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Mushroom (*Pleurotus ostreatus*) Waste Powder: Its Influence on the Growth and Meat Quality of Broiler Chickens (*Gallus gallus domesticus*)

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Abstract The study was composed of six levels of mushroom waste powder (0, 5, 10, 15, 20 and 25 grams MWP per kg of basal feed) supplemented to the basal feed of broiler chickens. The experiment was conducted in a completely randomized design in three replications to determine the effects of mushroom waste powder levels on body weight, feed consumption, feed conversion efficiency, average daily gain in weight, and meat quality of broiler chickens. Average daily gain (ADG) in weight and body weight (BW) negatively affected by MWP at the early age of broiler chickens, then slightly improved over time of feeding, but does not vary between treatments (P>0.05). Feeding broiler chickens up to 20 grams MWP significantly increased feed consumption (FC), however, a 25 grams MWP significantly decreased (P=0.01) feed consumption during 18 days period of feeding. Feed consumption efficiency (FCE) slightly improved over time but does not varies (P>0.05) with the control. Broiler meat quality varies significantly with the level of MWP in terms of texture (p=0.0017), tenderness, (p= 0.0001), taste p=0.049) and general acceptability (p=0.0018). However, within these parameters, meat quality of broilers fed with MWP at all levels generally does not vary from the control, except for T2 in terms of taste and tenderness where it is significantly lower compared to the control treatment. MWP does not compromise, in fact, slightly improved the meat quality of broiler chickens. A slight improvement of average daily gain in weight (ADG), body weight (BW), feed conversion efficiency (FCE) and meat quality; and a decrease in feed consumption (FC) with increasing levels of MWP is an indication that MWP is a potential feed additive in chickens. Another study to layer chickens and age of administration maybe done to investigate further the potential of MWP.

Keywords: *Feed Conversion Ratio, Average daily gain, Hedonic scale, Mushroom Waste Powder and Pleurotus*

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1. Introduction

A mushroom (or toadstool) is the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground on soil or on its food source. The standard for the name "mushroom" is the cultivated white button mushroom, *Agaricus bisporus*; hence the word "mushroom" is most often applied to those fungi (Basidiomycota, Agaricomycetes) that have a stem (stipe), a cap (pileus), and gills (lamellae, sing.lamella) or pores on the underside of the cap. These pores or gills produce microscopic spores that help the fungus spread across the ground or its occupant surface [1].

Mushrooms have been used as nutritious food and medicinal purposes. However, nowadays, its uses are more on nutraceuticals. Nutraceuticals are substances that may be considered as food or parts of a food that exhibit medical or health benefits [2]. Medical actions of mushrooms include antitumor, immunomodulating, antioxidant, radical scavenging, cardiovascular, antihypercholesterolemia, antiviral, antibacterial, antiparasitic, hepatoprotective, and antidiabetic effects [3]. Furthermore, there are a number of mushrooms known as "medicinal mushrooms" which can help the body fight cancer and build the immune system. These mushrooms contain a number of valuable cancer fighting and immune boosting compounds including polysaccharides such as lentinan, beta glucan, lectin and thioproline. Moreover, these compounds attack cancerous cells, prevent them from multiplying, and boost immune activity - including stimulating the body's natural production of interferon [4].

Filipino perception about mushroom has been changing over time. It is due to our growing awareness, interest and experiences about mushrooms. It is manifested by the increased number of mushroom farm projects and imports of mushroom products in the Philippines. According to Dr. Emily Soriano, a project leader of Mushroom Technology Center (MTC) in Tarlac, 90 percent of our mushroom was imported from other countries. http://businessdiary.com.ph/, reported that the country is estimated to import around 150 metric tons (MT) of mushrooms yearly largely from South East Asia—Taiwan, China, Thailand, and Japan [5].

The author theorized that while mushroom has been proven effective in preventing and controlling illness in human, this might have the same effect in poultry too. Mushrooms have been well known to have antibiotic properties, while poultry industry has been challenged to stop synthetic antibiotics as it develop resistance to antibiotics when consumed by humans, mushrooms might be a potential substitutes.

Mushroom extract and antibiotic Apramycin (APR) significantly stimulated growth of the chickens infected with avian Mycoplasma gallisepticum, however, the same study found out that the body weight of chicken fed with mushrooms extract is significantly lower compared to APR group. Furthermore, the same authors found out that the extract stimulated the number of the potentially beneficial bacteria (bifidobacteria and lactobacilli), while reducing the number of the potentially harmful bacteria (Bacteroides spp. and Escherichia coli) [6]. Owing to its low fat and low caloric content, mushroom powder may not be a good body weight enhancer, but of lean meat quality promoters which is good for health of chicken meat consumers. With the challenged to increase chicken meat yield production, sometimes the quality will be sacrificed. Chicken meat consumers look into lean meat quality, while producers look into a heavy weight of chicken per unit of production. If only growers can produced chicken meat of good quality, like organically grown chicken, one can demand for a good price without losing the preference by the consumers. Looking into the welfare of the chicken, producers and consumers, thus, this study was conducted, entitled, “Mushroom (Pleurotus ostreatus) Waste Powder : Its Influence on Growth and Meat Quality of Broiler Chickens (Gallus gallus domesticus)”.

1.1. Objectives of the Study

The primary objective of this study was to evaluate the growth performance (body weight, feed intake, feed conversion efficiency, and average daily weight gain) and meat quality (color, odor, texture, juiciness, and tenderness) of broilers fed with supplemental levels of mushroom waste powder in the diets.

1.2. Research Hypothesis

Mushroom powder levels have no effect on the body weight, feed intake, feed conversion efficiency.

2. Materials and Methods

2.1. Time and Place of the Study

The study was conducted at Sitio Daro, Barangay Poblacion, Claveria, Misamis Oriental, Philippines. This work lasted for a period of three months, from December 2014-March 2015. This period covered all activities in the study ranging from preliminary data/information gathering, like an interview with the Misamis Oriental State College of Agriculture and Technology – Korea International Cooperation Agency (MOSCAT-KOICA) personnel, paper proposal writing and defense, construction of birds’ house/cages, actual experimentation and final defense of the manuscript. The actual experimentation w covered 38 days which was also the rearing period of broiler chicken in the study.

2.2. Facilities and Other Equipment

The study utilized the following equipment: brooding cages and rearing pens, electric bulbs, weighing scales (macro and micro), plastic waterers and feeding troughs, news paper beddings, laminated sacks, oven drier, oven trays, net bags and mechanical/manual grinders.

