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Article

Dietary effect of mushroom (*Agaricus bisporus*) powder on growth performance of commercial broiler

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Abstract: The study was performed for investigating the dietary effect of different levels of mushroom (*Agaricus bisporus)* powder on the performance of broiler. Four experimental rations designated as T_0, T_1, T_2 and T_3 having 0g, 5g, 8g and 10g dried mushroom powder/kg of feed was fed to 120 broiler chicks (Cobb 500), randomly distributed into 8 replicates, so as to have 2 replicates per treatment containing 15 chicks in each. The experiment was carried out for 30 days. Average weight gain, feed consumption, feed efficiency, dressing yield and survivability were used as criteria of response to feeding mushroom powder. Organs weight including heart, liver and gizzard were also recorded. The mean body weight per broiler was 1292.24, 1501.66, 1445.19 and 1434.97g in 30 days for the treatment of groups T_0, T_1, T_2, and T_3 respectively ($P<0.01$). The average feed consumption per broiler was 2374.77, 2273.55, 2283.86 and 2276.3g ($P<0.01$) in 30 days for the groups of T_0, T_1, T_2, and T_3 respectively. The average feed efficiency (feed/kg body weight gain) was 1.84, 1.52, 1.58 and 1.59 ($P<0.01$) in 30 days for group T_0, T_1, T_2, and T_3 respectively. The mean dressing yield was 57.16%, 60.63%, 58.89% and 61.42% ($P<0.01$) for the groups of T_0, T_1, T_2, and T_3 respectively. The average weight of abdominal fat 2.69%, 1.55%, 1.74% and 1.65% ($P<0.01$) and heart was 8.5, 10.25, 8.5 and 7.6g ($P<0.05$). The average weight of liver was 43.1, 43.5, 46 and 43.5g ($P>0.05$) for the groups of T_0, T_1, T_2, and T_3 respectively. The mean gizzard weight was 35.25, 35, 34.5 and 35.75g ($P>0.05$) for the groups of T_0, T_1, T_2, and T_3 respectively. Survivability was 100%, for all the groups of T_0, T_1, T_2, and T_3 respectively. It may be concluded that the use of mushroom as feed additive at a level of 5g enhances the overall performance of broiler chicks.

Keywords: mushroom; broilers; carcass characteristics; dressing yield; survivability

1. Introduction

Broiler is an excellent source of protein to nourish human health. Poultry production system has triggered the discovery and widespread use of a number of "feed additives". The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a bird attains maximum marketable weight. The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. The main objective of adding feed additives are increasing their growth rate better feed efficiency, greater livability and lowered mortality in poultry birds. These feed additives are termed as "growth promoters" and often called as non-nutritive feed additives (Singh and Panda, 1992). Growth promoters are chemical and biological substances, which are added to livestock feed with the aim to improve the growth of chickens in fattening, improve the utilization of feed and in this way realize better production and financial results. Their mechanism of action varies.

Positive effect can be expressed through better appetite, improved feed efficiency, stimulation of the immune system and increased vitality, regulation of the intestinal micro-flora, etc.

