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Growth performance and blood profile of cockerel chickens on administration of oyster mushroom *(Pleurotus ostreatus)* in water and feed

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Additional keywords

Cockerel chickens.
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SUMMARY

This study investigated the growth performance and blood profile of 240 cockerel chickens on varying levels of oyster mushroom (*Pleurotus ostreatus* Jacq ex fr.) in water and feed for 12 weeks. The birds were brooded for 3 weeks and thereafter sub-divided into eight treatment groups in a 2 x 4 factorial experimental layout consisting of 2 routes of administration (water and feed) each at 4 levels of inclusion (0, 5, 10 and 15 ml/litre of water and 0, 500, 750 and 1000 ppm, respectively). Each treatment contained 30 birds with three replications of 10 birds each. Data obtained were subjected to Completely Randomized Design. Birds on 1000 ppm and 15 ml inclusion levels of oyster mushroom in feed and water, respectively had the highest (P<0.05) final weight and weight gain, and the best feed conversion ratios of 3.16 and 3.19, respectively. The PCV, Hb, RBC, total protein and globulin of the cockerel chickens were highest (P<0.05) in the inclusion of oyster mushroom at 10 ml in a litre of water. The total cholesterol, triglycerides, LDL and VLDL were lowest (P<0.05) in the cockerel chickens at the inclusion of 1000 ppm oyster mushroom in feed. Cockerel chickens at the inclusion of 15 ml and 750 ppm oyster mushroom in water and in feed, respectively recorded comparably highest HDL (49.50 mg/dL). It was concluded that administration of oyster mushroom in water and feed at 15 ml/litre and 750 ppm, respectively could be adopted in cockerel chickens' production for improved growth performance and blood profile.

Rendimiento del crecimiento y perfil de la sangre de gallos jóvenes por la administración del champiñón ostra *(Ostreatus pleurotus)* en agua y alimento

Palabras clave adicionales

Gallos jóvenes.
Champiñón ostra.
Rendimiento del crecimiento.
Hematología.
Perfil lipídico.

RESUMEN

Este estudio investigó el rendimiento del crecimiento y el perfil sanguíneo de 240 gallos jóvenes expuestos a diferentes niveles de champiñón ostra (*Pleurotus ostreatus* Jacq ex fr.) en agua y piensos durante 12 semanas. Las aves fueron criadas durante 3 semanas y posteriormente subdivididas en ocho grupos de tratamiento siguiendo un diseño experimental factorial de 2 x 4 consistente en 2 vías de administración (agua y piensos) cada una a 4 niveles de inclusión (0, 5, 10 y 15 ml/litro de agua y 0 , 500, 750 y 1000 ppm, respectivamente). Cada tratamiento contenía 30 aves con tres repeticiones de 10 aves cada una. Los datos obtenidos fueron sometidos a un diseño completamente aleatorio. Las aves en 1000 ppm y 15 ml de niveles de inclusión de champiñones ostra en pienso y agua, respectivamente, tuvieron el mayor peso final (P < 0.05) y aumento de peso, y las mejores proporciones de conversión de alimento de 3,16 y 3,19, respectivamente. El PCV, HB, RBC, la proteína total y la globulina de los gallos jóvenes resultaron los más altos (P < 0.05) en la inclusión champiñón de ostra en 10 ml en un litro de agua. El colesterol total, los triglicéridos, el LDL y el VLDL fueron los más bajos (P < 0.05) en los gallos jóvenes a la inclusión de 1000 ppm de champiñón ostra en la alimentación. Los gallos jóvenes, tras la inclusión de 15 ml y 750 ppm de champiñón ostra en agua y en alimentación, respectivamente registraron el HDL más alto (49,50 mg/dL). Se concluyó que la administración de champiñones ostra en agua y piensos a 15 ml/litro y 750 ppm, respectivamente, podría adoptarse en la producción de pollos de gallo para mejorar el rendimiento del crecimiento y el perfil sanguíneo.