2.3. Experimental Animals

A number of 100 broiler chicks of one day old, were purchased from commercial farm and had been initially reared for 10 days as a brooding stage. Only 72 heads of purchased chicks had been subjected to study as experimental birds. The other 28 heads served as allowance to ensure the required numbers of experimental chicks were met in cases other chicks died during rearing period. The experimental birds were randomly assigned to different treatments as stated. Broilers chicks were housed in 24x24 inches cages in which each cage was considered as one replication consisting four birds. Initial weighing was done after brooding and before assigning or feeding with experimental treatments, or this was simply 10 days. Weights were monitored every seven days up to four weeks or this was equivalent to 28 days treatment feeding period.

2.4. Experimental Housing and Cages

The birds were housed in an unused poultry building owned by Mr. Nelson B. Tomomnglay, at Sitio Daro, Barangay Poblacion, Claveria, Misamis Oriental, Philippines. There were two back-to-back Siamese twin pens consisting nine small subdivisions as cages constructed for this purpose. A floor space requirement of one square foot /bird.

2.5. Mushroom Waste Powder

The mushroom waste powder (MWP) was a powder preparation from mushroom waste produced from the Misamis Oriental State College of Agriculture and Technology – Korea International Cooperation Agency (MOSCAT-KOICA) mushroom production project. Mushroom wastes were mainly composed of the stem base of the oyster mushroom (Pleurotus estreatus) which was dried and has been grounded into powdered form. The proximate analysis of the mushroom waste powder used in the study was analyzed by the Regional Standards and Testing Laboratories, Department of Science and Technology X, Cagayan de Oro City, Philippines and is given in Table 1.

Table 1. Proximate analysis of mushroom waste powder used in the present study

Parameters	Method Used for Chemical Analysis	Result,%
Crude Protein	Official method 976.05, OMA AOAC 18th Ed.	27.11
Crude Fat	Official method 920.39, OMA AOAC 18th Ed.	0.79
Crude Fiber	Official method 962.09, OMA AOAC 18th Ed.	12.54
Ash	Official method 942.05, OMA AOAC 18th Ed.	16.09
Dry matter	Official method 925.23, OMA AOAC 18th Ed.	93.62
Nitrogen Free Extract	Calculation	37.09

2.6. Experimental Treatments and Design

The experiment was carried out in a completely randomized design with three replications with the following dietary treatments: Treatment 1= 0 grams mushroom waste powder (MWP)/kg of feeds; Treatment

2= 5 grams MWP/kg of feeds; Treatment 3= 10 grams MWP/kg of feeds; Treatment 4= 15 grams MWP/kg of feeds; Treatment 5= 20 grams MWP/kg of feeds; and Treatment 6= 25 grams MWP/kg of feeds. The birds were reared in an *ad libitum* drinking and feeding for a period of 38 days.

Table 2. Proximate analysis and composition of different treatments used in the study at the first week of feeding experiment using chick boaster mash

Treatment #	Mushroom, g/kg	Crude Protein,%	Crude Fat,%	Crude Fiber,%	Ash, %	Dry matter,%	NFE,%
1	0	22.000	4.000	5.000	10.000	88.00	47.00
2	5	22.025	3.984	5.038	10.030	88.043	46.97
3	10	22.051	3.968	5.075	10.060	88.085	46.93
4	15	22.076	3.953	5.111	10.090	88.127	46.90
5	20	22.100	3.937	5.148	10.119	88.169	46.87
6	25	22.125	3.922	5.184	10.149	88.210	46.83

Table 3. Proximate analysis and composition of different treatments used in the study at 2nd week of feeding experiment using chick starter crumble

Treatment #	Mushroom, g/kg	Crude Protein,%	Crude Fat,%	Crude Fiber,%	Ash,%	Dry matter,%	NFE,%
1	0	20.000	4.000	6.000	10.000	88.000	48.888
2	5	20.035	3.984	6.033	10.030	88.043	47.961
3	10	20.070	3.968	6.065	10.060	88.085	47.922
4	15	20.105	3.953	6.097	10.090	88.127	47.882
5	20	20.139	3.937	6.128	10.119	88.169	47.846
6	25	20.173	3.922	6.160	10.149	88.210	47.806

Table 4. Proximate analysis and composition of different treatments used in the study at 3rd to 5th week of feeding experiment using chick grower crumble

Treatment #	Mushroom, g/kg	Crude Protein,%	Crude Fat,%	Crude Fiber,%	Ash, %	Dry matter,%
1	0	16.00	3.000	8.000	10.000	88.00
2	5	16.06	2.989	8.023	10.030	88.043
3	10	16.11	2.978	8.045	10.060	88.085
4	15	16.16	2.967	8.067	10.090	88.127
5	20	16.22	2.957	8.089	10.119	88.169
6	25	16.27	2.946	8.111	10.149	88.210

2.7. Lay-out of Experiment and Random Assignment of treatments into Different Cages

The lay-out of the experiment follows the lay-out and design of the Housing Experiment. A built-in back-to-back identical Siamese twin pens consisting nine small subdivisions as cages was constructed inside the birds' house. Based on this condition, the lay-out of experiment with corresponding random assignment of treatments to different cages was given as follows:

T6R1	T1R2	T4R3	T6R2	T3R1	T5R1	T4R1	T6R3	T2R1
T3R3	T2R3	T5R2	T1R1	T4R2	T2R2	T3R2	T1R3	T5R3

Figure 1. Pen and experimental lay-out following a Completely Randomized design with six treatments in three replications

2.8. Preparation of Mushroom Waste Powder

Mushroom Waste Powder (MWP) was prepared out from the mushroom stem base and rejects from MOSCAT-KOICA mushroom production project. The mushroom waste was collected every after harvest which has been weighed, placed into net bags and subsequent air/sun drying was done. When a considerable amount of water was lost after sun drying, mushroom waste was subjected to oven drying to completely remove the water. A 60 degree Celsius was observed upon oven drying and the process was stopped when samples showed a stable weight. The oven-dried mushroom waste was grounded/crashed using feed grinder to particle size diameter resembles that of the particles of commercial feeds where it was mixed with. The resulting mushroom waste powder was placed in an air-tight transparent container for storage for the time being before it was mixed into the basal feeds. Proximate analysis of mushroom waste powder (MWP) was performed by DOST –X Regional Laboratory.

