



Growth performance and meat wholesomeness of broiler chickens reared on different types of litter materials

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Abstract

In an experiment carried out to determine the effects of using different litter materials on the growth performance and wholesomeness of broiler meat for consumption, one hundred and fifty day old broiler chicks were purchased from a commercial hatchery. The chicks were reared for eight weeks and thereafter examined for carcass quality and bacterial load. Wood shavings (control) and saw-dusts, both from *Brachystegia eurycoma* wood; rice-husks, sand and grass (*Eleusine indica*) were used as the study litter materials. These constituted the five treatments, each replicated thrice in a completely randomized design. Ten broiler chicks were weighed and randomly assigned per replicate. Data were taken per replicate on weekly basis. The results showed that birds reared on rice husks were significantly affected ($P < 0.05$) in weight gain in the first two weeks of the experiment, while feed consumption and feed conversion ratios were not significantly affected ($P > 0.05$) by all the treatments. Belly fat alone was significantly affected ($P < 0.05$) by type of litter materials in all carcass and organ parameters tested. Mortality rate of experimental birds were less than 3.5% throughout the period of the experiment. Bacterial counts of 3.4×10^3 and 7.5×10^3 colonies formed per unit (CFU) were found in the duodenum of broilers reared on grass and wood shavings, respectively. Bacterial isolates from the pure cultures included *Streptococcus faecalis*, *Esherichia coli*, *Staphylococcus aureus*, *Klebsiella* and *Salmonella* species. These results showed that any of the litter materials used in this study could be used for rearing broiler chickens on a deep litter system. Also, meat of broiler chickens reared on the study litter materials are safe and wholesome for human consumption.

Key words: Growth performance, bacteriological condition, broiler chickens, litter materials.

Introduction

Litter materials are the beddings used to cover the floor of poultry pens or houses in a deep litter system. These materials serve some important functions such as moisture absorption and promotion of drying environment, dilution of fecal materials and insulation of chicks from the cold effects of the ground⁶. Various materials have been used as litter at a point in time or the other, while some are still being investigated. The use of these materials depends on their availability in a particular locality and/or other factors of economic advantage including their post-bedding usage^{3, 5, 10}.

In broiler production, the quality of chicks, feed and water to be used had always received much attention, but such is not paid to the quality of litter materials used to rear them. This attitude has been described as unfortunate and also indicated that broilers would not perform to their genetic potential in a poor environment. This is because, the quality of the environment depends highly on the quality of the litter¹.

The fact that broilers are prone to litter-eating make them vulnerable to consuming litter materials and consequently may ingest bacteria that may cause the broiler meat not safe for consumption.

It is therefore important that litter materials used for rearing broilers in a deep litter system be evaluated for both the growth performance and safety of such broiler meat for human consumption.

Other factors that may determine the suitability of a material as a good litter source include high absorbent nature, a good drying time, ready availability and non-toxicity (as birds are given to litter-eating). Some litter materials, though readily available and cheap, may adversely affect broilers. For instance, the cost of poor litter condition to broilers have been conservatively estimated on a single broiler house with a capacity of 20,000 birds to be \$630.00⁶.

Similarly, in some studies involving the use of recycled paper materials and shredded newspaper as alternative bedding materials, some of the paper products were found to be high in litter moisture and caking levels, resulting in carcass defects thus culminating to potential loss^{3, 7, 8}.

In South West Nigeria, because of the availability of sawmills, the conventionally used litter material is the wood-shaving. Though not maximally exploited, some other materials equally available within the zone are saw-dusts, rice-husks (wastes from

the rice mills), sand and dried grass. Therefore, this study sought to investigate the use of these materials as potential alternative floor beddings for rearing broilers with the aim of producing healthy and wholesome broiler meat for human consumption.

Material and Methods

Experimental chicks: A total of one hundred and fifty day old broiler chicks were obtained from a commercial hatchery for the experiment.

Litter materials: Woodshavings and saw-dusts from the same wood type (*Brachystegia eurycoma*), rice-husks, sharp sand (from erosion deposits) and grass (*Eleusine indica*) (air dried at room temperature, cut to 25-30 mm lengths) were used.

