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Research Paper

Utilization of mushroom waste as non-conventional feed additive in broiler chicken

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ABSTRACT

A study of 42 days was conducted to investigate the effect of mushroom waste (MW) on performance, carcass traits and economics of broiler chicken. The Cobb broiler chicks (n=240) were randomly assigned to five groups having four replicates of 12 birds each. Birds in control group (T1) were fed the basal diet as per BIS specifications to meet their nutrient requirements, whereas basal diet was fortified with MW @ 0.5, 1, 1.5 and 2% in T2, T3, T4 and T5 respectively. The results indicated a non-significant (p>0.05) linear increase in the body weight gain and FCR of broiler chicken over control with increase in the level of mushroom fortified groups. No significant (p>0.05) effect was found in feed consumption of birds among various treatment groups. Non-significant (p>0.05) difference was observed in carcass traits between control and mushroom fortified groups. The profitability increased with mushroom fortification over control group with highest returns in the group fed 2% MW in the diet. It was concluded that 2% MW addition in broiler chicken improved the performance and profitability of a broiler enterprise.

Key words: Broiler chicken, carcass, economics, mushroom waste, performance

Poultry industry has seen an exponential growth over the past couple of decades mainly due to selection and breeding for the best genotype, balanced feeding, disease prevention and control measures, best management practices and above all use of growth promoters/feed additives. Growth promoters/feed additives are substances added to the balanced diets to increase its utilization and improve feed efficiency. For decades, conventional artificial feed additives, like antibiotic growth promoters, antioxidants, antifungal agents and anti-parasitic agents are used in poultry feed (Ahmad *et al.*, 2017). However, indiscriminate and long-term use of antibiotics in the poultry diet has negatively impacted the animal and human health. Antibiotic-resistant bacterial strains like staphylococcus, streptococcus species etc. are produced due to overuse of antibiotics in animals, thereby exposing humans to these bacteria (Zhang *et al.*, 2011; Roy and Fahim, 2019). Also, due to ban of antibiotics in the European Union in 2006, more and more attention has been paid to drug residues and drug-resistant bacteria. Therefore, the animal and poultry feed industry is looking for alternatives to antibiotics, which are safe, less toxic and natural. The alternatives currently available are prebiotics, probiotics, organic acids, phytogenics, agricultural wastes etc. Mushroom, a fleshy spore-bearing fruiting body of a fungus produced above ground on soil or on its food source. Mushrooms contain a variety of substances, possessing biological activity like polysaccharides, proteins, lectins, phenolics, glycoproteins and peptides, lipid components (ergosterol, terpenoids) alkaloids, small peptides and amino acids, nucleotides and nucleosides (Soares *et al.*, 2013). Mushrooms are rich in proteins having nutritive value comparable to muscle protein and contain approximately nine essential amino acids. Due to rise in mushroom cultivation, mushroom waste is available in a huge quantity from mushroom farms and possesses antimicrobial, antioxidant, prebiotic and antifungal properties (Shamsi *et al.*, 2015). Mushroom substrates generate almost 1-2 tonnes of waste for every tonne of mushrooms collected (Allen *et al.*, 1994). Mushroom waste is a very good source of bioactive substances having medicinal value, in addition to proteins, energy and critical amino acids like methionine. Hence, it can be a suitable replacement for antibiotics. Further, utilization of mushroom waste will enhance production efficiency and farm profitability due to bioactive substances and will curb the environmental pollution arising out of it.

Therefore, a study was planned to investigate the effect of feeding different levels of mushroom waste on performance, carcass traits and economics of broiler chicken.

MATERIALS AND METHODS

Collection of mushroom waste (MW): The MW was collected from Mushroom Research and Training Centre (MRTC), SKUAST-Kashmir.

Chemical analysis of MW: MW was analysed for the proximate components viz. dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and total ash as per the method of AOAC (2000).