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INTRODUCTION

In recent times, cockerel chickens which were usually destroyed upon hatching because they are slow growers but hardy and useful for meat and breeding purposes are reared to target body weight that far exceeds those of decades ago. Cockerel production is easier than other poultry species because the bird survives particularly in the rural area where infrastructural facilities are not available (Sogunle et al. 2012, p. 570 and 2013, p. 282). Its rearing is thereby a sure alternative for bridging the protein malnutrition gap in the developing countries including Nigeria. To account for the increased final body weight, it is imperative to develop

a better rearing alternative that will reduce the costs of feeding and resistant effects of antibiotics administration, what it is pursued in the literature with several strategies (Raji et al. 2016 pp. 140-1;.Majekodum et al. 2016 pp. 540-1)

The concerns about antibiotic residues and the emergence of antibiotics resistant strains of microorganisms in animal tissues led to the ban of antibiotic growth promoters in animal diets particularly poultry. Several alternative strategies to antibiotics in poultry and livestock production are under investigation (Zakeri & Kashefi 2011, pp. 1098-9; Seal et al. 2013, pp. 80-5) but none of the proposed strategies have been systematically implemented to date. However, continuous search for new approaches including organic acids with antimicrobial activities; herbs, spices and other plant extracts (González-Lamothe et al. 2009, pp. 3400-10) to prevent poultry diseases hence the search for oyster mushroom (*Pleurotus ostreatus*) which are phytogenic or phytobiotics. Extracts derived from various mushrooms confer health-promoting benefits, due to a multitude of compounds which are antioxidant, antibacterial, immune-enhancing, and stress reduction properties on farm animals (Dalloul et al. 2006, pp. 447-9; Dallloul & Lillehoj 2006, p. 144). Willis, Wall and Isikhuemhen (2012, pp. 434-6) reported that most medicinal mushrooms contain biologically active substances such as polysaccharides, glycoproteins and other macromolecules, which can serve as good dietary supplements and immuno-modulating agents.

Oyster mushrooms (*Pleurotus ostreatus*) have been reported to contain many valuable benefits such as rich in dietary fibre, protein, vitamins and mineral while having low fat and calorific values. Mushrooms with their flavour, texture, nutritional value and high productivity per unit area have been identified as an excellent food source to alleviate malnutrition in developing countries and has been utilized a long time ago for both food and medicine (Eswaran & Ramabadran 2000, p. 361-3; Cheung 2010, pp. 293-5). Besides its nutritive values, the unique functionality of β-glucan is its contribution towards healthy characteristics (Manzi & Pizzoferrato 2000, p. 317). However, its relevance in cockerel chickens' production in order to bridge the ever-widening animal protein source in human's diets in the developing countries has not been widely researched.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the poultry unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State. The area lies on latitude $7^0$13′N and longitude 3^0 2′E. It is 76m above sea level and located in the tropical rainforest vegetation zone with an average temperature of 34.7^{0}C and relative humidity of 82.1% (Google earth 2015). The preparation of the oyster mushroom was carried out at the Animal Products and Processing Laboratory, Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Experimental birds and management

A total number of 240, a day-old cockerel chicken were purchased from a reputable hatchery. The chicks were brooded for 4 weeks using coal pot as a source of heat and were housed in a deep litter cage. All medications and vaccinations schedules were strictly adhered to. After brooding the birds were sub-divided into two sub-groups of route of administration of oyster mushroom (*Pleurotus ostreatus)* in water or feed which were composed of 120 birds each. The experimental layout was a 2 by 4 factorial arrangement. This involved 2 routes of administration of oyster mushroom (in water and in feed) with each at 4 varying levels of inclusion of the oyster mushroom (0, 5, 10 and 15 ml oyster mushroom/litre of water and 0, 500, 750 and 1000 ppm oyster mushroom).

Treatment I contained no oyster mushroom extract (0 ml per litre of water). The birds were administered antibiotics and medications (Control).

Treatment II contained oyster mushroom extract at 5 ml per litre of water.

Treatment III contained oyster mushroom extract at 10 ml per litre of water.

Treatment IV contained oyster mushroom extract at 15 ml per litre of water.

Treatment V contained no oyster mushroom (0 ppm in feed). The birds were administered antibiotics and medications (Control)

Treatment VI contained oyster mushroom in feed at 500 ppm.

Treatment VII: Inclusion of oyster mushroom in feed at 750 ppm without antibiotics

Treatment VIII: Inclusion of oyster mushroom in feed at 1000 ppm without antibiotics

Each treatment of 30 birds was replicated three times with 10 birds each. The birds were fed *ad libitum* and provided with clean cool fresh water throughout period of the experiment which was 12 weeks (3 months) when the birds were matured for the market.

