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Effect of Levels of Oyster Mushroom (*Pleurotus ostreatus*) on Performance and Blood Biochemical Characteristics in Japanese Quails (*Coturnix coturnix*)

Research Article

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ABSTRACT

This experiment was conducted to determine the effects of oyster mushroom on performance and blood biochemical characteristics in Japanese quails (*Coturnix Japonica*). A total of 240 seven day old mix sexes quail chicks were randomly allocated to four experimental groups. Each treatment consisted of three replicate pens with 20 birds. Experimental groups included 0, 0.5, 1, 2% oyster mushroom in quail diet. Each replicate was housed in separate stainless floor pens under controlled temperature and light conditions. On 21st days of age, male and female chicks were separated. Weight gain, feed intake and feed conversion ratio were not significantly influenced by the dietary treatments. Total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL) significantly decreased ($P<0.05$) and high-density lipoprotein (HDL) cholesterol significantly increased ($P<0.05$) by the 2% diet contain mushroom compared to the control, but plasma glucose, uric acid, total protein of quails were not significantly influenced by the dietary treatments. Inclusion of 2% mushroom in the diet, positively affected blood biochemical characteristics of quails. Therefore it seems that mushroom may be a beneficial component in quail diet.

KEY WORDS blood biochemistry, mushroom (*Pleurotus ostreatus*), performance, quail.

INTRODUCTION

Mushrooms have long been appreciated as an important source of bioactive compounds of medicinal value (Breene, 1990). Some fungi have been used for centuries to combat disease outbreaks in many parts of the world and are still used in veterinary medicine in Asian and Mediterranean countries (Chang and Buswell, 1996). Mushrooms have a great nutritional value since they are quite rich in protein, with an important content of essential amino acids and fiber, but poor in fat. Edible mushrooms also provide a nutritionally significant content of vitamins (B_1, B_2, B_{12}, C, D and E) (Mattila *et al*. 2001). Edible mushrooms could be a source of many different nutraceuticals such as unsaturated fatty acids, phenolic compounds, tocopherols, ascorbic acid and carotenoids. Mushrooms also contain various biologically active compounds such as gallic acid, protocatechuic acid, chlorogenic acid, naringenin, hesperetin and biochanin-A (Alam *et al*. 2008; Alam *et al*. 2010). Guo *et al*. (2004); reported that the combined use of Chinese herbal and mushroom extracts can operate as alternatives to antibiotic growth promoters in broiler chicken. Oyster mushroom (*Pleurotus ostreatus*) are known to have antioxidant and immunomodulatory effects (Shamtsyan *et al*. 2007; Elmastas *et al*. 2007) and has been shown to improve growth, immunity and intestinal health (Guo *et al*. 2003; Machado *et al*. 2007; Giannenas *et al*. 2010). Synytsya *et al*. (2009); reported that oyster mushroom contains soluble

fiber compounds, especially non-starch glucans (442-901 g/kg DM) and small amount of other glucans such as chitin and galactomannans, which favor population of lactobacilli. The oyster mushroom is also famous for its cholesterol lowering effect (Bobek and Galbavy, 1999). Therefore, the aim of this study was to investigate the effects of supplementation of different levels of dried mushroom (*Pleurotus ostreatus*) powder on performance and blood biochemical characteristics of Japanese quails.

MATERIALS AND METHODS

Birds and experimental design

A total of 240 seven day old mix sexes quail chicks were randomly allocated to four experimental treatments. Each treatment consisted of three replicate pens with 20 birds. Each replicate was housed in separate stainless floor pens under controlled temperature and light conditions. Each pen was 100 × 100 cm. On 21st days of age, male and female chicks were separated. The lighting cycle was 23 h/day maintained at all growth times. The diets were formulated to meet the nutrients requirements of broilers as recommended by the National Research Council (NRC, 1994). Table 1 presents the ingredients and the composition of diets fed in mash form. The birds within the control group were given the basal diet for the respective growth stage. The other three groups were given experimental diets based on the basal diets containing 0.5, 1, and 2 percentage of ground dried mushroom (*Pleurotus ostreatus*). Birds had free access to feed and water during the 35 days of growth period.

Preparation of oyster mushroom diet

Fresh fruiting bodies of *Pleurotus ostreatus* were obtained from mushroom growers. Oyster mushrooms have a very low fat content and protein content was 190-350 g/kg (Synytsya *et al*. 2009). The whole mushrooms were dried out at 60 ˚C for 12 h and were added to experimental diets of chicks after grinding. After drying, fruiting bodies were milled to a powder approximately less than 1 mm in particle size using a cyclotec grinder (Tecator, Hoganas, Sweden). The chemical composition of *Pleurotus ostreatus* powder (oyster mushroom) was determined by the standard association of official analytical chemists (AOAC) methods (AOAC, 1995) and is shown in Table 2.

