, which can be due to excessive amounts of xanthophylls in the leaves.Mulberry leaves also have an enormous potential to reduce feed cost as they can be used instead of expensive protein sources such as soybean meal and fish meal in poultry diets. Studies conducted with poultry indicated that addition of mulberry leaves are possible up to certain limits in poultry diets without any adverse effect on their performance.

Keywords: Mulberry, Economical, Flavanoids, Xanthophylls, Thiobarbituricacid(TBA)

Introduction

Poultry production is one of the most important livestock sectors as it provides the cheapest animal protein in the form of eggs and meat for human consumption in the shortest period.India's poultry sector accounts for over 3% of the global poultry population and ranks third in egg production and sixth in meat production worldwide [1]. The poultry sector accounts for over 1% of total GDP, and about 13% of the livestock GDP and is recognized as one of the fastest growing sectors in India with an

annual growth rate of 6-8% in egg production and 10-12% in broiler chicken production per annum. Its use for food can be traced back to the Roman Empire, attributed with the development of breeds, particularly for egg production [2].

Feed cost typically accounts for 60-75% of the total cost of poultry production. However, the unavailability and consequentlyinflated costs of conventional chicken feed have affected poultry production in the tropics. Furthermore, feed availability is decreasing due to the increasing demands of an expanding human population and significantly increased levels of biofuel production. Finding economical, cost-effective, and locally available alternatives to conventional feed sources could be one way to reduce poultry feed costs. However, the use of unconventional feedstuffs for poultry production is limited due to their fibrousness and inability of birds to possess the cellulase enzyme that can digest the fibre[3]. Mulberry leaves, which have a high nutritional value, can be added to the list of feed alternatives for poultry feeding.

Mulberry is a prominent medicinal plant belonging to the *Moraceae* family. It thrives in the tropics and subtropics and is said to have high nutritional value as a forage plant.In many species, the plant starts off white, then turns pale yellow with pink edges, and finally turns red as it ripens. When completely mature, its hue changes from dark purple to black. They may also be found in Asia's subtropical areas, such as Japan, India, China, and Korea. Mulberry trees (*Morus species*) are planted in most of these countries for several reasons, including the production of silk worms and improving foliage yield in India and China [4]. Mulberry (*Morus spp*.) leaves have long been used as diet for the silk worm (*Bombyx mori*), and are thus vital to the sericulture industry. Mulberry is also largely appreciated for its fruit, as a nutritious vegetable (young leaves and stems), and as animal feed, in addition to its usage as silk worm feed [5].

It is widely grown for its leaves, which are used by the sericulture industry to raise silkworms, so it can serve as a potential feed source for poultry in areas where sericulture is practiced on large scale. Mulberry leaves are an alternative for poultry feeding because they offer a greater feeding value than other forages, with high dry matter, protein, and minerals, as well as a high level of accessible digestible energy, and little or minimal antinutritional components. Climate, soil qualities, variety, plant density, fertiliser treatment, and harvesting practices all influence the amount of fresh mulberry leaves and total dry matter (DM) produced per hectare, although mulberry yields more digestible nutrients than other traditional forages [5].

Nutritional Composition

Mulberry leaves contain15.64% crude protein, 5.48% ether extract, 14.24% crude fibre, 10.36% total ash and 54.28 % nitrogen free extract on dry matter basis [6]. The mineral content is also high in mulberry leaves (2.42-4.71%) and their metabolizable energy content is around 1,130-2,240 Kcal/kg [7,8]. Mulberry leaves contain prominent levels of β-carotene, which can be converted with varying efficiency to vitamin A by poultry andcontainxanthophylls, which can serve as an excellent source of the pigmentation to egg yolk [9,10]. They are rich in Calcium and Ascorbic acid as well as vitamin B_1, folic acid, folinic acid and vitamin D. The

antioxidant ability of mulberry leaf extracts and improved amino acid composition may aid in the relief of heat stress in birds.