Experimental layout: Ten broiler chicks were weighed and randomly assigned per replicate in a completely randomized design. The study litter materials constituted the five treatments of this experiment with woodshavings as control. Each treatment was replicated thrice to a depth of about 75 mm per replicate. Used litter materials were removed and replaced with equivalent fresh litter every fortnight till the end of the experiment. Feed and water were provided *ad libitum* for all the birds throughout the eight weeks of the experiment. Medication and vaccinations against endemic diseases were routinely done. Birds from each replicate were weighed on weekly basis starting from Day 1. Feed consumption of the birds per replicate were estimated on weekly basis. The percentage mortality of the birds was recorded per replicate per week.

Organ and carcass measurements: At the end of the experiment, one broiler chicken per replicate was randomly selected, weighed and slaughtered, scalded and de-feathered. The dressed and eviscerated weights were expressed in percentages of the live weights, while the carcass and organ parameters were expressed in g/kg body weight.

Bacteriological examination: Test samples were taken from the heart, liver and duodenum of freshly eviscerated broiler chickens randomly selected from each treatment group. The samples were cultured and incubated at 37°C for 24 hours and thereafter inspected for growth (appearance of colonies). The numbers of colonies were expressed as colonies formed per unit (cfu). Well-separated colonies from the culture plates respectively were 210 fished out, rubbed over prepared agar slants and incubated at 37°C for 24 hours. They were then stored in the refrigerator for further studies to identify the isolates.

Drops from each of the pure cultures were placed on clean glass slides and Gram stained. Motility test was carried out using the Donovan's median. Biochemical examinations carried out included the catalase, oxidase, coagulase and indole test as well as sugar fermentation and oxidation fermentation (O/F) tests, respectively.

Statistical analysis: Data on growth performance, carcass and organ measurements were subjected to analysis of variance (ANOVA)^{4,9}.

Results and Discussion

Weight gain: At Weeks 1 and 2, broiler chickens on rice-husk litter materials recorded a remarkable increase in weight gain when compared with other chickens on different litter materials (Table 1). This indicates that rice-husk litter material used in rearing the broilers in this study group significantly ($P < 0.05$) affected the weight gain of the broilers within the first two weeks of their life (78.93 ± 4.4 and, 264.53 ± 3.9 g for the two weeks, respectively) consequent of much litter eating of rice-husks. This observation was not experienced beyond this age. This is slightly different from the results obtained by some early workers^{9,10} who recorded no significant difference in broiler chickens reared on different types of litter materials (saw-dust, paddy straw, sand and rice-husks).

Feed consumption: Broilers reared on sand, wood shavings (control) and grass litter materials recorded the highest average feed consumption at Weeks 1- 5 (Table 2). This may be because the broilers under these treatments concentrated more on the feed provided. The lowest average feed consumption rates were recorded in broilers reared on sawdust (at Weeks 1- 2 and 5 - 6) and rice-husk (at Weeks 3 - 4). The reason for this might be due to more litter eating and while less attention was paid to feeding on the actual feed. Conversely at Weeks 7 and 8, broilers on sand treatment recorded lowest feed consumption. However, these variations were not significant ($P > 0.05$) when compared with values obtained from other treatment groups reared on different litter materials.

Feed conversion ratio (FCR): Feed conversion ratio was highest at the 7th week for broilers reared on sand litter material and at Weeks 1 and 2 for rice-husks. Thereafter, the values obtained did not show any significant differences. However, the values did not follow any pattern relative to the litter materials used (Table 3). This finding is in agreement with some works^{1,2} for chicks reared on rice-husk, sawdust and sugar baggass.

Carcass characteristics: Belly fat was significantly affected ($P < 0.05$) by sand and grass (Table 4). This might not be unconnected with the rough and gritty nature of these bedding materials as the adult (matured) broilers prefer to rest on their bellies.