Mushrooms **(***Agaricus bisporus***)** are simple forms of plant life which lack chlorophyll and hence cannot produce their own food. They depend upon other living on dead plants and organic matter. Mushrooms are rich sources of proteins, vitamins and minerals. Low content of carbohydrate and fat makes mushrooms an ideal food for diabetes and persons who wish to shed excess fat. Mushrooms are also good source of energy about 454g of fresh mushrooms providing 120 kilocalories. Most of the edible varieties of mushroom belong to the family Agaricaceae of class basidiomycetes (Srivastava and Kumar, 2002). Mushroom can be used as a growth promoter in broiler production. The active ingredients found in mushrooms are antioxidants, phenolic compounds, tocopherols, carotenoids, and antibacterial compounds (Zhou *et al*., 2010; Hernandez *et al*., 2004). Additionally, mushrooms have been reported to have immune enhancing and stressreducing properties (Dalloul and Lillehoj, 2006; Borchers *et al*., 2008). Oyster mushrooms (*Pleurotus ostreatus*) are one of the commonly cultivated mushroom species which have antiviral and anticancer properties (Tabeidian, 2014). Mushrooms may have a wide range of activities (Guo *et al*., 2003). Mushrooms have health-promoting benefits, due to a multitude of compounds with antioxidant, antibacterial, immune-enhancing, and stress reduction properties on farm animals (Dalloul and Lillehoj, 2006; Dalloul *et al*., 2006). It has been reported that the combined use of Chinese herbal and mushroom extracts can operate as alternatives to antibiotic growth promoters in broiler chicken (Guo *et al*., 2004a; Guo *et al*., 2004b.) Over the past 100 years, much research has persisted on coccidiosis because it represents a major disease problem demanding the attention of the poultry producers, feed manufacturers, and the poultry disease experts (Reid, 1978), coccidiosis can be controlled by mushroom feeding. Natural medicinal products originating from fungi or herbs have been used in animal feeding to improve performance through amelioration of feed properties, promotion of production performance, and improving the quality of animal origin food (Toghyani *et al*., 2010; Guo, 2003). Mushrooms have long been appreciated as an important source of bioactive compounds of medicinal value (Breene, 1990). It must be mentioned that different concentrations of methanol extract derived from mushrooms can eliminate free radicals. This antioxidant property of mushrooms is because of the presence of phenolic compounds (Yang *et al*., 2002), which also possess antioxidant properties due to their renewal capacity as well as their chemical structure that enables them to neutralize free radicals (Mazaheri *et al*., 2014). So, scientists are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants, which can be safely used to increase poultry production. Considering the above things, the objectives of the present study are to investigate the effect of mushrooms **(***Agaricus bisporus***)** powder on growth performance of commercial broiler and to investigate the effect of mushrooms **(***Agaricus bisporus***)** powder on carcass characteristics of commercial broiler.

2. Materials and methods

2.1. Statement of the research work

The experiment was conducted at the poultry shed under the Department of Dairy and Poultry Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, to investigate the effect of mushroom powder in broiler production (Cobb 500) during the period from 10 April to 11 May, 2016.

2.2. Preparation of the experimental house and equipment

An open sided house with two rooms was used for rearing the experimental birds. The experimental house was properly washed and cleaned by forced water using a hosepipe. After washing with clean water, the rooms were disinfected by quick lime and then left vacant for 15 days. At the same time all feeders, plastic buckets, waterers and other necessary equipments were also properly cleaned, washed and disinfected with detergent and potassium permanganate, subsequently dried and left them empty for at least one week before the arrival of chicks. Ceiling, walls, and wire nets were also thoroughly disinfected by spraying Virocid® (4 ml/lit).

2.3. Collection of the experimental birds

A total 120 day-old broiler chicks (Cobb 500) were purchased from CP Bangladesh Limited, Kalitola, Dinajpur, Bangladesh.

2.4. Layout of the experiment

The day-old chicks were reared at brooder house to adjust with the environmental condition up to 7 days. After 7 days, chicks were randomly allocated four dietary treatment groups of 30 chicks each; each treatment was composed of two replications with 15 birds. The layout of the experiment is shown in Table 1.

2.5. Procurement of feed ingredients

Required amounts of feed for making the experimental diets were procured from the local market of Dinajpur town. During procurement, feeds were evaluated carefully for their freshness.

2.6. Collection, processing and storage of mushroom powder

Dried mushroom purchased from Horticulture centre, Dinajpur Bangladesh. The samples were further ground into powder using blender machine at Dairy and Poultry Science Lab. The obtained powder was packed in a poly-ethylene bag and preserved in the feed storage room until used for feed formulation. Proper care was taken in the feed storage room to avoid spoilage.

2.7. Preparation of the experimental diet

Pellet feed was used throughout the experimental study. The experimental period was divided into two phases (broiler-starter and broiler-finisher). Broiler starter diet was provided between 0 and 14 days, and broiler finisher was fed from 15 to 30 days. Composition of the experimental starter and finisher diets fed to broilers are shown in Table 2. Chemical composition of experimental ration is shown in Table 3. Mushroom powder was incorporated into the experimental diets manually in appropriate doses.