2.9. Proximate Analysis of mushroom Waste Powder (MWP)

A minimum of 250 grams of mushroom waste powder was submitted to Department of Science & Technology Regional Standards and Testing Laboratories, Region 10 for proximate analysis. The contents of the sample analyzed include dry matter, crude protein, crude fat/lipid, crude fiber and total ash which were analyzed according to the fallowing laboratory methods; Official method 925.23, OMA; AOAC 18th Ed., Official method 976.05, OMA AOAC 18th Ed.; Official method 920.39, OMA, AOAC 18th Ed.; Official method 962.09, OMA AOAC 18th Ed.; and Official method 942.05, OMA AOAC 18th Ed. respectively. The Nitrogen-free extract (NFE) was be obtained by computation using the following formula:

$$\%NFE = \%\ DM - \left(\begin{array}{l} \%\text{Crude protein} + \%\text{Crude Fat} \\ +\%\ \text{Crude Fiber} + \text{Ash} \end{array} \right).$$

2.10. Mixing of Mushroom Waste Powder and Commercial Feeds

Commercial feeds and mushroom waste powder were mixed manually according to the treatments of the study. The mixing was done every week so that the amount of feed mixture was enough to cover the feed budget in a week. The mixture was placed in a plastic bag doubled with a sack and was properly tightened so that air comes out from the bag to preventing decomposition of feeds.

The proximate analysis of the mixture was computed based on the percentage composition and weight of mushroom to commercial feed ratio. This was given as follows:

$$\%\ PAM = \left\{ \left[(\ WM)(\%PAm) \right] + \left[(\ WCF)(\%PAf\ ) \right] \right\} / \ M$$

Where % PAM =Proximate analysis Component of feed mixture; WM = weight of mushroom in feed mixture; %PAm= proximate analysis of mushroom; WCF= weight of commercial feeds in feed mixture ; PAf = proximate analysis of commercial feed ; and M=total weight of feed mixture. Weight of component was expressed in the same unit, likewise, concentrations were in the same unit as well.

2.11. Brooding Management

The initial weights of chicks were recorded before placing them in a brooding pen. The brooding area was thoroughly cleaned and disinfected prior to the arrival of chicks to eliminate possible pathogenic organisms that may cause disease(s). The birds were brooded into two separate pens containing suspended bulbs, water and feeding troughs. Water and feeds were provided in ad libitum feeding and drinking system. After 10 days, birds were transferred to experimental pens and cages, then the experimental feeding commenced.

2.12. Rearing Management

After brooding, the birds were weighed before putting into the experimental cages, and then the experimental feeding was started. The cages were installed with feeding devices, drinking troughs, and lighting facilities. Feeding management system was varied based on the proposed treatment of the study, while other factors were on ceteris paribus. The feeds and water were supplied in ad libitum. Newspapers were laid out on the floor cages as litter bed and for feed waste collection. A sanitation was observed at all times in the birds' house. All materials and surrounding were cleaned regularly. Litters and manures were kept properly to keep insects, particularly flies from hovering around which could be a possible carrier of the animal disease. All sides of the bird house were installed with rollable tent wall to prevent the birds from chilling during cold temperature, especially during rainy and cold night temperature.

2.13. Feeding Management

On the brooding stage all birds were fed the same diet. Feeding transition was observed every change of diet at 75/25, 50/50, 25/75 and 0/100 old to new diet ratio for four days. Experimental diet, except the control (treatment 1), were prepared weekly for one week feeding budget. Feed mixture was tended properly by placing in sealed containers to prevent from hygroscopic moisture absorption, animal intrusion and decomposition. Apart from feeds, water was made available in ad libitum.

2.14. Data Collection Procedure

Measurement of body weight data was done in different periods. Individual weight of day- old chicks was noted. Another weighing was performed after brooding as an initial weight of chicks before the administration of the treatments. Weighing thereafter was done every seven - day interval to assess the weight progression as affected by the treatments. The weights were recorded in grams in 2 decimal places. The accumulated and weight increase per week was recorded.

Weekly feed intake was computed by subtracting the remaining feeds from the total amount of feeds given in a week. This was given as follows:

$$\text{Feed Intake }(\text{FI}) = \text{Total Feeds served} - \text{Remaining feeds.}$$

Feed Conversion Ratio/Efficiency was computed side by side or in parallel with body weight and feed intake data. There was weekly feed conversion ratio/efficiency, as well as, the final feed conversion ratio. This data was computed as follows:

$$\text{FCR } = \frac{\text{Total amount of feed consumed}}{\text{live weight produced}}.$$

Average Daily Gain in weight was likewise computed side by side with body weights and feed consumption data. There was weekly ADG and final ADG. This was computed as follows :

$$\text{ADG } = \frac{\text{Total weight gained}}{\text{number of days}}$$

$$\text{or } \frac{\text{End weight} - \text{Beginning weight}}{\text{End date} - \text{Beginning date}}.$$

Broiler chicken meat was subjected to a sensory evaluation and assessment to check the effect of Mushroom waste powder on meat quality. A 10 point hedonic scale sensory assessment tool was utilized for this purpose. A meat quality parameters evaluated includes color, taste, juiciness, texture, and tenderness. Fifteen panels of experienced meat and sensory taste evaluator were invited to assess the quality of meat based on pre-determined parameters. The 10 –point hedonic scale assessment tool matrix was given to the evaluators at least two days before the final judging. However, before the assessment started, a short orientation was conducted for leveling about the assessment matrix. The meat was evaluated in steamed-cooked condition. During judging, the panels were provided with water to rinse their tongues every after and before testing the other samples. Sensory taste evaluation for a stemmed meat used anatomical breast cuts as an observation unit.

2.15. Statistical Analysis

Analysis of variance and co-variance were employed to assess the test for the general significant difference;

furthermore, the Tukey studentized range test was used to compare treatment means differences. The trends and behavior of the dependent variables were also observed and investigated using the regression analysis using spreadsheet excel 2007.

3. Results and Discussion

Weight data in Table 5 were the accumulated average weights including the initial weights of broiler chickens.

Table 5. Accumulated average weight of broiler chickens fed with varying levels of mushroom waste powder supplements in their diet at seven-weight sampling periods

Treatment g MWP/kg feed	6days g	10 days g	14 days g	18 days g	21 days g	24 days g	28 days g
0	647.92	926.67	1151.25	1357.54	1538.79	1738.80	1935.10
5	675.00	947.50	1172.50	1339.30	1533.29	1702.63	1973.80
10	669.42	970.83	1195.00	1393.43	1600.92	1790.21	2034.80
15	665.42	958.75	1200.83	1361.27	1533.62	1750.68	1968.30
20	658.33	965.83	1195.00	1386.24	1561.94	1797.15	2002.60
25	644.17	935.83	1171.67	1387.17	1552.02	1791.05	1999.40
c.v., %	5.40	5.70	9.21	8.90	8.70	9.20	13.18
Pr>F	0.64	0.60	0.39	0.82	0.48	0.37	0.76

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

Results of the statistical analysis showed that there were no significant differences (P>0.05) on the weekly weight of broiler chickens fed with addition levels of mushroom waste powder at all weight sampling periods. This finding agreed with the result of a study conducted by Fard, which reported that 1%mushroom waste inclusion not significantly increase body weights of broiler chickens [7]. However, as reflected in Figure 2, there was a positive and consistent increased in body weights of broiler chickens (though not significant) as manifested by a positive slopes between the levels of mushroom waste powder and accumulated body weights starting from the 10days up to 28 days after feeding the broilers with mushroom waste powder supplements. Another interesting to note was the decreased in body weights of broiler chickens 6 days after feeding with mushroom supplements. This finding indicates that mushroom might decrease the weights of broiler chickens at an early age as reflected by a negative slopes (y = -0.415x + 665.2) between mushroom waste powder and accumulated body weights at 6 days after the start of feeding with MWP. On the other hand, MWP gradually improved the body weights as the broilers grow from 10days to 28days after the start of feeding experiment as manifested by positive slopes between MWP levels and accumulated body weights on Figure 2.