Source, Preparation of concentrate and powdered oyster mushroom

Fresh oyster mushrooms (*Pleurotus ostreatus*) were purchased from a reputable market in Ibadan, Oyo State. The mushrooms were properly rinsed so as to remove any form of dirt on it, all external materials such as stones and leaf debris were also removed from it. After cleaning, hot water extraction procedure was applied by extending the boiling process of the mushroom so as to fully extract the mushroom which is considered to be medicinal out of the mushroom cell wall. A 500 g of oyster mushroom to 1 litre of water was cooked at 57.2 ^{0}C for twenty (20) minutes. The newly formed extracts were then cooled and strain-off the mushrooms with the aid of a sieve. The extracts were kept in a dark-coloured recipient (to prevent photolysis due to light penetration) and then stored in the refrigerator until needed. A whole oyster mushroom was also oven dried at 60 ^{o}C to constant weight and milled into pow-

der. This was included in the feed as described in the treatment groups.

Experimental Diet

The composition of experimental diet fed the birds is shown in **Table I**. All diets were formulated to meet the nutrient requirements of cockerel chickens (NRC 1994).

Data collection

Growth performance characteristics

The following growth performance parameters: feed intake, weight gain and mortality were measured weekly and the feed conversion ratio was calculated as the ratio of the feed intake to the weight gain. The birds were observed daily as a preventive measure to check for clinical signs of diseases or its predisposing factors as well as vice habits among the flocks.

Blood collection and analysis

At the 12th week of the experiment, 2 birds per replicate were selected and 4 ml blood samples were collected in the morning between 7:00 am and 9:00 am by vein puncture. About 2 ml was used for white blood cell differential and was stored in Bijou bottles with ethylene-diamine tetra acetate (EDTA) as anticoagulant while the other 2 ml was stored without coagulant for serum biochemical analysis. Sample bottles containing the collected blood were placed in ice packs to maintain a cool and stable temperature and immediately sent for laboratory analysis. The estimate of the total number of white blood cells was carried out immediately after collection of blood samples from the animals using Neubauer haemocytometer counting chamber (Jain 1986). About 0.2 ml of blood sample was pipetted and mixed with 4 ml of white blood cell diluting fluid (white blood cell fluid made up of 3% aqueous solution of acetic acid and 1% gentian violet). The sample was then put into the haemocytometer, cell counted and expressed as 10^9 white blood cell per litre of blood. White blood cell differentials (neutrophils, lymphocytes, monocytes, eosinophils and basophils) were also determined via slide reading under microscope after blood smear and staining.

For the analysis of blood serum biochemical indices including the blood lipid profile, the other 2 ml of blood samples were maintained in collection tubes with no additives for 2 h at 20 to 22 °C and then centrifuged (Minifuge RF, Heraeus, Hannover, Germany) at 1200 × g and 4 °C for 20 min. Serum was separated and stored frozen at –30 °C until assayed. Serum cholesterol, triglyceride, albumin, total protein, creatinine, urea and glucose concentrations were measured by using an auto analyser (Hitachi 747, Boehringer Mannheim, Madrid, Spain).

Table I. Composition (%) of experimental diet (Composición (%) de la dieta experimental).

Ingredient	% Composition
Maize	38.30
Fishmeal (72 % CP)	1.00
Groundnut cake	12.00
Soybean meal	10.00
Wheat offal	34.00
Oyster shell	2.00
Bone meal	2.00
*Vitamin/Mineral premix	0.25
Lysine	0.10
Methionine	0.10
Salt (NaCl)	0.25
Total	100.00
Determined analysis (%)	
Dry matter	87.80
Crude protein	18.29
Ether extract	6.60
Crude fibre	6.49
Ash	19.10
Nitrogen-free extract	49.52

Statistical analysis

Data collected were subjected to Analysis of Variance in a Completely Randomized Design. Significant ($P<0.05$) differences among means were separated using Tukey Test as contained in Minitab version 17 (Minitab 2013).

The model used was:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}$$

Where:

Y_{ijk} = individual observation

μ = overall mean

A_i = effect of Factor A (Route of Administration: i = Water, Feed)

B_j = effect of Factor B (Varying inclusion levels: j = 0, 5, 10 and 15 ml oyster mushroom/litre of water and 0, 500, 750 and 1000 ppm oyster mushroom)

$(AB)_{ij}$ = effect of interaction AB (Route of Administration* Varying inclusion levels)

ε_{ijk} = Experimental error

RESULTS

Effects of route of administration and varying inclusion levels of oyster mushroom in water and feed on growth performance of cockerel chickens

The main effects of route of administration and varying inclusion levels of oyster mushroom in water and feed on growth performance of cockerel chickens are shown in **Table II**. Varying inclusion levels of oyster mushroom significantly ($P<0.05$) affected the final weight, weight gain and feed conversion ratio. Final weight and weight gain increased as the levels of inclusion of oyster mushroom increased. Birds on the 4th level of inclusion had the highest final weight (2111.0g) and weight gain (19.14g/b/d) and the least value was observed on the control diet 1612.9 g and 14.35 g/b/d,

Table II. Effects of route of administration and varying inclusion levels of oyster mushroom in water and feed on growth performance of cockerel chickens (Efectos de la vía de administración y los diferentes niveles de inclusión de champiñón ostra en el agua y el rendimiento del crecimiento de gallos jóvenes).

