Assessing Spent Mushroom Substrate as a Replacement to Wheat Bran in the Diet of Broilers

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Abstract

This study investigates the use of spent (used) mushroom substrate (SMS) as a replacement to wheat bran on broiler performance. Five diets were formulated such that diet I with 0% SMS served as the control while for diets II-V wheat bran was replaced with SMS at graded levels of 25, 50, 75 and 100% respectively. One hundred and fifty broilers were randomly assigned to the dietary treatment replicated thrice and lasted for eight weeks. Results showed that at both starter and finisher phases the feed intake increased as the SMS inclusion increased. The body weight gained of those fed with diets I and II were significantly P<0.05 higher than others at starter phase. While at finisher phase, those fed with diets I and II were significantly P<0.05 lowered than others. The feed conversion ratio (FCR) adjudged diets I and II better than other diets at starter phase whereas diet I was better than other diets at the finisher phase. Carcass cuts showed that dietary treatment does not significantly P>0.05 affect the breast, thigh drumstick, back, neck, wings and shoulder. Mortality that occurred at the starter phase could not be linked to the dietary treatment. Conclusively SMS could replace wheat bran in broilers production.

Keywords: spent mushroom substrate, wheat bran, broiler performance, feed intake, starter and finisher phases

Introduction

The expansion of the mushroom industry is a global phenomenon; its world aggregate production in 2011 was 7698773 tons FAO [1] and production is still on the increase especially with the increase campaign on health, nutritional and medicinal benefits Adedokun and Akuma [2]. Mushrooms are produced on natural materials taken from agriculture, woodlands, animal husbandry, and manufacturing industries. . Production of mushrooms however is accompanied with the generation of millions of tons of residue refer to as spent or used mushroom substrates (SMS/UMS) which remains after the mushroom crop has been harvested Rinker [3]. The annually renewable agricultural residues represented an abundant, inexpensive and readily available source of renewable lingo-cellulosic biomass as reported by Azubuike and Okhamafe [4]. The major ingredients in mushroom growing are typically recycled agricultural waste products and other materials which include hay, straw, horse bedding, poultry litter, corn cobs, corn stover, cotton seed meal, cocoa hulls in various amounts and proportions.(Chang and Miles [5];Stamets [6]. After a cropping cycle has been completed and the substrate has been depleted of nutrients needed for growing mushrooms, the substrate is removed from the production facility and discarded. SMS is the soil-like material remaining after a crop of mushrooms. Spent substrate is high in organic matter consisting of decomposed plant, animal and fungal residues and materials making it desirable for use as a soil amendment or soil conditioner even in land reclamation Rupert [7]; Davis et al [8]; Lemaire et al[9]; Lohr et al [10]; Rinker [3];Wang et al.[11];Wuest et al[12]). In a report by Rinker [3], used mushroom growing substrates are far from spent and can be put to various other uses. Spent substrate is the choice ingredient by those companies making the potting mixtures sold in supermarkets or garden centers. Most of the needed ingredients for chicken feed are not locally available and have to be imported according to Shaiful [13].

This has necessitated the search for cheap feed ingredients by animal scientists and nutritionists and the research torchlight is now being directed to use of wastes such as spent mushroom substrate in poultry feeding. Fasidi and Kadiri [14] reported that utilizing sawdust as compost for growing agricultural products like mushroom can help in ameliorating environmental hazards caused by sawdust. Mushroom has been found to have some nutritional values that can enhance the growth and performance of broiler chickens and human beings in general.(reference) This study investigates the potential use of spent mushroom substrates (SMS) as an alternate feed resource for livestock.

Materials and Methods

SMS for *pleurotus ostreatus* was from the University of Port-Harcourt Faculty of Agriculture Mushroom Farm. *pleurotus ostreatus* was cultivated on sawdust substrate, the mycelia was allowed to ramify the substrate for a period of 4 weeks, the mushrooms were harvested and the spent growing substrate was harnessed as possible feed resource in broiler production. The spent substrate was pasteurized by autoclaving to eliminate germs, weeds or insect. Five diets were formulated such that the wheat bran was substituted at graded levels of 0, 25, 50 75 and 100% with the SMS. Weekly average feed intake was recorded by subtracting feed left over from quantity of feed given. Weight gain was recorded on weekly basis by subtracting previous body weight from the current body weight for each week. Average daily gain and cost of feed per kg gain were calculated. Mortality was also recorded as it occurred.