Experimental birds and diets: The present study was conducted at Experimental Poultry farm, Division of Livestock Production and Management, Faculty of Veterinary and Animal Sciences, SKUAST Kashmir, Jammu and Kashmir, India. Cobb broiler chicks (n=240) were procured from reputed source and brooded in battery cages under uniform feeding and management conditions for one week with optimum brooding temperature of 95°F. On 8th day, the birds were randomly assigned to five groups having four replicates of 12 birds each. The birds were distributed randomly to different treatment groups having similar body weights and reared in battery cages for a period of six weeks. The birds were vaccinated as per standard schedule and offered *ad lib.* feed twice daily along with clean potable drinking water. All together five types of diets were prepared viz. T1 (Control) group: Basal diet without any additive prepared as per BIS (1992), T2 group: Basal diet was fortified with 0.5% MW, T3 group: Basal diet was fortified with 1% MW, T4 group: Basal diet was fortified with 1.5% MW and T5 group: Basal diet was fortified with 2% MW.

Collection and analysis of data: The weekly body weight, weekly feed consumption, cumulative feed consumption and mortality were recorded for all the treatment groups. The body weight of the experimental birds was recorded on individual basis at weekly intervals. The feed consumption was recorded on group basis at weekly intervals. From recorded data, body weight gain and feed conversion ratio was calculated. The economics of feeding was calculated by taking into account all the inputs as per the prevailing market rates and the sale proceed of the birds obtained at the end of experiment. The data obtained were statistically analysed as per the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The proximate composition of MW has been shown in Table 1. MW had 93.82% dry matter, 8.47 % crude protein and 2471.7 kcal/kg metabolizable energy. More or less similar results were observed by Fard *et al.* (2014).

The weekly body weight gain (g) of broiler chicken under different treatment groups with varying inclusion levels MW has been presented in Table 2.

Table-1: Proximate composition of Mushroom waste

Attributes	Value
Dry matter (%)	93.82
Crude protein (%)	8.47
Ether extract (%)	0.45
Crude fibre (%)	27.8
Total ash (%)	3.50
Nitrogen Free Extract (%)	59.78
Metabolizable Energy (Kcal/ kg)*	2471.7

*calculated value

The initial body weight gain in first week was 205.5±4.24, 210.1±2.44, 231.6±6.02, 237.4±6.51 and 238.2±8.09 in T1, T2, T3, T4 and T5 respectively. The final body weight gain in last week was 1575.8±43.2, 1582.6±31.5, 1620.9± 55.1, 1633.8±24.3 and1644.3±27.9 in T1, T2, T3, T4 and T5 respectively. During the entire experimental trail the experimental group supplied with 2% of the MW (T5) showed highest weight gain. The results of the study are in agreement with the findings of Langote *et al.* (2020) who reported that birds fed with 2% of the MW achieved highest body weight in six weeks period. Lai *et al.* (2015) found in their study that MW based feeding @ 0.5% level improved the body weight gain by 12 t0 18% in broilers. However the results of Kavyani *et al.* (2012) revealed that mushroom waste based feeds did not have any beneficial effect on the body weight of the birds.

Table-2: Effect of dietary supplementation of Mushroom waste on body weight gain in broiler chicken

Age	T1 (control group)	T2 (0.5% MW)	T2 (1% MW)	T4 (1.5% MW)	T5 (2% MW)
1-2 weeks	205.5±4.24	210.1±2.44	231.6±6.02	237.4±6.51	238.2±8.09
1-3 weeks	462.0±17.0	471.3±6.31	472.7 ±14.9	478.3±16.2	486.2±5.02
1-4 weeks	801.9±16.5	835.2±5.25	857.4±12.7	859.8±26.9	860.9±10.0
1-5 weeks	1162.9±7.46	1196.6± 11.5	1202.3± 17.7	1208.4±19.5	1221.2±18.6
1-6 weeks	1575.8±43.2	1582.6±31.5	1620.9± 55.1	1633.8±24.3	1644.3±27.9

The results in the Table 3 represent the effect on feed consumption of broiler chicken after supplementation with MW. The total feed consumption of the broiler chicken in 6th week was 2858.2±52.7, 2868.7±57.0, 2876.5± 65.3, 2891.6±72.5 and 2896.8±64.8 T1, T2, T3, T4 and T5 respectively. There was no significant ($p>0.05$) effect on feed consumption of birds except that there was a marginal increase in feed consumption with the supplementation of MW. The results were similar to the findings of the Kavyani *et al.* (2012) who found that feeding mushroom increased the feed consumption in birds. Likewise, Dajazi *et al.* (2017) found that MW increases feed consumption in quails.