Parameters							
Factors		Initial weight (g/b)	Final weight (g/b)	Feed intake (g/b/d)	Weight gain (g/b/d)	Feed Conversion Ratio	Mortality (%)
Route of Administration	Water	101.75	188.89	61.66	17.00	3.67	0.83
	Feed	102.44	1949.55	62.79	17.59	3.61	1.47
	SEM	1.56	57.10	1.25	0.55	0.05	0.95
	P-Value	0.761	0.445	0.529	0.455	0.377	0.639
Levels of Inclusion	1	105.88	1612.94^{b}	58.01^{b}	14.35^{b}	4.04^{a}	1.28
	2	98.33	1953.82^{a}	66.59^{a}	17.67^{a}	3.78^{b}	1.67
	3	102.50	1995.07^{a}	63.69^{ab}	18.02^{a}	3.55^{b}	1.67
	4	101.67	2111.04^{a}	60.62^{ab}	19.14^{a}	3.18^{c}	0.00
	SEM	2.21	80.80	1.76	0.77	0.06	1.34
	P-Value	0.159	0.003	0.019	0.003	0.000	0.792
Route of Administration*Levels of Inclusion	0 ml/litre	105.34	1584.97^{b}	56.80	14.09b	4.04a	0.00
	5 ml/litre	100.00	1875.69^{ab}	66.00	16.91^{ab}	3.91^{ab}	0.00
	10 ml/litre	98.33	2028.57^{ab}	64.42	18.38^{ab}	3.53^{bc}	3.33
	15 ml/litre	103.33	2058.33^{ab}	59.42	18.62^{ab}	3.19^{c}	0.00
	0 ppm	106.41	1640.91^{ab}	59.21	14.61^{ab}	4.05^{a}	2.56
	500 ppm	96.67	2031.94^{ab}	67.17	18.43^{ab}	3.65^{ab}	3.33
	750 ppm	106.67	1961.57^{ab}	62.96	17.67^{ab}	3.57^{bc}	0.00
	1000 ppm	100.00	2163.76^{a}	61.83	19.65^{a}	3.16^{c}	0.00
	SEM	3.12	114.00	2.49	1.09	0.09	1.90
	P-Value	0.239	0.789	0.848	0.762	0.352	0.322

^{a,b,c} Means in the same column by factor with different superscripts differ significantly (P<0.05), g/b/d- gram per bird per day; g/b- gram per bird ppm – parts per million or milligram/kilogram (mg/kg).

respectively. The best feed conversion ratio of 3.18 was also obtained in cockerel chickens on the 4th level of inclusion of oyster mushroom. In the interactive effect, there were significant (P<0.05) differences in final weight, weight gain and feed conversion ratio. Birds fed diets containing 1000 ppm inclusion level had the highest final weight (2164.00g/bird) and weight gain (19.65g/b/d) while the control diet recorded the least value. The best feed conversion ratios of 3.19 and 3.16 were also obtained in birds administered oyster mushroom extract at 15 ml/litre of water and birds fed diets containing 1000 ppm oyster mushroom, respectively.

Effects of route of administration and varying inclusion levels of oyster mushroom in water and feed on blood profile of cockerel chickens

The main effects of route of administration and varying inclusion levels of oyster mushroom in water and feed on blood profile of cockerel chickens are presented in **Table III**. The administration of oyster mushroom in water gave significantly (P<0.05) higher packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell (RBC), albumin, globulin, total cholesterol, triglycerides, low density lipoprotein and very low density lipoprotein in the cockerel chickens than obtainable on the administration of oyster mushroom in feed. On the other hands, only the white blood cell and high density lipoprotein were higher (P<0.05) in the cockerel chickens on the administration of oyster mushroom in feed. The varying inclusion levels of oyster mushroom significantly (P<0.05) influenced the blood profile of the cockerel chickens across the treatments but with no particular trend. However, the total cholesterol and low density lipoprotein of the cockerel chickens were reduced while the bird's high density lipoprotein increased at the 4th level of inclusion of oyster mushroom either in water or in feed.