Experimental design: The experiment was carried out in a Completely Randomized Design (CRD). Treatment (Diet) was handled in three levels with three replicates.

The model used was :

$Yij = \mu + ti + €ij$

Where:

Yij = Observed effect of the treatment on the performance of the birds
μ = Population mean
ti = Treatment effect
$€ij$ = Error term associated with the observations

Assumptions: The error terms are randomly, independently and normally distributed with a mean, zero and a common variance. The main effects is additive.

All the data were expressed as mean and standard deviation. The statistical analyses were carried out using the SAS package. Means and standard deviations were calculated according to the standard methods for all parameters. One-way ANOVA was used to determine the differences between means of the experimental groups, accepting the significance level at $P<0.05$ using SAS package [15]

Metabolic Trial

At the 8th week broilers of similar weights from each dietary treatment were separately housed in metabolic cages. Equal quantity of 75g feed was served at 8.00am daily to each bird. The birds were routinely managed. Droppings were collected and weighed daily separated from feed and other extraneous materials then oven dried at 85°C for 48 hours. Weights of wet and oven dried droppings were recorded to calculate the dry matter. The dried samples were kept for chemical analysis according to AOAC [16].

Carcass Analysis

At the completion of the digestibility study two broilers with representative weights were selected from each replicate for carcass analysis. Birds were killed, eviscerated and viscera organs of interest were harvested weighed using the sensitive digital balance (PGW453i-model) and expressed as percentages of the carcass weight.

Chemical Analysis

The proximate composition of the test ingredients, experimental diets and droppings were estimated by the methods of AOAC [16] while the gross energy values of the diets were determined using the bomb calorimeter.

Results

The proximate content of the SMS and Wheat bran is as shown in Table 1.Gross composition of the experimental diets is as indicated in Table 2 while Table 3 reflects the performance characteristics and cost implication of raising the broilers fed with the experimental diets at both phases. Feed intake was influenced as those on SMS consumed more feed than control. The body weight was also significantly P<0.05 influenced. Values recorded varied from 0.58 to 0.63 kg. The feed conversion ratio (FCR) does not have a particular statistical trend. Mortality that occurred was not traceable to diet.

The feed intake (average daily and total feed consumed) were significantly P<0.05 influenced with no particular statistical trend it varied from 1.98 to 2.12kg. The FCR recorded for this study ranges from 2.93 for control and 3.48 for those on diet V. Apparent digestibility result is shown in Table 4. The result of the carcass evaluation is shown in Table 5. Diet IV had the highest cost per kg (#71.65) while diet V had the least cost of #69.27 Cost of feeding a bird was highest for broilers on diet V. The economic data though not subjected to statistical analysis in terms of obtaining maximum profit birds on control was the best.

Table 1: Proximate Composition of SMS and Wheat Bran

Parameters	Wheat bran	SMS
Crude Protein	17.10	7.88
Crude Fiber	11.25	29.57
Ether Extract	2.11	1.71
Ash	6.11	9.92
Nitrogen free extract	63.43	42.85

Table 2: Gross Composition of the Experimental Diets

Ingredients (%)	Starter phase					Finisher phase				
	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
Maize	61.0	60.5	58.8	56.0	54.5	55.5	54.5	53.5	51.5	50.5
Wheat bran	10.0	7.5	5.0	2.5	0	10	7.5	5.0	2.5	0
SMS	0	2.5	5.0	7.5	10.0	0	2.5	5.0	7.5	10
Palm-kernel cake	3.5	3.5	1.2	1.5	0.0	11.0	11.0	9.0	8.0	6.0
Soybean meal	15.0	17.0	19.5	21.0	23.0	14.0	16.0	18.0	20.0	22.0
Fishmeal	6.0	5.0	6.0	7.0	8.0	5.0	4.0	5.0	6.0	7.0
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Oyster shell	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100
Lysine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Crude protein %	22.50	22.48	22.30	22.29	22.24	20.25	20.43	20.45	20.75	20.86
ME kcal	2729.45	2765.35	2751.10	2746.25	2733.95	2624.35	2666.88	2691.40	2693.63	2696.83