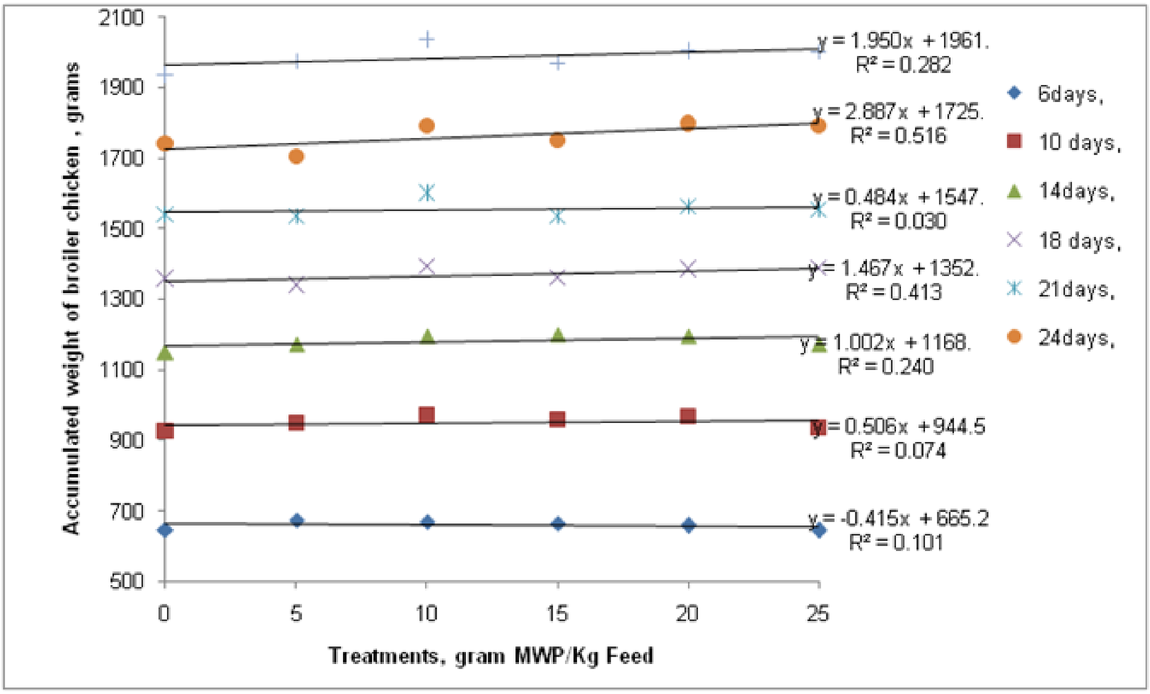

Figure 2. Regression lines and coefficients of broiler accumulated weight from supplemental feed levels of mushroom waste powder at different weight-sampling periods

The accumulated body weight of broiler chickens at column 28 days in Table 6 showed that addition of MWP slightly increased where all MWP-fed broilers outweigh the weight of no MWP-fed broilers. The highest body weight increase was observed at 10 grams MWP/kg feeds and lowest at 0 grams MWP/kg of feeds. However, this increase was not enough to post significant differences among body weight differences between treatments.

Table 6. Accumulated average weight increase of broiler chickens fed with varying levels of mushroom waste powder supplements in the diet at seven-weight sampling periods disregarding initial weights

Treatment g MWP/kg feed	6days g	10 days g	14days g	18 days g	21 days g	24 days g	28 days g
0	318.92	597.67	822.25	1028.54	1209.79	1409.80	1606.1
5	323.67	596.17	821.17	987.97	1181.95	1351.30	1622.4
10	338.58	640.00	864.17	1062.59	1270.09	1459.37	1704.0
15	319.50	612.83	854.92	1015.36	1187.70	1404.77	1622.4
20	310.83	618.33	847.50	1038.74	1214.44	1449.65	1655.1
25	310.25	601.92	837.75	1053.25	1218.10	1457.13	1665.5
c.v., %	14.26	9.70	13.58	9.40	9.09	9.80	15.24
Pr>F	0.76	0.63	0.46	0.66	0.32	0.28	0.72

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

Although statistics is not able to detect significant differences between body weight increases, however, Figure 3 indicates that there was some positive relationship between MWP levels and accumulated body weight increase as manifested by positive slopes on period 10days up to 28 days from the start of feeding experiment. Research conducted with young birds, however, have shown that the inclusion of moderate amounts of some fiber sources in the diet might stimulate GIT development and HCl and enzyme production and eventually, benefit digestive physiology and growth performance in broilers [8].