In **Table IV**, the interactive effects between route of administration and varying inclusion levels of oyster mushroom in water and feed on blood profile of cockerel chickens are shown. Significant (P<0.05) differences were obtained in all the parameters considered across treatments. The PCV, Hb, RBC and albumin of the cockerel chickens were highest in the inclusion of oyster mushroom at 10 ml in a litre of water but the WBC, total serum protein and globulin of the cockerel chickens were highest in the inclusion of oyster mushroom at 5 ml in a litre of water. The lipid profile showed that the triglycerides, LDL and VLDL were lowest in the cockerel chickens at the inclusion of 1000 ppm oyster mushroom in feed. Highest HDL (48.67 mg/dL) was obtained in cockerel chickens at inclusion of 750 ppm

Table III. Main effect of route of administration and varying inclusion levels of oyster mushroom in water and feed on blood profile of cockerel chickens (Efecto principal de la vía de administración y niveles de inclusión variables de champiñón ostra en el agua y la alimentación sobre el perfil sanguíneo de gallos jóvenes).

	Route of administration				Inclusion level					
Parameter	Water	Feed	SEM	P-Value	1	2	3	4	SEM	P-Value
Haematological parameter										
Packed Cell Volume (%)	34.88^{a}	30.75^{b}	0.49	0.000	35.00^{a}	30.67^{b}	34.17^{a}	31.33^{b}	0.69	0.000
Haemoglobin (g/dL)	11.83^{a}	10.00^{b}	0.12	0.000	10.92	10.80	11.15	10.78	0.06	0.404
White Blood Cell (×10^{9}/L)	11.83	12.05	0.20	0.443	11.22^{b}	13.03^{a}	12.48^{a}	11.03^{b}	0.28	0.000
Red Blood Cell (×10^{6}/mm^{3})	2.30^{a}	1.93^{b}	0.05	0.000	2.15^{ab}	2.03^{b}	2.30^{a}	1.98^{b}	0.06	0.014
Serum parameter										
Total Serum Protein (g/dL)	33.42	32.75	0.43	0.288	31.50^{b}	35.83^{a}	30.67^{b}	34.33^{a}	0.61	0.000
Albumin (g/dL)	17.92^{a}	15.58^{b}	0.30	0.000	15.67^{b}	17.50^{a}	16.83^{ab}	17.00^{ab}	0.43	0.046
Globulin (g/dL)	15.50	17.17	0.58	0.060	15.83^{ab}	18.33^{a}	13.83^{b}	17.33^{a}	0.83	0.008
Lipid profile parameter										
Total cholesterol (mg/dL)	77.75^{a}	70.50^{b}	0.69	0.000	78.17^{a}	74.17^{b}	74.00^{bc}	70.17^{c}	0.97	0.000
Triglyceride (mg/dL)	85.88^{a}	61.17^{b}	0.53	0.000	93.00^{a}	58.33^{d}	78.83^{b}	63.83^{c}	0.75	0.000
High density lipoprotein (mg/dL)	40.67	42.00	0.46	0.059	36.17^{c}	43.67^{ab}	41.17^{b}	44.33^{a}	0.66	0.000
Low density lipoprotein (mg/dL)	19.92^{a}	16.27^{b}	0.78	0.004	23.40^{a}	18.83^{b}	17.07^{bc}	13.07^{c}	1.10	0.000
Very Low density lipoprotein (mg/dL)	17.18^{a}	12.23^{b}	0.11	0.000	18.60^{a}	11.67^{d}	15.76^{b}	12.77^{c}	0.15	0.000

^{a,b,c} Means in the same row with different superscripts differ significantly (P<0.05).

oyster mushroom in feed and this is comparable to 45 mg/dL at inclusion of 5 ml oyster mushroom extract in water for the cockerel chickens.