Phytochemicals in Mulberry

Mulberry contains various phytochemicals such as alkaloids, anthocyanins, flavonoids, saponins, stilbenes, triterpenes (lupeol), sterols (β-Sitosterol), coumarins and phenolic acids [11,12,13]. The alkaloid 1-deoxynojirimycin (DNJ) is found in leaves [14]. Cyanidin 3-rutinoside and cyanidin 3-glucoside are the predominant anthocyanins found in mulberry [15]. Stilbenes discovered in mulberries include Resveratrol, Oxyresveratrol, and Mulberroside A [16]. Chlorogenic acid, caffeic acid, vanillic acid, p-hydroxybenzoic acid, p-coumaric acid, sinapic acid, protocatechuic acid, and ferulic acid have all been identified as major phenolic acids in mulberry leaves [17]. The antimicrobial activity of *Morus* species is present in the stem bark of the mulberry plant while the methanolic extract of *M. alba* L. has shown high immunomodulatory activity [18].

Mulberry leaves are considered as nontoxic natural therapeutic agents and are known to possess antimicrobial, antimutagenic, anticancer, anxiolytic, anthelmintic, antistress, immunomodulatory, hypocholesterolemic, nephroprotective, hepatoprotective properties. Mulberry plant has also been used in traditional medicine to cure diabetes, hypertension, and neutral fat levels [19]; these medicinal benefits are due to the phenolic content of the leaves, which has effective antioxidant qualities [20]. The leaves can also be used as cattle fodder; as they are nutritious and palatable, and are stated to improve milk yield when fed to dairy animals.

Mulberry leaves as poultry feed

Mulberry leaf fodder can be employed successfully in the poultry diet. They are readily digestible (70-90%) by herbivorous animals as well as monogastric and are found to contain little or no anti-nutritional factor or toxic compounds. The leaves can also be used as a feed supplement for dairy cattle in place of concentrates, as a primary feed for goats, lambs, and rabbits, and as a component in monogastric diets [5].

Effect on Growth Performance in Poultry

Mulberry leaf/powder positively influences the growth performance and nutrient utilization in broiler and laying hens. In an experiment conducted by **[21]**-thin, dietary supplementation of mulberry (*Morus alba*) leaf powder as a growth promoter in place of antibiotic gave non-significant effects on production performance of broiler chickens. Mulberry leaf powder was supplemented at levels of 0, 0.1, 0.2 or 0.3% and/or with 0.11% chlortetracycline (CTC). However, broiler chicks treated with mulberry leaf powder at all levels performed much better than control and CTC groups in terms of growth, particularly the 0.3 percent mulberry leaf powder treatment group. [22] incorporateddifferent levels of mulberry leaf powder *i.e.*, 0, 5, 10, 15, and 20% in the broiler diet and found the highest mean body weight in treatment group supplemented with 10% mulberry leaf powder. Simol et al. [23]also studied the effect of substituting commercial broiler chicks' diet with 20, 30, 40 and 50% of mulberry leaf powder. Results showed that broiler chicks fed with

diets containing up to 30% mulberry leaf powder had no significant difference in feed consumption. Islam et al. [24] studied the effect of dietary mulberry leaf meal supplementation on production performance of boiler chicks by offering manually prepared diets for a period of 6 weeks incorporated with 2.5, 3.5, 4.5% mulberry leaf meal (MLM), MLM extract and 0.5% antibiotic and found that average body weight (g) gain increased with 2.5 or 4.5% supplementation of MLM and with MLM extract compared to control and antibiotic fed group. When 4.5 % supplementation and MLM extract were added, the feed conversion ratio was found to be better than control. Tilahun et al.[25] also conducted a study to evaluate the effect of substituting commercial broiler feed with mulberry leaf meal on growth performance and found that the feed intake was reduced when mulberry leaf meal was substituted at a rate of 7.5 percent and higher, however, when compared to the other treatment groups, the weight gain in the control group was shown to be greater.