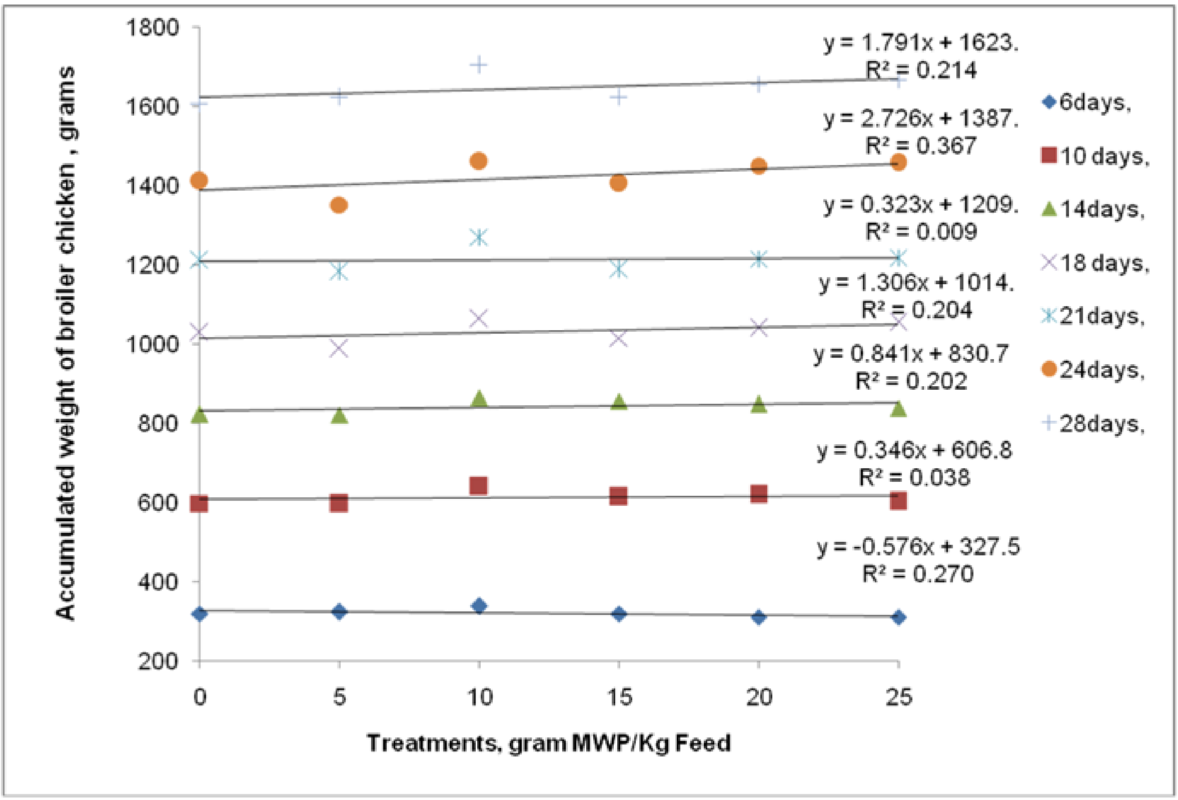

Figure 3. Regression lines and coefficients of broiler accumulated weight from supplemental feed levels of mushroom waste powder at different weight-sampling periods

Another important observation in here was the decrease in accumulated body weights of broiler at an early stage of growth as it was observed with a negative slope on 6days from the start of feeding experiment. The decrease in body weights at an early age maybe attributed to the total amount of dietary fiber of the ration. Considering MWP to have the high crude fiber of 12.57% (Table 1), eventually its addition to basal commercial feed diet would certainly increase the fiber content. On Table 2, which presents the calculated proximate analysis of feeds served to broiler at an early stage on different treatments showed that crude fiber from treatment 1,2,3,4,5 and 6, are 5, 5.038, 5.075, 5.111, 5.148 and 5.184, respectively. These values are fairly high for younger broiler chickens. According to Mateos, et. al, 2013, commercial diets, especially those for young poultry, are formulated to contain less than 3-4% crude fiber.

Table 7 presents the feed consumption of broiler chickens fed with supplemental levels of MWP in diets at different sampling periods. It was found out that there were significant differences ($p< 0.05$) on the feed consumption at 6, 14, 18, 21, and 28 days after the start of feeding with MWP.

Table 7. Feed consumption of broiler chickens fed with supplemental levels of mushroom waste powder in diet at different sampling periods

Treatment, gMWP/kgFeed	6days (g)	10days (g)	14days (g)	18 days (g)	21days (g)	24days (g)	28days (g)
0	486.35ab	942.58	1430.08ab	1972.90b	2436.90bc	2941.10	3662.99ab
5	497.34a	975.00	1469.17a	1997.66a	2489.25a	2996.86	3735.33a
10	490.01a	970.50	1458.42a	1996.15a	2479.56ab	2989.32	3703.32ab
15	478.13ab	949.26	1461.34a	1990.17a	2440.25bc	2952.84	3635.32b
20	496.29a	967.89	1463.30a	1987.55a	2428.09cd	2968.82	3672.89ab
25	461.94b	915.26	1404.43b	1943.68c	2388.40d	2919.18	3627.76b
c.v., %	2.70	3.30	1.80	0.52	1.02	1.02	1.25
Pr>F	0.05	0.36	0.02	0.01	0.04	0.13	0.06

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

After 6 days from the start of feeding with MWP, highest feed consumption was observed in chickens fed with 5 gramsMWP/kg of feeds (T2), however it does not vary significantly with the rest of the treatments, except to 25gramsMWP/kg feeds (T6). Broiler chickens assigned to T6, exhibit the lowest feed consumption which differs and significantly lower compared to that of broilers fed with 5, 10,and 20 grams MWP/kg feeds.

Observing keenly on the feed consumption of the MWP-fed broiler chicken group in Table 7, it decreases with the increase in MWP. However a significant decrease (p=<0.05) becomes more evident if treatment was increased to 25gramsMWP/kg feeds (2.44%MWP). This finding is concordant with the result of a study conducted by Fard, et.al., 2014 that using 2 % Oyster mushroom waste deteriorated body weights of broiler chickens.

Figure 4 presents the trends of feed consumption of broilers against levels of MWP in feeds across different sampling periods. It was so clear that the relationship between levels of MWP and feed consumption was negatively related as it was manifested with negative slopes of all it lines from different sampling periods.

Another interesting to note here is the increasing negative values of slopes as the broiler chickens get older. This implies that the effect MWP on feed consumption, though significant already, becomes more evident as the chickens get older up to 28 days of feeding, as in the case of this study.