Table-3: Effect of dietary supplementation of Mushroom waste on feed consumption in broiler chicken

Age	T1 (control group)	T2 (0.5% MW)	T2 (1% MW)	T4 (1.5% MW)	T5 (2% MW)
1-2 weeks	263.7±2.71	277.2±2.62	283.5±5.13	283.8±4.80	287.2±5.93
1-3 weeks	603.4±10.0	613.6±14.1	623.7 ±12.5	629.4±11.4	636.8±13.7
1-4 weeks	1189.4±25.1	1222.8±33.4	1228.2±31.5	1232.7±21.4	1239.5±19.4
1-5 weeks	1904.8±44.6	1924.2± 47.4	1938.3± 59.8	1941.6±49.6	1948.2±44.7
1-6 weeks	2858.2±52.7	2868.7±57.0	2876.5± 65.3	2891.6±72.5	2896.8±64.8

Results in Table 4 represent the effect of dietary supplementation of MW on FCR in broiler chicken. The effect of MW supplementation on FCR of broiler chicken during first week was 1.28±0.11, 1.32±0.15, 1.20±0.08, 1.21±0.17 and 1.23±0.01 in T1, T2, T3, T4 and T5 respectively. The commulative FCR in the 6th week was 1.81±0.13, 1.81±0.28, 1.75±0.17, 1.78±0.38 and 1.76±0.25 in T1, T2, T3, T4 and T5 respectively. Better FCR was found in the group wherein 2 % MW was supplemented (T5), followed by T4 in which 1.5% MW was used. The results are in accordance with the study of Chuang *et al.* (2020) who concluded that feeding mushroom waste compost to broilers as dietary supplementation improved the FCR. The results are also supported by the findings of other researchers (Ebenebe *et al.*, 2011; Gianneanas *et al.*, 2011; Willis *et al.*, 2012; Willis *et al.*, 2013) who in their respective studies observed that mushroom waste is beneficial for poultry in terms of improved FCR.

Table-4: Effect of dietary supplementation of Mushroom waste on FCR in broiler chicken

Age	T1 (control group)	T2 (0.5% MW)	T3 (1% MW)	T4 (1.5% MW)	T5 (2% MW)
1-2 weeks	1.28±0.11	1.32±0.15	1.20±0.08	1.21±0.17	1.23±0.01
1-3 weeks	1.32±0.18	1.30±0.01	1.29±0.19	1.34±0.22	1.33±0.19
1-4 weeks	1.49±0.09	1.46±0.17	1.43±0.14	1.43±0.28	1.44±0.13
1-5 weeks	1.63±0.21	1.60±0.28	1.61±0.23	1.61±0.24	1.59±0.47
1-6 weeks	1.81±0.13	1.81±0.28	1.75±0.17	1.78±0.38	1.76±0.25