Studies have also been conducted on laying hens. Al-Kirshiet al. [26] conducted a 12-week feeding experiment to study the effects of feeding of mulberry (*Morus alba*) leaf meal in the diet of laying hens. Mulberry leaf meal was included at different levels, 0 (control; Diet A), 10% (Diet B), 15% (Diet C) and 20% (Diet D). It was observed that feeding mulberry leaf meal (MLM) to chickens lowered feed intake. The feed conversion ratio was however unaffected. The findings suggested that up to 10% mulberry leaf meal might be included in the diets of egg-laying hens.Similarly, Olteanu et al. [27] conducted a study by the dietsthat_contained 3% (E1) and 6% (E2) mulberry leaves. In all the treatment groups, there was no significant difference in feed intake, feed conversion ratio. Al-Kirshiet al. [28] conducted an experiment to determine the digestibility of nutrients in the broiler and laying hens fed with mulberry (*Morus alba*) leaf meal (MLM). Fifteen layer and fifteen broiler chickens were used in the digestibility trial to study nutrient utilization. The findings suggested that the nutrient digestibility of DM and NDF was higher in laying hens than in broiler birds. No significant effect was observed in ME value and other nutrient digestibility between the two classes of fowls. In general, the incorporation of MLM diet could serve as a reliable source of protein for the birds. Panja [29]also conducted an experiment to study the effects of feeding mulberry leaves (*Morus alba*) on production performance of broiler and laying chicken. Two separate experiments were conducted for broiler and layer birds, respectively. In experiment I (broiler chicks), 240 three-week-old male broiler chicks were allocated into five groups, each with four replicates of 12 birds. Mulberry leaves were added to the diets at 0, 0.5, 1.0, 1.5, and 2.0 percent of the total diet. Feed intake, weight gain, feed efficiency, nitrogen, and calorie intake were not significantly different across treatments, according to the findings. Hence, it was concluded that mulberry leaves supplementation at 0~~/~~-~~/~~2 % had no effect on performance of the broiler chicken. In experiment II (Layers), 200 27-week-old laying hens were split into five groups, each with four replicates of ten birds. The results found that feed intake did not differ significantly across treatments and so the results of experiment II revealed that mulberry leaves supplementation had no effect on productivity of laying hens.

El-hadyet al. [30] investigated the effect of feeding mulberry (*Morus nigra*) fruits juice on the performance of Muscovy ducks. The first group was fed the basal diets, while the diets of groups 2, 3 and 4 contained black mulberry fruits juice at a rate of 1, 2 and 4 %, respectively. Results showed that the average body weight gain, final weight, and feed conversion ratio were improved in treatment groups compared

to control group and feed consumption was also increased significantly in groups fed with mulberry juice than in the control group. MLM also exhibited decreased weight gains, elevated feed consumption and an increased feed to gain ratio [31].*Morus alba* leaf meal inclusion with or without multienzyme showed significantly higher body weight compared to control [32].

Effect on Hematobiochemical Parameters

It has been found that mulberry leaves contain a variety of active substances, including polysaccharides, flavonoids, and polyphenols, which can reduce blood glucose and triglycerides, and have the function of antioxidation and regulation of lipid metabolism [33,34,35]. In a study conducted by Panja [29] mulberry leaves were added to the diets at 0, 0.5, 1.0, 1.5, and 2.0 percent of the total diet in broilers and a significant decline in blood cholesterol and triglycerides levels were observed. Islam et al. [24]also observedsignificant ($P<0.05$) reductions in total cholesterol and triglycerides as compared to the control group at 2.5, 3.5, 4.5% mulberry leaf meal (MLM).Significant improvement in the immune response of ducks, in terms of increase in WBCs count, heterophils, lymphocytes and serum globulin level in the treatment groups compared to control group were observed when mulberry fruit juice was supplemented at 1, 2 and 4% level [30]. El-hadyet al. [30] also investigated the effect of the supplementing dietary mulberry (*Morus Nigra*) fruits juice as natural antioxidative additive. Results showed that the GSH level increased significantly in the treatment groups fed with fruit juice and hence, dietary black mulberry juice addition to the diet of ducks can reduce the oxidative effect. Lin et al. [36] conducted a study to evaluate the antioxidant ability of mulberry leaf extract (MLE)and found that all the ML-supplemented groups had lower serum malondialdehyde levels and higher catalase and superoxide dismutase activities than the control group.