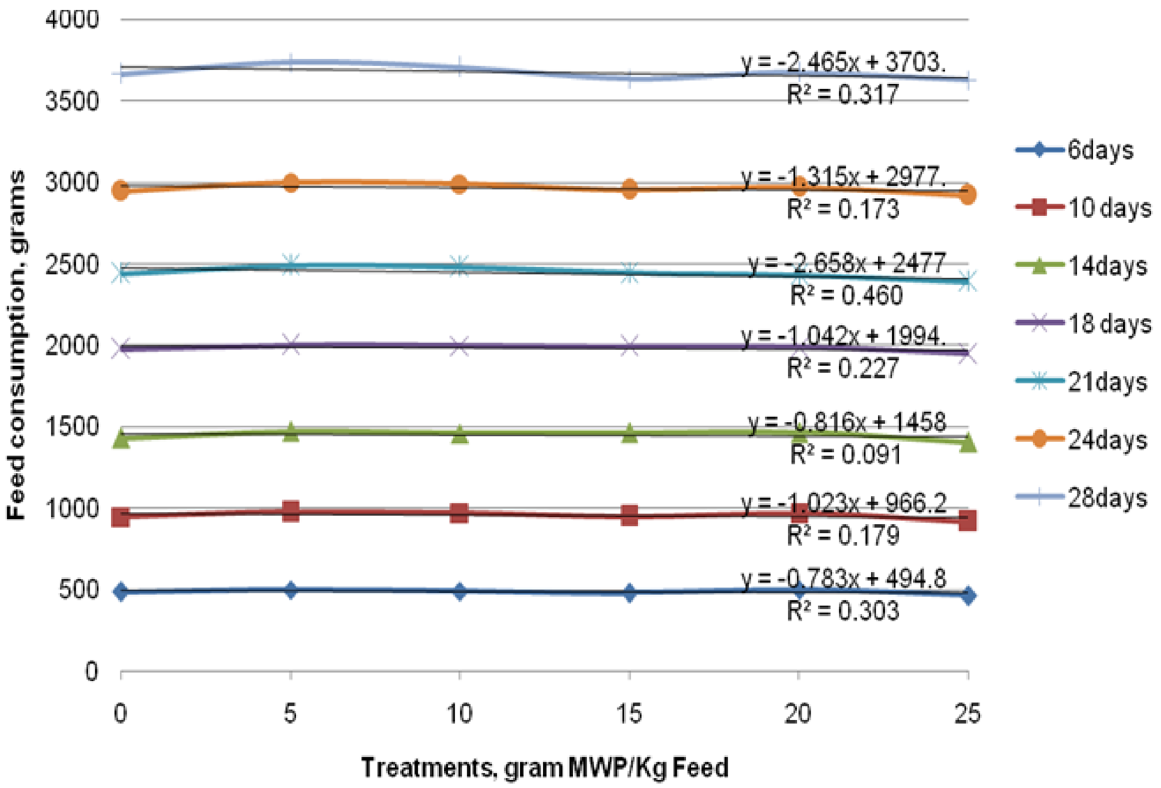

Figure 4. Regression lines and coefficients of Feed consumption of broiler chickens fed with supplemental levels of mushroom waste powder in their diet at different sampling periods

Analysis of variance of feed conversion efficiency showed no significant differences between treatment means as affected by MWP additions as shown in Table 8. However, the general trend of FCE is decreasing as the amount of MWP supplementation was increased from 0 to 25 grams MWP per kilogram of feeds. This behavior can be clearly observed in Figure 5 showing the FCE trend lines of negative slopes. This implies that feed efficiency slightly improved with an added increase of MWP. This finding agreed with the findings of Giannen (I, Pappas and Mavridis), et. al, 2009, which reported that that dietary mushroom supplementation at both inclusion levels was accepted well by the broiler chicken and improved feed efficiency compared with the control diet.

Table 8. Feed conversion efficiency (FCE) of broiler chickens fed with supplemental levels of mushroom waste powder on their feed ration at different sampling periods

Treatment, gMWP/kgFeed	6 days	10 days	14 days	18 days	21 days	24 days	28 days
0	1.57	1.60	1.77	1.96	2.05	2.13	2.32
5	1.60	1.67	1.82	2.05	2.13	2.24	2.33
10	1.46	1.53	1.70	1.90	1.98	2.07	2.19
15	1.54	1.59	1.75	2.01	2.08	2.13	2.28
20	1.60	1.57	1.74	1.92	2.01	2.07	2.23
25	1.52	1.54	1.70	1.86	1.98	2.03	2.21
c.v., %	4.83	11.77	8.55	12.29	8.68	7.83	11.23
Pr>F	0.83	0.72	0.82	0.21	.17	0.88	0.74

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

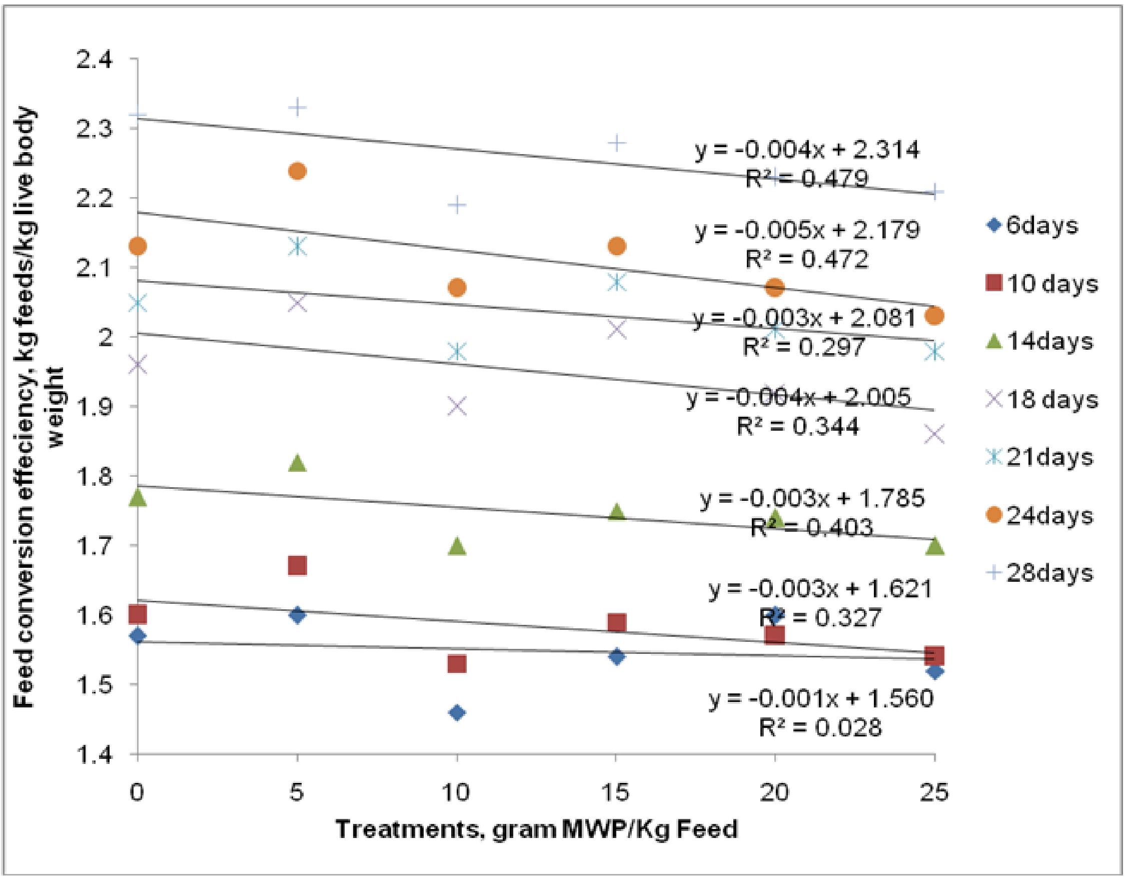

Figure 5. Regression lines and coefficients of feed conversion efficiency (FCE) of broiler chickens fed with supplemental levels of mushroom waste powder on their feed ration at different sampling periods

Analysis of variance for average daily gain in weight revealed that no significant differences were observed between treatments across all sampling periods as show in Table 9. This finding conforms to findings of Mahata, et. al, that supplementation of oyster mushroom at 0, 1, 2,3 & 4% in the diet did not affect the ADG of broiler chickens. However, noting its general behavior in Figure 6, ADG in weight improved slightly over time. This is manifested by a negative slope of its trend line at the first week of feeding (after 6 days), then slightly increase to positive slopes over time. However, this improvement was not enough to post significant differences (p>0.05)between. Highest ADG was posted at 10 days of feeding with MWP supplementation.