Relative organ weights: The study litter materials did not show any significant difference ($P > 0.05$) on relative organ weights (Table 5). However, numerical values for heart (4.47 ± 0.10 g/kg body weight) were found to be the same for broilers on woodshavings (control) and sawdust. This may probably be as a result of the influence of the same wood type, *Brachystegia eurycoma*.

Mortality: Mortality rate of 3.33% was recorded throughout the period of the experiment. It is, however, worth noting that 3 chicks on sand and 2 on saw-dust litter materials had their crops impacted in the first and second week of life, respectively.

Bacteriological examination: The heart and liver samples of broilers in all study litter materials were free of any bacterial isolate while the duodenum recorded counts of 3.4×10^3 and 7.5×10^3

Table 1. Effect of rearing broiler chickens on different litter materials on weight gain Average \pm SE weekly body weight gains (g/bird/week).

Treatments	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8
Wood Shavings	88.87 \pm 1.9ab	297.50 \pm 5.2a	515.37 \pm 28.60	730.97 \pm 27.0	1092.93 \pm 67.6	1399.60 \pm 57.73	1735.17 \pm 51.0	2161.93 \pm 57.30
Rice Husk	78.93 \pm 4.4b	624.53 \pm 3.9b	516.97 \pm 8.5	713.60 \pm 38.7	1040.47 \pm 13.3	1335.67 \pm 54.0	1621.30 \pm 56.0	2036.67 \pm 19.6
Saw Dust	85.33 \pm 4.1ab	285.53 \pm 9.5a	532.97 \pm 19.1	684.43 \pm 15.1	1042.03 \pm 56.2	1372.60 \pm 82.6	1728.33 \pm 109.0	2060.37 \pm 103.7
Sand	95.10 \pm 1.3a	287.87 \pm 4.8a	541.97 \pm 16.1	733.60 \pm 23.5	1047.13 \pm 48.4	1297.70 \pm 118.5	1597.17 \pm 130.3	2038.97 \pm 140.9
Grass	90.57 \pm 3.2b	287.40 \pm 6.4a	532.60 \pm 13.8	715.12 \pm 20.3	1022.40 \pm 22.7	1305.57 \pm 41.2	1724.17 \pm 20.5	2145.43 \pm 43.44.8
Statistical Significance	*	*	NS	NS	NS	NS	NS	NS

Treatments: litter materials used as bedding for poultry pen floors. * = Significantly different (P < 0.05), WK = Week, NS = Not significantly different (P > 0.05). Mean with different subscripts within the same column are significantly different (P < 0.05). Difference in live weight gain of broiler reared on different types of litter materials (sawdust, paddy straw, sand and rice husks).

Table 2. Feed consumption of broiler chicks reared on different litter materials Average \pm SE weekly feed consumption (g/bird/week).

Treatments	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8
T ₁	196.10 \pm 14.55	1340.37 \pm 25.58	1340.37 \pm 54.42	1870.17 \pm 73.35	1870.17 \pm 73.35	3722.50 \pm 137.17	4813.13 \pm 176.57	6024.73 \pm 242.41
T ₂	187.00 \pm 8.21	708.67 \pm 11.8	1310.13 \pm 5.13	1843.87 \pm 26.95	2649.40 \pm 54.71	2649.40 \pm 58.41	4876 \pm 107.17	6161.03 \pm 187.95
T ₃	178.70 \pm 5.16	693.87 \pm 20.41	1314.60 \pm 48.69	1844.20 \pm 58.92	2640.50 \pm 82.18	7698.43 \pm 114.12	4940.10 \pm 68.49	6166.03 \pm 107.78
T ₄	198.50 \pm 5.32	722.00 \pm 8.50	1340.33 \pm 15.25	1869.93 \pm 30.10	2672.70 \pm 56.36	3725.63 \pm 97.82	4811.57 \pm 151.72	6023.43 \pm 171.33
T ₅	190.25 \pm 25.59	714.80 \pm 10.92	1338.53 \pm 12.43	1868.53 \pm 21.51	2674.07 \pm 59.26	3777.63 \pm 124.45	4865.76 \pm 424.41	6093.75 \pm 231.33
Statistical Significance	NS	NS	NS	NS	NS	NS	NS	NS

Treatments: Litter materials used as bedding for poultry pen floors. T₁ = Wood shavings, T₂ = Rice husk, T₃ = Saw dust, T₄ = Sand, T₅ = Grass, WK Week, NS = No significant difference (P > 0.05).