At first required amount of feed was weighed by digital weighing balance. Then different level of mushroom powder was mixed with different treatment. Cross mixing was applied during the time of mixing. Mixing was done manually and no coccidio-stat or any other feed additives were added to the formulated diets in order to obtain clear-cut effect of the test-diet. The experimental diets were designed as- T_0 : control,T_1 : control+ 5g mushroom powder per kg feed,T_2 : control+ 8g mushroom powder per kg feed and T_3 : control+ 10g mushroom powder per kg feed.

2.8. Routine management

The experimental birds were exposed to similar care and management in all treatment groups throughout the experimental period. The following management practices were followed during the whole experimental period and these management practices were identical for all dietary groups.

2.9. Litter management

Fresh, clean and dried rice husk was used as litter materials at a depth of about 3 cm. The litter was well covered by clean newspaper up to the first 7 days. Before use of litter calcium carbonate was spread on the floor. After first week, upper part of the litter with droppings were removed regularly and stirred three times a week up to the end of the experiment. The litter was disinfected with Virocid® solution in every other day. Litter materials, when found damp for any reason, were removed to prevent accumulation of ammonia and other harmful gases. At the end of each week, litter was stirred to break its compactness and maintain proper moisture. At the end of 2nd and 3rd weeks of age, dropping were cleaned from the surface of litter.

2.10. Floor space

All the broilers were given a floor space of 1 sq. feet / bird.

2.10.1. Brooding of broiler

The experiment was conducted in summer (April to May/2016). The broilers were housed on floor and routinely managed as any other commercial broiler flock. Heating was provided by a single electric brooder, where the initial temperature was set at 37^o C and decreased gradually at the rate of 3^o C in each week until they were adjusted to normal environmental temperature of the house and final temperature was 28^o C at the end of experiment.

2.10.2. Lighting

All birds were exposed to continuous lighting of 23 hours and one hour dark period per day throughout the experimental period. The dark period was practiced to make the 16 broilers familiar with the possible darkness due to electricity failure. Supplementary light at night was provided by electric bulb by hanging at a height of 2.8 miters to provide necessary lighting.

2.10.3. Feeding and drinking

Feeds were supplied to the chicks on clean newspapers at three hours interval for the first 3 days. Linear feeder and round plastic drinker were used during brooding period. After that linear feeder was replaced by round

plastic drinker. After 2 weeks, feeds were supplied thrice daily (once at morning, at noon and again at night) and water was supplied thrice daily (once at morning, at noon and again at night). Fresh water was offered to the bird ad libitum. One round plastic feeder and drinker were provided for fifteen birds**.** Feeders were cleaned at the end of each week and drinkers were washed daily. All broilers in different treatments had fresh feed and drinking water adlibitum throughout the experimental period.

2.10.4. Immunization

All broilers were vaccinated against New Castle (Ranikhet) Disease and Infectious Bursal (Gumboro) Disease as per the schedule shown in Table 4.

2.10.5. Medication

Immediately after unloading from the chick boxes the chicks were given Glucose and Vitamin-C to prevent the stress occurring during transport. Water soluble vitamin and normal saline were also provided for the first 3 days of brooding. During the course of experimental period, electrolytes and vitamin-C were added with the drinking water to combat stress due to high environmental temperature (33 to 37^{o}C).

2.10.6. Sanitation

Proper hygienic measures and strict sanitation programs were followed during the experimental period. The entrance point and veranda were kept clean and disinfectant was sprayed regularly. In addition, the service area of the experimental rooms, outside wall and feed storage room were kept clean.