Table 9. Average daily gain in weight (ADG) of broiler chickens fed with supplemental levels of mushroom waste powder on their feed ration at different sampling periods

Treatments, gMWP/kgFeed	6days (g)	10 days (g)	14days (g)	18 days (g)	21days (g)	24days (g)	28days (g)
0	45.56	59.77	58.73	57.14	57.61	58.74	57.36
5	46.24	59.62	58.65	54.89	56.28	56.30	57.94
10	48.37	64.00	61.73	59.03	60.48	60.81	60.86
15	45.64	61.28	61.07	56.41	56.56	58.53	57.94
20	44.40	61.83	60.54	57.71	57.83	60.40	59.11
25	44.32	60.19	59.84	58.51	58.00	60.71	59.48
c.v., %	15.69	11.04	6.89	11.01	7.18	7.79	10.04
Pr>F	0.70	0.56	0.90	0.56	0.55	0.50	0.92

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

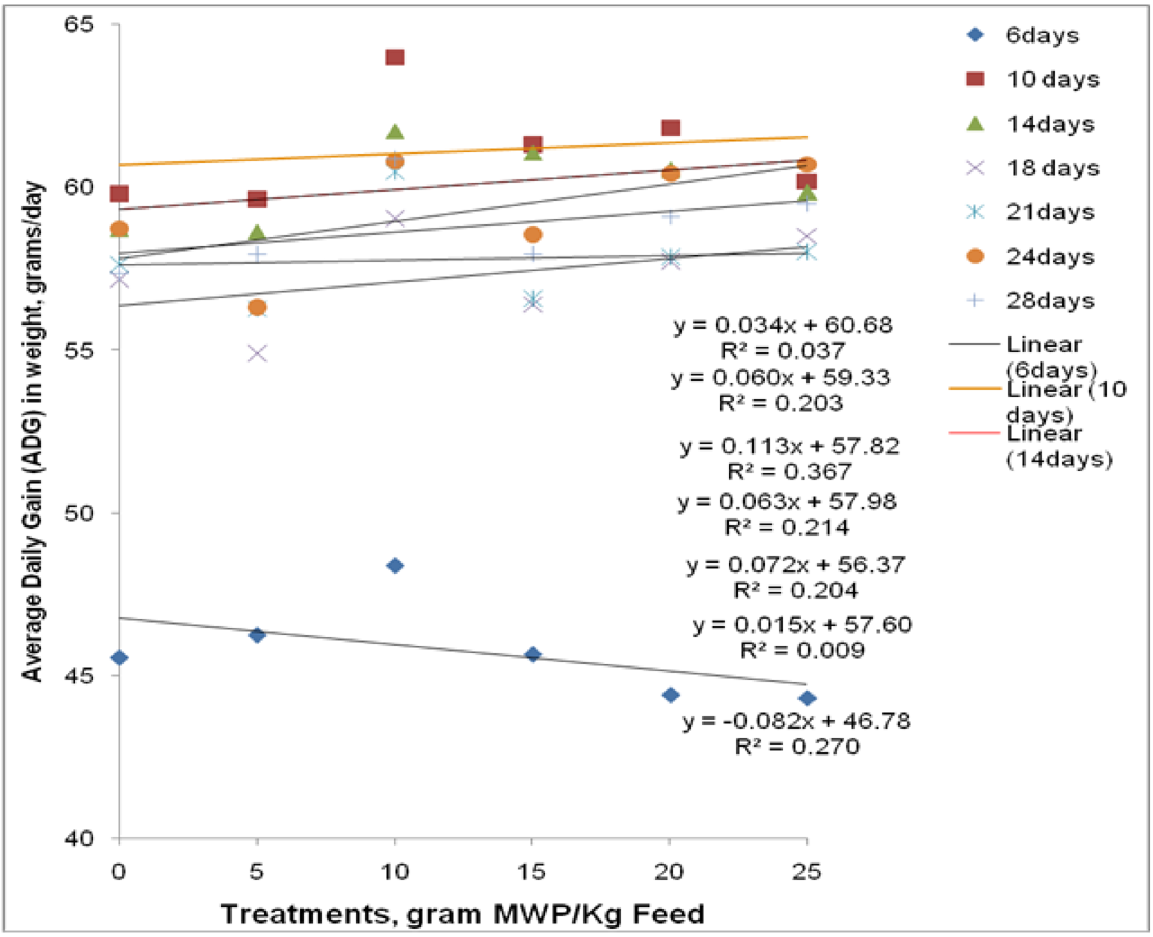

Figure 6. Regression line and coefficients of average daily gain in weight (ADG) of broiler chickens fed with supplemental levels of mushroom waste powder on their feed ration at different sampling periods

Stem cook with no seasoning breast cuts of broiler chickens was used as a sampling unit for sensory evaluation on the effect of the treatments to meat quality. A labeled 10-point hedonic scale was used as an evaluation instrument/tool to rate different meat quality parameters.

Table 10 revealed that there are some significant variations in meat quality in terms of texture (P>0.0017), tenderness (p>0.0001), taste (p<0.049) and general acceptability (p<0.0018); while no significant differences were observed on color and odor where probability values are greater than 0.05 alpha level of significance.

Table 10. Meat quality evaluation rating of broiler chickens based on a 10-point hedonic scale rating as affected by Mushroom waste powder supplementation levels on diet.

Treatment, gMWP/kgFeed	Color	Odor	Texture	Juiciness	Tenderness	Taste	Accep-tability
0	7.111	6.956	6.911ab	7.244	7.200a	7.111a	7.200ab
5	7.311	7.000	6.667b	6.822	6.022b	6.844b	6.733b
10	7.400	7.600	7.778a	7.689	7.667a	7.644a	7.956a
15	7.533	7.089	7.533ab	7.356	7.400a	7.422a	7.378ab
20	7.600	7.133	7.533ab	7.311	7.222a	7.311a	7.400ab
25	7.778	7.444	7.578a	7.622	7.711a	7.644a	7.667a
c.v., %	18.69	18.77	20.09	20.99	25.22	19.10	19.02
Pr>F	0.28	0.14	0.0017	0.110	0.0001	0.049	0.0018

Note: Probability values (Pr>F) greater than 0.05 α, are considered no significant difference between treatment means. Means having common letter notation are considered the same by Tukey studentized range test.