2.5kg of Premix contains 12,500,00 iu vit A, 2,500,00 iii Vit D3, 40,000 mg VitE, 2000mg Vitk3 3,000mg vit BI, 5,500mg vit B2 55,000mg Niacin 11,5000mg calcium panthothenate, 5000mg vit B6, 25mg vit B12 1000mg Folic Acid, 800mg Biotin, 500,000mg choline chloride 120,000mg manganese, 100,000mg iron , 80,000mg Zinc, 8500 copper, 1500mg iodine, 300mg cobalt, 120.mg selenium, 120, 00mg Antioxidant

Table 3: Performance Characteristics and Cost Implication of Raising Broilers on the Experimental Diets

Starter phase	I	II	III	IV	V
Initial body weight (kg)	0.040±0.001	0.043±0.001	0.041±0.001	0.042±0.001	0.041±0.001
Average daily feed intake(kg	0.052±0.001^{b}	0.053±0.001^{b}	0.062±0.001^{ab}	0.080±0.002^{a}	0.10±0.002^{a}
Total feed consumed(kg)	1.46±0.01^{c}	1.48±0.01^{c}	1.74±0.02^{b}	2.24±0.02^{b}	2.80±0.03^{a}
Final body weight (kg)	0.62±0.01^{a}	0.63±0.01^{a}	0.60±0.009^{b}	0.60±0.009^{b}	0.58± 0.009^{c}
Feed conversion ratio	2.52	2.52	3.11	4.01	5.19
Mortality%	0±0.00	3.0±0.01	0±0.00	3.0±0.01	3.0±0.01
Finisher phase					
Initial body weight (kg)	0.62±0.01^{a}	0.63±0.01^{a}	0.60± 0.009^{b}	0.60± 0.009^{b}	0.58± 0.009^{c}
Average daily feed intake(kg)	0.21 ±0.006^{c}	0.23 ±0.007^{b}	0.26 ±0.007^{b}	0.30± 0.008^{a}	0.33± 0.09^{a}
Total feed consumed(kg)	5.88 ±0.09^{c}	6.44± 0.10^{bc}	6.60± 0.10^{b}	6.84± 0.10^{b}	7.24± 0.15^{a}
Final body weight (kg)	2.63± 0.06^{c}	2.61 ±0.07^{c}	2.72 ±0.10^{a}	2.68 ±0.08^{b}	2.66 ±0.08^{b}
Feed conversion ratio	2.93	3.25	3.11	3.30	3.48
Cost of feed/kg #	69.31	69.80	70.85	71.65	69.27
Cost of feed per Kg weight gain(#)	203.08	226.85	220.34	236.45	241.06

abc— Values within a row with different superscripts differ significantly at $P<0.05$

Table 4: Apparent Digestibility of Broilers fed with the Experimental Diets

parameters	I	II	III	IV	V	SEM
Dry matter%	65.75	62.35	60.33	63.78	64.89	0.68
Crude protein %	59.65	56.60	57.00	55.90	54.16	0.68
Crude fibre%	62.56	63.45	63.82	62.75	61.76	0.36
Ether extract%	59.77	60.45	59.86	57.86	58.89	0.26
Ash %	72.33	71.56	72.20	71.40	71.66	0.61

abc— Values within a row with different superscripts differ significantly at $P<0.05$

Table 5: Carcass Indices of Broilers fed Experimental Diets

Carcass cuts	I	II	III	IV	V	SEM
Liveweight (g)	2010	1980	2120	2080	2080	70.03
Dressed weight(g)	1631.7	1283	1144	1257	1244	78.30
Dressing %	60.14^{a}	58.14^{a}	56.56^{b}	59.23^{a}	55.25^{b}	1.25
Breast %LW	19.21	18.36	17.86	19.18	17.85	0.68
Thigh % LW	10.36	10.15	10.52	10.06	10.18	0.50
Drum% LW	9.00	10.00	9.43	9.68	9.87	0.33
Back %LW	9.03	7.52	8.28	8.95	7.33	0.42
Neck % LW	6.15	6.05	6.29	6.49	6.00	0.15
Wings%LW	3.78	4.09	4.22	4.24	4.13	0.13
GIT cm	200.3	197.5	206.6	203	206	8.81

abc— Values within a row with different superscripts differ significantly at $P<0.05$