DISCUSSION

The result on the growth performance of cockerel chickens in terms of final weight, weight gain and feed intake showed a significant effect of the treatments, as in other reports using substances with vegetable precedence (Vieltes et al., 2018, pp. 417-8). Cockerel chickens on 1000 ppm inclusion level had the highest body weight gain and best FCR compared to other treatments thereby implying that oyster mushroom in cockerel chicken's diet did not retard growth. This is supported by the findings (Guo, Kwakkel & Williams

Table IV. Interactive effect between route of administration and varying inclusion levels of oyster mushroom in water and feed on blood profile of cockerel chickens (Efecto interactivo entre la vía de administración y los distintos niveles de inclusión de champiñón ostra en el agua y la alimentación del perfil sanguíneo de los gallos jóvenes)

Route	Water				Feed					
Inclusion level	0 ml	5 ml	10 ml	15 ml	0 ppm	500 ppm	750 ppm	1000 ppm	SEM	P-value
Haematological parameter										
Packed Cell Volume (%)	37.00^{ab}	31.00^{c}	38.00^{a}	33.33^{abc}	33.00^{bc}	30.33^{c}	30.33^{c}	29.33^{c}	0.97	0.023
Haemoglobin (g/dL)	11.67^{a}	11.50^{a}	12.37^{a}	11.77^{a}	10.17^{b}	10.10^{b}	9.93^{b}	9.80^{b}	0.24	0.149
White Blood Cell (×10^{9}/L)	10.76^{c}	13.60^{a}	11.77^{abc}	11.20^{c}	11.67^{bc}	12.47^{abc}	13.20^{ab}	10.87^{c}	0.12	0.018
Red Blood Cell (×10^{6}/mm^{3})	2.40^{a}	2.00^{ab}	2.37^{a}	2.43^{a}	1.90^{bc}	2.07^{ab}	2.23^{ab}	1.53^{e}	0.09	0.000
Serum parameter										
Total Serum protein (g/dL)	30.33^{b}	39.33^{a}	32.67^{b}	31.33^{b}	32.67^{b}	32.66^{b}	28.67^{b}	37.33^{a}	0.86	0.000
Albumin (g/dL)	16.67^{bcd}	17.33^{abc}	19.67^{a}	18.00^{ab}	14.67^{cd}	17.67^{ab}	14.00^{d}	16.00^{bcd}	0.60	0.001
Globulin (g/dL)	13.67^{b}	22.00^{a}	13.00^{b}	13.33^{b}	18.00^{b}	14.67^{b}	14.67^{b}	21.33^{a}	1.17	0.000
Lipid profile parameter										
Total Cholesterol (mg/dL)	95.00^{a}	81.00^{b}	61.00^{d}	74.00^{c}	61.33^{d}	67.33^{cd}	87.00^{b}	66.33^{d}	1.38	0.000
Triglyceride (mg/dL)	134.33^{a}	60.67^{e}	66.00^{d}	82.33^{c}	51.67^{f}	56.00^{ef}	91.67^{b}	45.33^{g}	1.06	0.000
High Density Lipoprotein (mg/dL)	41.00^{c}	45.00^{abc}	33.67^{d}	43.00^{bc}	31.33^{d}	42.33^{bc}	48.67^{a}	45.67^{ab}	0.93	0.000
Low Density Lipoprotein (mg/dL)	27.13^{a}	23.87^{a}	14.13^{bc}	14.53^{be}	19.67^{ab}	13.80^{be}	20.00^{ab}	11.60^{c}	1.56	0.001
Very Low Density Lipoprotein (mg/dL)	26.87^{a}	12.13^{e}	13.20^{d}	16.47^{c}	10.33^{f}	11.20^{ef}	18.33^{b}	9.07^{g}	0.21	0.000

^{a,b,c,e,d} Means in the same row with different superscripts differ significantly (P<0.05).

2004, pp. 1125-7: Giannenas et al. 2010, p. 305) that feed containing mushroom and herb polysaccharides increased body weight gain and enhance feed: gain in chickens. The mushroom composition in relation to physiochemical properties; the phenolic compounds and polysaccharide fractions as well as sugar composition, molecular weights, and structures could be the basis for the observed results of Guo, Kwakkel and Williams (2004, pp. 1128).