Analytical procedures

At 35 day of age, the feed consumption and total weight of each pen were used to calculate live body weight (LBW), average daily gain (ADG), feed intake (FI) and feed conversion ratio (FCR). At 35 days of age, two birds from each pen were picked out randomly, based on the average weight of the group and slaughtered through partial slicing of the neck by a manual neck cutter and collected of blood for analysis blood biochemical parameters. Plasma glucose, uric acid, total protein, total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL) cholesterol, were measured using commercial kits (Pars Azmoon Co, Auto analyzer Alison- 300, America). The low-density lipoprotein (LDL) cholesterol, was calculated using the following formula (Friedeward *et al*. 1972).

LDL cholesterol= total cholesterol − HDL cholesterol− (triglyceride/5)

Table 1 Composition of experimental diets with or without mushroom (%)

Ingredients	Control	Mushroom (0.5)	Mushroom (1)	Mushroom (2)
Yellow corn	53.31	52.00	52.00	52.08
Soybean meal	39.69	39.00	38.75	39.50
Corn gluten meal	3.07	4.20	4.00	2.57
Vegetable oil	1.00	1.38	1.33	0.98
Oyster mushroom	-	0.50	1.00	2.00
Oyster shell	1.22	1.22	1.22	1.22
Dicalcium phosphate	0.77	0.77	0.77	0.77
L-lysine	0.06	0.06	0.06	0.06
DL-methionine	0.12	0.12	0.12	0.12
Mineral-vitamin premix*	0.5	0.5	0.5	0.5
Sodium chloride	0.25	0.25	0.25	0.25
Calculated analysis				
Metabolizable energy (kcal/kg)	2900	2900	2900	2900
Crude protein (%)	24.00	24.00	24.00	24.00
Calcium (%)	0.80	0.80	0.80	0.80
Avail.phosphorus (%)	0.29	0.29	0.29	0.29
Sodium (%)	0.11	0.11	0.11	0.11
Lysine (%)	1.30	1.30	1.30	1.30
Methionine + cysteine (%)	0.89	0.89	0.89	0.89

* Supplemented for kg of the diets: vitamin A: 12000 IU; D_3: 2000 IU; E: 20 mg; K_3: 3 mg; B_2: 7 mg; Niacin: 12 mg; Pantothenic acid: 3mg; B_{12}: 0.03 mg; Biotin: 0.1 mg; Choline chloride: 300 mg; Mn: 130 mg; Fe: 70 mg; Zn: 60 mg; Cu:12 mg; I: 1 mg; Se: 0.2 mg and adequate antioxidant.

Table 2 Proximate analysis of oyster mushroom

Component	Composition
Metabolizable energy (kcal/kg)*	1898
Moisture (%)	7.01
Crude ash (%)	6.55
Crude fat (%)	2.3
Crude protein (%)	21.86
Nitrogen-free extract (%)	62.28

* ME (kcal/kg)= 37.5 CP + 46.39 EE + 14.9 NFE (Janssen, 1989).

Statistical analysis

Data were statistically analyzed using the general linear model (GLM) procedure of SAS (2001). Test of significance for the differences between means of each classification was done by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The present study was designed to evaluate the effect of sustained consumption of a natural product such as *Pleurotus ostreatus* mushroom, rich in antioxidant polyphenols and polysaccharides, and its potential application as dietary supplement.

Previous studies had shown putative beneficial effects of different mushrooms on broiler chicken performance and in particular immune-enhancing benefits in Eimeria-challenged chicken (Guo *et al*. 2003). In our study, the amount of dried mushrooms added to the basal diet, it was consumed as a part of the usual feeding regimen of Japanese quails. The inclusion of oyster mushroom powder was not significantly influenced by the supplementation of mushroom in the 5-weeks period (Tables 3 and 4). In addition, the level of mushroom had no significant effect on feed intake, weight gain and feed conversion ratio among the groups.

These data support the observations that the mushroom extract did not impede weight gain. Guo *et al*. (2004); incorporated the same level of different mushroom powder (*Lentinus edodes* and *Tremella fuciformis*) to broilers diet and concluded that these additives had no significant effect on the birds'body weight. Giannenas *et al*. (2010); showed improved performance of broiler chickens on adding 10 and 20 g/kg of an edible mushroom (*Agaricus bisporus*) to the diet. The inconsistency of our finding with those reported by others may be related to differences in chemical composition of different mushroom species. Guo *et al*. (2003); stated wide variety of the physicochemical properties of different mushroom polysaccharides, such as sugar composition, molar weights, and structures.

In present study, findings about relative weight are in agreement with observations by Daneshmand *et al*. (2011).

Blood parameters

The effect of dietary inclusion of mushroom powder on the blood biochemical components of quails are shown in Tables 5 and 6. Glucose, uric acid, total protein were not significantly influenced by mushroom supplementation, but total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL) and low- density lipoprotein (LDL) cholesterol were affected significantly (P<0.001). A similar hypocholesterolemic effect of the oyster mushroom (*Pleurotus ostreatus*) was also observed in hamsters (Bobek *et al*. 1991) and in rabbits (Bobek and Galbavy, 1999). Dried oyster mushrooms (*Pleurotus ostreatus*), which are believed to contain a natural lovastatin-like compound, have been shown to provide significant cholesterol reductions in animal models. Administering at 5% dried *Pleurotus ostreatus* powder to male rats, decreased serum and liver cholesterol 33% by and 27%, respectively (Bobek *et al*. 1994).