2.10.7. Processing of broilers

At 30 days of age, one bird from each replication was selected randomly. Before slaughtering the birds were kept in fasting condition for 24 hours. Just before slaughtering the birds were weighed. Birds were slaughtered according to halal method. Following slaughter, broilers were allowed to bleed for about 2 minutes. Then the birds were scaled in hot water (60-65o C) for about 120 seconds in order to loosen the feather of the carcasses and weighed again. Breast meat, thigh meat, drumstick meat were separated from the carcass. Finally, processing was performed by removing head, shank, viscera, oil gland, kidney and giblets. As soon as these were removed the gall bladder was removed from the liver and pericardial sac and arteries were cut from the heart. Cutting it loose in front of the proventriculus and then cutting with both incoming and outgoing tracts removed the gizzard. Then, it was split open with knife, emptied and washed and the lining removed by hand.

2.10.8. Data collection and record keeping

The records of live weight, feed consumption, survivability, temperature and dressing yield were kept during 30 days of rearing period.

2.10.9 Live weight gain (g)

The average body weight gain of per bird was calculated by deducting initial body weight from the final body weight of the bird.

2.10.10. Feed intake (g)

Feed intake was calculated as the total feed consumption in a replication divided by number of birds in each replication.

Feed Intake (g/bird) =Feed intake in a replication÷ No. of birds in a replication

2.10.10.1. Feed efficiency (kg)

Feed efficiency (F.E) was calculated as the total feed consumption divided by weight gain in each replication.

F.E = Feed intake (kg) ÷ Weight gain (kg)

2.10.10.2. Survivability

Survivability percentage was calculated as the total broilers survived divided by the number of starting birds multiplied by 100.

2.10.10.3. Dressing yield

Dressing yield is based on the relationship between the dressed carcass weight and live bird weight after things like the skin and internal organs have been removed. Dressing yield can be calculated by taking weight of the carcass divided by weight of live bird.

Dressing yield =Weight of the carcass÷Weight of live bird

2.10.10.4. Statistical analysis

Data on different variables were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD), (Steel and Torrie, 1980). The significant differences between the treatment means were calculated from analysis of variance (ANOVA) table. All analyses were performed by using 'IBM SPSS' Statistics 20 Program.

3. Results and Discussion

3.1. Performance of broiler

The results of production performance in terms of feed consumption, live weight gain, feed efficiency, survivability, dressing yield, organ growth traits, were used as criteria for response of broiler to different dietary levels of mushroom powder are presented in the following sections.

3.2. Effect of mushroom powder on body weight gain

Initial body weight of day-old broiler chicks fed on different dietary treatment was similar ($P>0.05$) (Table 5). From 1 to 14 days of age, the highest (384.59g) body weight gain was attained by broilers received mushroom powder at 5g/kg feed ($P<0.01$) and also from 15 to 30 days of age, the body weight gain was significant ($P<0.01$) in treatment T1 (1117.07g). During 1 to 30 days of age, the body weight gain (1501.66g) in birds fed diet containing mushroom powder at level of 5g/kg feed was significantly higher ($P<0.01$) followed by birds received 8g/kg feed (1445.19g), 10g/feed (1434.97g) and 0g/kg feed (1292.24g) mushroom powder. The significant increase in body weight in treatment T1 (1501.66g) may be due to optimum antioxidant activity of mushroom at the level of 5 g/kg feed that can stimulate protein synthesis by bird‟s enzymatic system. The significant effect of mushroom powder on body weight was in agreement with the findings of some previous reports (Ashkan *et al.*, 2014; Kavyani *et al*., 2012; Giannenas *et al.*, 2010; Cheskin *et al.*, 2008; Dalloul and Lillehoj, 2006; Dalloul *et al*., 2006; Guo *et al*., 2004a,b; Visek, 1978). They found that inclusion of mushroom at the rate of 5g or 10g/kg feed significantly increase body weight of broiler. But these findings contradict with the observation of Sepideh *et al*. (2015) who stated that broiler fed on mushroom powder either at 0, 0.5, 1.0, 1.5, and 2.0g/kg of diet did not significantly affect body weight gain.