The significant differences obtained in PCV, Hb, RBC and WBC corroborate the reports by Iheukwumere, Okoli and Okeudo (2002, p. 222) that haematological parameters of chickens differ across treatments on varying inclusion levels of oyster mushroom. However, the values obtained are within the normal reference range for domestic chickens (Jain 1986). Ogbe et al. (2010, pp. 8924-5) however stated that fluctuations in haematological values of avian blood are a normal phenomenon, and in most instances the variations in haematological values depend on the physiological state of the birds. This could also be responsible for the variations in the values of total protein, albumin and globulin of the cockerel chickens in the present study. Various studies (Manzi, Aguzzi & Pizzoferrato 2001, p. 324; Mattiala, Suonpa & Pilronen 2006, pp. 694-6; Cheung 2010, p. 294) have reported that the mushrooms can reduce free-cholesterol in serum as confirmed in this study. In addition, Lavi et al. (2006, p. 63) reported that the administration of polysaccharides from *Pleurotus ostreatus* significantly reduced serum total cholesterol, triglyceride and low-density lipoprotein cholesterol and enhanced high density lipoprotein. Birds on administration of oyster mushroom in feed at 1000 ppm inclusion level greatly reduced the total cholesterol which could be attributable to the hypocholesterolemic effects of some fruiting bodies of edible mushroom as reported by Khan (2010, pp. 2-7). The author also stated that the soluble dietary fibre has shown healthy effects on serum lipid levels. Contrarily, Daneshmand et al. (2011, pp. 91-4) noted that oyster mushroom did not affect antibody response against total cholesterol concentration, but decreased the high density lipoproteins concentration of poultry. However, Deepalakshmi and Mirunalini (2014, p. 724) confirmed that the fatty acid pattern of oyster mushrooms seems to contribute to reducing serum cholesterol.

CONCLUSION

From this study, it could be concluded thus:

Cockerel chickens on the administration of either 5 ml/litre of water or 1000 ppm in feed of oyster mushroom inclusion level had a higher final weight, weight gain with the best feed conversion ratio.

Cockerel chickens on the administration of oyster mushroom in feed at 1000 ppm level of inclusion recorded reduced total cholesterol, triglycerides, low density lipoprotein and very low density lipoprotein. The high density lipoprotein of the cockerel chickens was increased at 5 ml and 750 ppm oyster mushroom inclusion in a litre of water and in feed, respectively.

RECOMMENDATION

For improved growth performance and blood profile, administration of oyster mushroom in water and feed at 5 ml/litre of water and 750 ppm, respectively can be adopted in cockerel chickens' production.

CONFLICT OF INTEREST

The authors hereby declare that they have no conflict of interest

ETHICAL APPROVAL

All applicable international, national and/or institutional guideline for the care and use of animals were followed.

INFORMED CONSENT

Consent of every individual included in this study was obtained.

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BIBLIOGRAPHY

Cheung, PCK 2010, 'The nutritional and health benefits of mushrooms'. *Nutrition Bulletin*, 35: 292-299.

Dalloul, RA, Lillehoj, HS, Lee, JS, Lee, SH & Chung, KS 2006, 'Immunopotentiating effect of a *Fomitella fraxinea*-derived lectin on chicken immunity and resistance to coccidiosis'. *Poultry Science*, 85(3): 446-51.

Dalloul, RA & Lillehoj, HS 2006, 'Poultry coccidiosis: recent advancements in control measures and vaccine development'. *Expert Review of Vaccines*, 5(1):143-163.

Daneshmand, A, Sadeghi, G, Karimi, A & Vaziry, A 2011, 'Effect of oyster mushroom (*Pleurotus ostreatus*) with and without probiotic on growth performance and some blood parameters of male broilers'. *Animal Feed Science Technology*, 170 (1-2): 91-96.

Deepalakshmi, K & Mirunalini, S 2014, '*Pleurotus ostreatus*: an oyster mushroom with nutritional and medicinal properties'. *Journal of Biochemical Technology*, 5(2): 718-726.

Eswaran, A & Ramabadran, R 2000, 'Studies on some physiological, cultural and post-harvest aspects of oyster mushroom, *Pleurotus ostreatus*'. *Tropical Agricultural Research*, 12: 360 – 374.

Giannenas, I, Pappas, IS, Mavridis, S, Kontopidis, G, Skoufos, J & Kyriazakis, I 2010, 'Performance and antioxidant status of broiler chickens supplemented with dried mushrooms (*Agaricus bisporus*) in their diet'. *Poultry Science*, 89 (2): 303-311.

González-Lamothe, R, Mitchell, G, Gattuso, M, Diarra, MS, Malouin, F & Bouarab, K 2009, 'Plant antimicrobial agents and their effects on plant and human pathogens'. *International Journal of Molecular Science*, 10: 3400–3419.

Google earth 2015. Google earth 7.1.5.1557. http://www.google.com/earth

Guo, FC, Kwakkel, RP & Williams, BA 2004, 'Effects of mushroom and herb polysaccharides on cellular and humoral immune responses of *Eimeria tenella*-infected chickens'. *Poultry Science*, 83(7): 1124-32.