The improved growth, body weight, FCR, feed consumption hence economics can be attributed to the fact that mushroom wastes improve the gut environment, decrease the stress conditions and prove to be the immune modulating to the birds. The mushroom based feeds increases SOD and CAT activities, ileum villus height and lactic acid bacteria number in cecum hence better gut environment (Lai *et al.*, 2015) and good feed conversion ratios. Mushroom stalk residues are known to increase Lactobacillus spp. numbers while lowering Coliform levels (Hsieh *et al.*, 2021) that can be due to the antibacterial effects of the polysaccharides present in mushrooms wastes that helps to improve the gut health (Attia *et al.*, 2016). The presence of the functional components like Crude triterpenes, phenols, flavonoids, gallocatechin, and epigallocatechin in the mushroom waste can be responsible for the increase in antioxidant capacity, adipolysis, and gut barrier expression in the broilers (Chuang *et al.*, 2020). Triterpenoids prevent the onset of diseases and have role in preventing the oxidative damage caused by free radicals (Yin, 2012) while as phenolic compounds reduce lipid oxidation (Hassan and Fan, 2005). Typically, animals are exposed to a wide range of stimuli that increase oxidative stress in the body and this stress turns to be the reason for many disease conditions leading to decrease in the overall performance of the birds (Hsieh *et al.*, 2021).

Table-5. Effect of dietary supplementation of Mushroom waste on carcass traits in broiler chicken

Slaughter traits	T1 (control group)	T2 (0.5% MW)	T3 (1% MW)	T4 (1.5% MW)	T5 (2% MW)
% Heart wt	9.83±0.66	9.83±0.60	9.83±0..72	10.6 ±0.33	9.66±0.16
% Liver wt	40.5±4.72	42.3±1.20	40.8 ±4.34	42.3 ±1.76	39.8 ±2.13
% Gizzard wt	35.3 ±4.91	37.5 ±2.56	33.3 ±4.84	33.0±2.00	35.5 ±2.25
% Drum stick weight	166.6±9.86	164.3 ±5.54	177.3 ±14.4	165.0±9.23	169.3 ±9.02
% Thigh weight	174.6±13.8	169.0 ±5.13	191.0 ±12.1	169.6±16.0	155.0 ±15.5
% Breast weight	457.3±28.5	395.0 ±9.45	444.3 ±30.8	398.0±21.2	391.0 ±24.1
% Wing weight	152.0 ±7.50	144.6±10.33	168.6 ±10.9	157.0±8.73	154.6 ±12.1
% Back weight	183.0 ±10.9	200.3 ±5.36	207.0 ±15.8	200.6±10.9	188.6 ±15.7
% Neck weight	89.3±9.49	85.6 ±13.3	96.6 ±15.8	94.3±6.69	88.0 ±5.56

Effect of the supplementation of MW on carcass traits is presented in Table 5. No significant difference was found between different treatment groups with regard to any of the carcass traits. The results were more or less similar to the findings of Ekunseitan *et al.* (2019) who found no significant variation between the carcass traits with different treatment groups fed mushroom in the diet. Feeding cost is the largest cost in rearing of poultry and has most profound effect on the economics of poultry rearing. Table 6 represents the economic parameters of the broiler chicken fed with different inclusion levels of the mushroom waste. The cost of feeding, input cost, selling price and the profit increased with the increase in the inclusion level of the mushroom waste from the control treatment (T1) to the T5. Highest returns were seen in the group wherein 2 % MW was supplemented (T5), followed by T4 in which 1.5% MW was used.

Table-6: Economics of dietary supplementation of Mushroom waste in broiler chicken

Parameter (in Rupees)	T1 (control group)	T2 (0.5% MW)	T2 (1% MW)	T4 (1.5% MW)	T5 (2% MW)
Cost of Day old chick	40	40	40	40	40
Cost of Feed	102.8	103.2	103.5	104.0	104.2
Cost of feeding MW	-	-	-	-	-
Miscellenous cost	7	7	7	7	7
Total input cost	149.8	150.2	150.5	151.0	151.2
Sale of birds @ 100/kg	157.5	158.2	162.0	163.3	164.4
Profit/bird	7.7	8.0	11.5	12.3	13.2

CONCLUSION

Use of mushroom waste as feed additive in broiler ration resulted in a linear non-significant increase in body weight of broiler chicken with increase in the level of MW from 0.5 to 2%.There was an improvement in the FCR of broiler chicken fed diets supplemented with MW. Supplementation of MW resulted in better economics with high returns in the group fed 2% MW in the diet.

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