3.3. Effect of mushroom powder on feed intake

Feed intake of broilers in different dietary treatments from 1 to 14 days of age, 15 to 30 and also 1-30 days of experimental periods was statistically significant ($P<0.05$) (Table 5). The above results agreement with Kavyani *et al.* (2012). However, these results disagreed with (Giannenas *et al.* (2010) who found that no significant difference in feed consumption.

3.4. Effect of mushroom powder on feed efficiency

Feed efficiency in different dietary treatments during the whole experimental period was statistically significant ($P<0.01$). At the end of the trial (30 days of age), better FE was in treatment T1 (1.52) followed by T2 (1.58), T3 (1.59) and T0 (1.84) respectively (Table 5), indicating that the best feed efficiency was due to optimum antioxidant activity of mushroom powder at the level of 5g MP. Similar result was found by Ashkan *et al*., 2014; Giannenas *et al.*, 2010; Guo *et al*., 2004a). They reported that broilers that received diet 5g MP utilized their diets more efficiently but Kavyani *et al.* (2012) stated that the FE obtained in bird fed diet containing 5g MP/kg diet was lower than those fed diet containing antibiotic, 20 or 30g mushroom/kg at starter period ($P < 0.05$).

3.5. Effect of mushroom powder on survivability

No mortality was observed throughout the experiment. Survivability of broilers fed on different dietary treatments was 100%. Due to the presence of antioxidant (Selenium, Ergothioneine) survivability is more.

Table 1. Layout showing the distribution of experimental broilers Dietary treatments Number of broilers in each replication.

Dietary treatments		Number of broilers in each replication		Total
		R_1	R_2	
Control (without mushroom powder)	T_0	15	15	30
Control+5g mushroom powder	T_1	15	15	30
Control+8g mushroom powder	T_2	15	15	30
Control+10g mushroom powder	T_3	15	15	30
Total No. of broilers		60	60	120

Table 2. Composition of the experimental starter and finisher diets fed to broilers.

Feed ingredients	Amount (kg/100kg feed)	
	Starter (1-14 days)	Finisher (15-30 days)
Maize	53.5	57.00
Rice polish	10.0	10.0
Soybean meal	23.0	18.0
Protein Concentrate	10.0	10.0
Oyester shell	1.0	0.75
DCP(Di-calcium phosphate)	0.5	0.75
Soybean oil	1.5	3.0
Common salt	0.25	0.25
Vitamin- mineral- amino acid premix	0.25	0.25

Mushroom powder was added to the experimental diets (except control diet) at required amount according to each treatment.

Table 3. Chemical Composition of experimental ration.

Nutrients	Starter diet	Finisher diet
ME (Kcal/kg)	2977	3074
CP (%)	23.5	20.5
CF (%)	5	5
Ca (%)	1.00	0.95
Available P (%)	0.74	0.75
Ash (%)	6	6
Lysine (%)	1.02	0.89
Methionine (%)	0.35	0.35

Table 4. Applied vaccination program.

Diseases	Day	Vaccine	Route	Time
Ranikhet	4	CEVAC New L	Eye	Evening
Gumboro	9	Gumboro vac	Eye	Evening
Gumboro	16	CEVAC IBD L	Drinking water	Evening
Ranikhet	21	CEVAC New L	Drinking water	Evening

3.6. Effect of mushroom powder on meat yield

Data on carcass characteristics and organ weights are presented in Table 6. This study showed that fat content of broiler was decreased significantly by supplementation of mushroom powder in broiler ration ($P<0.01$). Among different dietary treatments, amount of abdominal fat was lowest in T1 (1.55%) followed by T2 (1.74%), T3 (1.65%) and T0 (2.69%) respectively (Table 6). These results agreed with some other researchers (Giannenas *et al*., 2010; Ashkan *et al*., 2014), who reported lower fat content in broilers that fed diet containing 10% mushroom powder.

Table 5. Effect of mushroom powder supplementation on the performance of broiler chicks.