Discussion

The proximate content of the SMS compared with wheat bran revealed that wheat bran has appreciable crude protein value than SMS (Table 1). In all other proximate content wheat bran had higher values than SMS. The gross composition was formulated in such a way to foreclose bias or error. The feed met the nutrient requirement of the broilers. The feeds were isocaloric and isonitrogenous (Table 2).The feed intake at the starter phase indicated broilers took more to satisfy their needs. This is in agreement with Ajala *et al.* [17] who reported decreased nutrient utilization in birds fed with highly fibrous diets. The authors reported a resultant metabolic dysfunction with the attendant weight reduction.

Chicks fed with high fiber diets could have utilized most of available nutrients for maintenance and channeled less nutrients for growth hence the depressed growth. The feed intake and the depressed body weight of the chicks could also be explained with the findings of An [18] who reported that when energy levels dropped below body requirement birds tend to channel the available energy for maintenance which was probably the situation in this study. The higher feed intake of diets 2-5 was not surprising since feed intake in chickens is inversely related to dietary energy concentration. Fiber has been confirmed to have laxative effect; high rate of gastric evacuation in birds is usually compensated by increased feed intake McDonald *et al*. [19]. The term fiber in this context refers to a combination of cellulose hemicelluloses and lignin. It has been reported that high levels of fiber produce adverse effects on the growth performance of non ruminants Longe and Ogedegbe [20], Aderemi *et al*. [21].

At the finisher phase the feed intake also had a similar pattern to the starter phase as those on SMS had values which were significantly ($P<0.05$) higher than those fed control. The increased feed intake of chicks on SMS diets might be attributed to high fibre content of SMS which had diluted other nutrients in the feed. Animal therefore need to eat more to satisfy their energy requirement and similar report had been given by Aderemi *et al*. [21]. The superior body weight gain of broilers on SMS when compared with control could be explained thus; it could be that the heat treatment applied to SMS before its inclusion in the diets helped to improve the heat labile toxic compounds and anti-nutritional factors or even pathogenic compounds in the SMS. Similar to the findings of Khan et al [22] that heat treatment improved texture palatability and nutritive value of legumes. It has been reported that sometimes the physical methods do affect the chemical composition of the feed under treatment. Reece [23] indicated that food intake does not depend on the nutrient composition of feed alone but other factors such as palatability, food texture as well as taste mechanism. Palatability in particular had been shown to influence feed intake and hence overall performance of animals (Holness [24], Jurgens [25]. The term “digestibility” as it is used in animal nutrition refers to the percentage of a nutrient or a feed that is available for absorption and use by the body Schneider and Flatt, [26] and is therefore one of the determining factors of the nutritive value of a feedstuff Schneider and Flatt,[26]; Chung and Baker, [27].

The observed similarity in the digestibility of crude fiber (CF) dry matter (DM) crude protein (CP) ether extract (EE) and even ash across the diets is an indication that SMS is not inferior to wheat bran in this regards. It has been established that dietary fibre influences the passage rate of digest, it decreases the transition time their ion exchange and absorption characteristics. It does retard digestion and absorption of nutrient as discussed by Nasi [28]. The carcass evaluation showed that with the exception of the dressing percentage replacement of wheat bran with SMS had no significant effect on the carcass cuts (breast, thigh drumstick back neck wings shoulder) Effect of dietary treatment on gastro intestinal tract (GIT) was not significant an indication that the GIT can possibly tolerate SMS without physiological aberration of the vital components of the digestive system. This confirmed the report of Hetland et al [29] and Svihus et al [30] that perhaps the coarse nature of SMS was able to create a digesta with suitable physical and chemical characteristics favorable for enzymatic degradation which the upper digestive tract needs to receive stimulation for adequate organ development and function. Increasing SMS which amount to increasing fiber level resulted in significant reduction in feed cost per cost kg weight gain of the broilers across the diets. From this study broilers fed with control was cheaper than those with SMS diet.

Conclusion

The use of agricultural waste as feed ingredient has several merits. It is a local resource that reduces cost. This utilization will help to solve environmental issue that could result from accumulation of agricultural wastes. Further studies will be required to make SMS more profitable in raising broilers.

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