Table 3 Effect of oyster mushroom (%) on body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) of male quail chicks (5 weeks)

Treatment	Feed intake (g)	Weight gain (g)	Feed conversion ratio
Control	140.94	37.12	3.76
Mushroom (0.5)	145.14	38.33	3.78
Mushroom (1)	144.65	38.54	3.75
Mushroom (2)	139.08	36.47	3.81
SEM	2.98	0.80	0.02
P-value	0.4552	0.2853	0.3187

SEM: standard error of the means.

Table 4 Effect of oyster mushroom (%) on body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) of female quail chicks (5 weeks)

Treatment	Feed intake (g)	Weight gain (g)	Feed conversion ratio
Control	234.97	63.00	3.70
Mushroom (0.5)	234.40	63.24	3.70
Mushroom (1)	239.35	64.34	3.71
Mushroom (2)	240.66	63.72	3.72
SEM	2.80	0.80	0.01
P-value	0.3548	0.6681	0.1189

SEM: standard error of the means.

Table 5 Effect of oyster mushroom (%) on plasma glucose, uric acid, total protein, total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol of male quail chicks (35 days age)

Treatment	Glucose (mg/L)	Triglyceride (mg/L)	Total cholesterol (mg/L)	HDL (mg/L)	LDL (mg/L)	Total protein (g/L)	Uric acid (mg/L)
Control	3355.0	2244.5^{a}	1995.0^{a}	1145.8^{c}	399.9^{a}	34.8	87.8
Mushroom (0.5)	3346.6	2219.6^{b}	1883.5^{b}	1182.7^{b}	256.4^{b}	35.0	88.0
Mushroom (1)	3318.3	1835.4^{c}	1852.5^{c}	1216.5^{a}	268.7^{b}	34.8	87.3
Mushroom (2)	3300.0	1789.4^{d}	1754.3^{d}	1226.8^{a}	169.3^{c}	35.0	87.9
SEM	5.18	0.57	0.43	0.83	0.73	0.11	0.24
P-value	0.8655	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.9993	0.9972

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 6 Effect of oyster mushroom (%) on plasma glucose, uric acid, total protein, total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL) and low-density lipoprotein (LDL) of female quail chicks (35 days age)

Treatment	Glucose (mg/L)	Triglyceride (mg/L)	Total cholesterol (mg/L)	HDL (mg/L)	LDL (mg/L)	Total protein (g/L)	Uric acid (mg/L)
Control	3301.6	2257.2^{a}	1875.5^{a}	1156.6^{b}	267.2^{a}	37.0	116.1
Mushroom (0.5)	3283.3	2204.0^{b}	1875.0^{a}	11757^{b}	258.0^{a}	36.8	109.8
Mushroom (1)	3296.6	1844.5^{c}	1806.0^{b}	1205.4^{a}	231.4^{b}	37.0	121.0
Mushroom (2)	3260.0	1803.3^{d}	1759.1^{c}	1217.6^{a}	180.5^{c}	37.1	114.0
SEM	2.92	0.78	0.47	0.76	0.86	0.09	0.42
P-value	0.7492	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.9965	0.3317

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Mushrooms contain also the hypocholesterolaemic agent mevinolin (Gunde-Cimerman *et al*. 1993) which may be involved in decreasing the activity of the 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase (Bobek *et al*. 1995) which is the rate-limiting enzyme of cholesterol biosynthesis.

Thus, feeding mushrooms may involve suppression of endogenous cholesterol biosynthesis by inhibiting HMG-CoA reductase activity. Again in male rats, feeding of oyster mushrooms reduced HMGCoA reductase by more than 30% (Bobek *et al*. 1998).

Another potential benefit of mushrooms is that they contain large amounts of water-soluble fiber called beta-glucans. Bile acids are composed of cholesterol derivatives, and according to the studies (Wolkoff and Cohen, 2003), 95% of the bile secreted by the liver is reabsorbed in the intestine. Beta-glucans increase the viscosity of bile inside the intestines and decrease reabsorption of cholesterol derivatives.

According to a study by Chen and Huang (2009), supplementation of beta-glucans may not only increase the effectiveness of treatment with statins, but may also reduce the required dosage.

Coupling beta-glucans with statin treatment creates a cholesterol-lowering scenario where cholesterol production is limited and increased amounts are excreted from the body. Beta-glucans taken alone -without statins- have been known to increase HDL and decrease LDL, which can help lower the risk of atherosclerosis.

CONCLUSION

This paper clearly demonstrates that oyster mushroom has the ability to decrease cholesterol, LDL, triglyceride in blood. These results suggest that dietary content of mushroom could have anti-hypercholesterolemic effect. Effects of *Pleurotus ostreatus* are likely due to the result of a number of mechanisms involving dietary lovastatin-like, beta-glucans and other active components in the mushroom acting alone or in combination. These results suggest that dietary inclusion of mushroom could decrease total cholesterol (TC), triglyceride (TG), LDL cholesterol and increase HDL. In an overall conclusion, the mushroom (*Pleurotus ostreatus*) could be a beneficial supplement in quail diet.

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