Parameters	T_0	T_1	T_2	T_3	Level of significance
Initial body weight (g/bird)	43.50±0.050[a]	43.52±0.005[a]	43.40±0.050 [a]	43.42±0.050 [a]	NS
Feed consumption (g/bird)					
1-14 days	492.46±0.07[a]	482.05±1.32[b]	483.94±0.57[b]	482.10±0.60[b]	**
15-30 days	1882.33±0.50[a]	1791.5±1.0[d]	1799.93±0.10[b]	1794.2±0.03[c]	**
1-30 days	2374.77±0.44[a]	2273.55±2.32[c]	2283.86±0.47[b]	2276.3±0.63[c]	**
Weight gain (g/bird)					
1-14 days	331.50±10[d]	384.59±0.95[a]	368.29±1.35[c]	374.70±1.5[b]	**
15-30 days	960.74±1.0[c]	1117.07±1.0[a]	1076.90±0.5[b]	1060.27±0.49[b]	**
1-30 days	1292.24±1.0[c]	1501.66±0.05[a]	1445.19±1.85[b]	1434.97±1.99[b]	**
FE					
1-14 days	1.49±0.00428[a]	1.26±0.00653[d]	1.32±0.00328[b]	1.29±0.0068[c]	**
15-30 days	1.96±0.02092[a]	1.67±0.00086[c]	1.67±0.00086[b]	1.69±0.0008[b]	**
1-30 days	1.84±0.01598[a]	1.52±0.00149[c]	1.58±0.0017[b]	1.59±0.0027[b]	**
Survivability (%)	100±0.000	100±0.000	100±0.000	100±0.000	NS

Where, T0 =0g; T1 =5g; T2 =8g; T3 =10g of mushroom powder /kg feed. abcd Figures in the row with similar superscripts alphabet did not differ significantly. **=(P<0.01), *=(P<0.05), NS=(Non-significant).

Table 6. Effect of mushroom powder supplementation in diet of broiler on meat yield at 30 days of age.

Parameters(g)	T0	T1	T2	T3	Level of significance
Abdominal fat (%)	2.69±0.010 [a]	1.55±0.010 [d]	1.74±0.010 [c]	1.65±0.010 [b]	**
Heart (g)	8.5±0.5[b]	10.25±0.25[a]	8.5±0.5[b]	7.6±0.20[b]	*
Liver (g)	43.1±0.1[a]	43.5±1.5 [a]	46±1.0[a]	43.5±0.5[a]	NS
Gizzard (g)	35.25±0.25[a]	35±1.0[a]	35.75±0.25[a]	34.5±0.50[a]	NS
Dressing yield (%)	57.16±0.0 [d]	60.63±0.015[b]	58.89±0.01[c]	61.42±0.11[a]	**

Where, T0 =0g; T1 =5g; T2 =8g; T3 =10g of mushroom powder /kg feed. abcd Figures in the row with similar superscripts alphabet did not differ significantly. **=(P<0.01), *=(P<0.05), NS=(Non-significant).

3.7. Effect of mushroom powder on the weight of internal organs

The non significant (P>0.05) effect of mushroom powder on the weight of internal organs (liver and gizzard except heart) of broilers fed experimental rations were in close agreement with the observation (Giannenas *et al*., 2010), who reported that feeding of mushroom powder did not alter the size of liver, gizzard.

3.8. Effect of mushroom powder on the dressing yield

This study demonstrated significant (P < 0.05) difference in dressing yield. The highest dressing yield (61%) was found in T3 (10g MP) followed by T1 60.63% (5g MP), T2 58.89% (8g MP) and the lowest value (57.16%) found in T0. Kavyani *et al,* (2012) used mushroom powder and found dressing percentage 74.10, 73.81, and 74.89 using 5g MP, 10g MP, and 20g MP respectively.

4. Conclusions

Based on the results of the present study, it may be concluded that mushroom powder supplemented at a level of 5g MP has significant effect on body weight gain, FE, abdominal fat content, and survivability of broiler, except feed intake and dressing percentage. The results of the study also suggest that the supplementation of mushroom powder at 5g MP level in diets has high potential as commercial applications for production performance of broiler. Therefore, mushroom powder can be used along with the other conventional feed ingredients.

Conflict of interest

None to declare.

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