Iheukwumere, FC, Okoli, IC & Okeudo, NJ 2002, 'Preliminary studies on raw *Napoleona imperialis* as feed ingredient. II: Effect on performance, haematology, serum biochemistry, carcass and organ weight of weaner rabbits'. *Tropical Animal Production Investigation*, 5(2): 219-227.

Jain, NC 1986, *Schalm Veterinary Haematology* (4th edition). Lea and Febiger, Philadelphia. Pp. 285.

Khan, MA 2010, 'Nutritional composition and hypocholesterolemic effect of mushroom: *Pleurotus sajor-caju* and *Pleurotus florida*'. LAP Lambert Academic publishing Gmbh & co. KG: Saarbrucken, Germany, pp. 1-11

Lavi, I, Friesem, D, Geresh, S, Hadar, Y & Schwariz, B 2006, 'An aqueous polysaccharide extract from the edible mushroom (*Pleurotus ostreatus*) induces anti-proliferative and pro-apoptotic effects on HT-29 colon cancer cells'. *Cancer Letters*, 2444: 61-70.

Majekodunmi, BC, Ogunwole, OA & Sokunbi, OA 2016, 'Plasma corticosterone and adrenal gland histomorphometry of heat stressed broiler chickens given supplemental electrolytes or vitamin C'. *Archivos de zootecnia*, 65 (252) 535-540.

Manzi, P & Pizzoferrato, L 2000, 'Beta-glucans in edible mushrooms'. *Food Chemistry*, 68: 315-318.

Manzi, P, Aguzzi, A & Pizzoferrato, L 2001, 'Nutritional values of mushrooms widely consumed in Italy'. *Food Chemistry*, 73(3):321-325.

Mattila, P, Suonpa, K & Pilronen, V 2006, 'Functional properties of edible mushroom'. *Nutrition Journal*, 16: 694-696.

Minitab 17 Statistical Software. 2013. Stable release 17.1.0.

NRC 1994. 'Nutrient Requirements of Poultry': Ninth Revised Edition, National Academy Press Washington, D.C.

Ogbe, AO, Atawodi, SE, Abdu, PA, Oguntayo, BO & Noel, D 2010 'Oral treatment of *Eimeria tenella*-infected broilers using aqueous extract of wild mushroom (*Ganoderma sp*): Effect on haematological parameters and histopathology lesions'. *African Journal of Biotechnology*, 9: 8923-8927.

Sogunle, OM, Olaniyi, OA, Shittu, TA and SS Abiola 2012, 'Performance and meat attributes of chickens reared on deep litter and free range'. *Archivos de zootecnia*, 61 (236) 569-576.

Raji, MO, Adeleye, OO, Mosobalaje, MA, Ogunjimi, JT & Tewe, OO 2016, 'Growth response and serum biochemical parameters of starter broiler chicken fed toasted African yam bean (*Sphenostylis stenocarpo*) seeds meal with enzyme supplementation'. *Archivos de zootecnia*, 65 (250) 535-540.

Seal, BS, Lillehoj, HS, Donovan, DM, & Gay, CG 2013, 'Alternatives to antibiotics: a symposium on the challenges and solutions for animal production'. *Animal Health Research Review*, 14: 78–87.

Sogunle, OM, Olaniyi, OA, Egbeyale, LT, Akinola, OS, Shittu, TA, Abiola, SS, Ladokun, AO & Sobayo, RA 2013, 'Free range and deep litter production systems: Effect on performance, carcass yield and meat composition of cockerel chickens'. *Tropical Animal Health and Production*, 45 (1) 281 -288.

Vieites, FM, Brusamarelo, E, Corrêa, G da SS, Souza, CS, de Oliveira, CFS, de Moraes, GHK & Caramori Júnior, JG 2018, '1,25-dihidroxicolecalciferol de origem herbal *(Solanum glaucophyllum)* mantém o desempenho e a qualidade óssea de frangos de corte fêmeas durante restrição de cálcio e fósforo'. *Archivos de zootecnia*, 67 (259) 414-419.

Willis, WL, Wall, DC & Isikhuemhen, OS 2012, 'Effect of different mushrooms fed to eimeria-challenged broilers on rearing performance'. *International Journal of Poultry Science*, 11(7): 433-437.

Zakeri, A & Kashefi, P 2011. 'The comparative effects of five growth promoters on broiler chickens humoral immunity and performance'. *Journal of Animal Veterinary Advances*, 10, 1097–1101.