Effect on Carcass Characteristics of Broiler Chicken

Mulberry leaf powder supplementation produces meat with longer storage life [21]. The level of thiobarbituric acid (TBA) in the breast meat of all mulberry leaf powder supplemented groups have also been lower than the control groups. Panja [29] found that there was no significant difference in carcass weight, dressing %, or percent of abdominal fat pad when the basal diets contained mulberry leaves at 0, 0.5, 1.0, 1.5 and 2.0/% of diet. In another study conducted by Olteanu et al. [37]the broiler chicks were allocated to 3 groups (C, E1 and E2) with 38 animals per group. The diets for groups E1 and E2 also included mulberry leaves at 2 and 5% levels, respectively. It was found that the saturated fatty acids dropped, while polyunsaturated fatty acids increased by 14.53 percent in group E1 and 25.58 percent in group E2 compared to the control group, with a significant difference between E2 and C groups. The cholesterol concentrations in the experimental groups also reduced, with a significant difference between groups E2 and C. Hence, it was established that including up to 5% mulberry leaves in broiler chick's diets improved the quality of the breast muscle by lowering saturated fatty acid levels and cholesterol levels. Tilahun et al. [25] conducted a study to evaluate carcass characteristics of broiler chicks by substituting commercial broiler feed with mulberry leaf meal. Treatment diets were prepared by replacing 7.5, 15 and 22.5% of commercial broiler feed with mulberry leaf meal during the starter, grower and finisher phases and it was hence concluded that mulberry leaf meal substituted at 7.5 percent and higher level had a beneficial

influence on broiler carcass quality and belly fat reduction, which can positively affect consumer demand for meat.

Effect on Egg Quality Parameters in Layers

Mulberry leaf powder supplementation has a positive effect on egg quality parameters.The yolk colour has been improved in the eggs of the birds fed with mulberry leaf powder, which can be due to excessive amounts of xanthophylls in the leaves. Pigmentation score of yolk color measured using Roche yolk color fan was found to be higher in all treatment groups [6, 38, 39, 27]. Therehad been no negative impacts observed on egg production rate, egg weight, yolk weight, albumin weight, or shell thickness when compared to the control group. Haugh unit had also been reported to be positively influenced by supplementation of mulberry leaf powder [26]. Mulberry leaf powder supplementation also reduces the yolk cholesterol level at 2% level of inclusion which was studied by Panja [29]. Kamruzzamanet al.[~~1440~~]also found that with 3, 6, and 9% dietary supplementation of mulberry leaf meal, egg-yolk cholesterol reduced by 9.4%, 12.5%, and 14.8% respectively. Hence, ML can be used as a new feed additive to potentially modulate the egg quality in laying hens.

Conclusion

Mulberry leaves can be used as feed for poultry and livestock in fresh or dried, crushed form or used with other feeds. They positively influence the performance of both broilers and laying hens. The color of egg yolk can be significantly improved, the quality of eggs is improved, the number of eggs is increased and the flavor of chicken is improved. Mulberry leaves also have an enormous potential to reduce feed cost as they can be used instead of expensive protein sources such as soybean meal and fish meal in poultry diets. Studies conducted with poultry indicated that addition of mulberry leaves are possible up to certain limits in poultry diets without any adversely effect on their performance.

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