The texture quality of broiler meat fed with 5 grams MWP (T) per kg of feeds showed a lowest sensory rating and it varies significantly compared to broilers fed with 10 and 25 grams of MWP per kg of feeds. The remaining treatments do not vary significantly.

There are significant differences observed on tenderness level of broiler meat quality, however, most of the MWP-fed chickens does not differ significantly with the control treatment, except for treatment 2 (5 grams MWP) which is significantly lower compared to the rest of treatments.

The taste quality of broiler meat fed with 5 grams MWP/kg is significantly lower compared to rest of the treatments, the remaining treatments does not vary significantly.

The general acceptability of broiler meat quality also differed significantly. However, MWP-fed broilers do not vary significantly compared to the control (0 grams MWP). Significant variations were observed within the MWP-fed group. The lowest general acceptability rating was observed on broilers fed with 5 grams MWP/kg of feed, which significantly different compared to broilers fed with

10 and 25 grams of MWP per kg of feeds. The general acceptability of the remaining treatments does not vary significantly.

Although most of the MWP-fed broilers, except in treatment 2, do not vary significantly with the rest of the treatments, a slight increase in quality rating was observed in all parameters. The trends of meat quality are towards a higher rating as manifested by a positive relationship in Figure 7 between meat quality and MWP level.

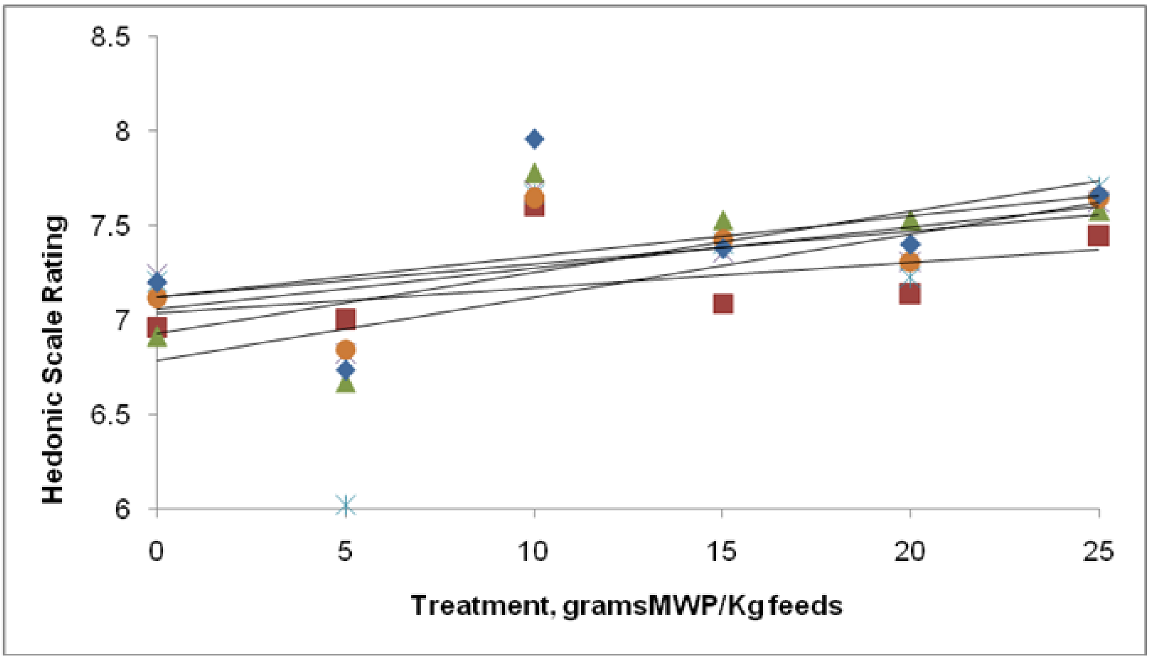

Figure 7. Regression trend lines of broiler chicken meat quality parameters as affected by mushroom waste powder supplementation on diets

4. Conclusion and Recommendations

The study revealed that MWP levels of supplementation in the diet does affect significantly ($p>0.05$) the body weights of broiler chickens. It has a slight negative effect on body weights at an early stage of age, however, its effect improves slightly over time (as the animals get older) as manifested by increasing positive slopes at different periods of weight sampling.

The feed consumption varies significantly between at 1st, 2nd, 3rd and 4th week of treatment feeding periods. Most MWP-treatment does not vary significantly with the control treatment, except in 3rd week where feeding broilers with 5 grams per kilogram of feed (T2) has the highest and significantly different to control (o grams MWP), 20 grams MWP/kg feed (T5) and 25 grams MWP/kg feed (T6). Generally, within this study, feed consumption varies negatively with an increase in MWP levels in the basal diet.

Because body weights of broiler chickens slightly increase with MWP levels in basal diet over time, while feed consumption decreases with MWP levels in basal diets over time, consequently, it is expected that FCE would likely to improve slightly over time. It is really what this actual study has shown. Though no significant variations were detected in ANOVA for this parameter between treatments across different periods, however, FCE over time slightly improved as shown by the increasing magnitude of negative slopes across a period of samplings. This further implies that the effect of MWP on FCE becomes distinct and clearer as the broilers get older within the period of this study.

Because body weights of broiler chickens slightly increase with MWP levels in basal over time, it should follow that average daily gain in weight would increase. This is what really happens on the ADG of broiler chickens in this study. During the early age of feeding MWP at 6 days from the start of feeding, there is a decrease in ADG with an increasing amount of MWP as manifested by negative slopes in this period. Eventually, ADG slightly improves over time as shown by its increasing positive slopes and shift-in-line above previous periods' trend lines.

Table 10 revealed that there are some significant variations in meat quality in terms of texture ($P>0.0017$), tenderness ($p>0.0001$), taste ($p<0.049$) and general acceptability ($p<0.0018$); while no significant differences were observed on color and odor where probability values are greater than 0.05 alpha level of significance. Although most of the MWP-fed broilers, except in treatment 2, does not vary significantly with the rest of the treatments, a slight increase in quality rating was observed in all parameters. The trends of meat quality were towards a higher rating as manifested by a positive relationship in Figure 7 between meat quality and MWP level.

As it was observed from the regression lines of all dependent variables of this study that all have improved slightly with the addition of MWP over time, the author suggested that another study should be conducted varying the time or period of administration within the growing or rearing period of broiler chickens. It is also recommended that mushroom waste powder study is conducted on layer chickens to capitalize its good effect over time of feeding. Because analysis of variance does not look into the relationship and the movement of dependent variables as the independent variable being varied, it is also suggested that correlation and regression analysis be conducted on the same and/or another study.

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