Table 3. Effect of rearing broiler chicks on different litter materials on feed conversion ratio of the birds. Average \pm SE feed conversion ration (g feed/g weight gain).

Treatments	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8
Wood Shavings	2.20 \pm 0.05	2.04 \pm 0.45	2.60 \pm 0.06	0.55 \pm 0.04	23.46 \pm 0.10	2.67 \pm 0.06	2.77 \pm 0.03	2.78 \pm 0.04
Rice Husk	2.38 \pm 0.19	2.68 \pm 0.07	2.53 \pm 0.04	2.59 \pm 0.11	2.45 \pm 0.02	20.80 \pm 0.13	3.01 \pm 0.16	3.02 \pm 0.12
Saw Dust	2.09 \pm 0.47	2.29 \pm 0.15	2.47 \pm 0.08	0.69 \pm 0.07	2.54 \pm 0.13	2.70 \pm 0.12	32.81 \pm 0.27	3.00 \pm 0.18
Sand	2.08 \pm 0.04	2.51 \pm 0.06	2.47 \pm 0.07	0.55 \pm 0.06	2.56 \pm 0.13	2.90 \pm 0.21	3.04 \pm 0.17	2.97 \pm 0.13
Grass	2.11 \pm 0.06	2.48 \pm 0.03	2.51 \pm 0.05	2.61 \pm 0.03	2.61 \pm 0.04	2.90 \pm 0.12	2.83 \pm 0.08	2.84 \pm 0.09
Statistical Significance	NS	NS	NS	NS	NS	NS	NS	NS

Treatments: Litter materials used as bedding for poultry pen floors. WK = Week, NS = No significant difference (P > 0.05).

Table 4. Carcass characteristics of broiler chickens reared on different litter materials.

Parameter	Treatment					Statistical significance
	Wood shavings	Rice-husks	Saw-dust	Sand	Grass	
Dressed weight (%)	86.53 \pm 0.90	89.67 \pm 2.10	88.05 \pm 0.98	87.26 \pm 0.98	89.45 \pm 2.93	NS
Eviscerated weight (%)	80.28 \pm 0.84	83.70 \pm 1.85	82.15 \pm 2.54	80.12 \pm 1.37	84.09 \pm 2.81	NS
Head (g/kg body weight)	24.96 \pm 0.58	24.90 \pm 1.18	25.05 \pm 1.28	27.13 \pm 1.83	26.76 \pm 1.35	NS
Neck (g/kg body weight)	30.77 \pm 3.83	30.93 \pm 2.89	31.47 \pm 2.69	36.96 \pm 1.64	31.71 \pm 0.88	NS
Wing (g/kg body weight)	81.15 \pm 8.52	93.85 \pm 6.25	87.97 \pm 2.56	87.60 \pm 4.80	81.34 \pm 3.13	NS
Upper back (g/kg body weight)	78.97 \pm 9.39	79.43 \pm 8.44	69.14 \pm 3.11	84.14 \pm 5.58	74.22 \pm 3.24	NS
Lower back (g/kg body weight)	73.25 \pm 5.57	79.14 \pm 9.56	74.31 \pm 2.68	68.62 \pm 1.51	81.55 \pm 2.96	NS
Chest (g/kg body weight)	182.95 \pm 19.54	188.34 \pm 9.24	163.38 \pm 27.19	152.70 \pm 5.54	196.21 \pm 6.80	NS
Thigh (g/kg body weight)	103.02 \pm 3.02	118.13 \pm 9.53	109.81 \pm 4.05	98.43 \pm 10.76	104.40 \pm 3.99	NS
Drumstick (g/kg body weight)	103.05 \pm 5.09	99.16 \pm 6.33	114.51 \pm 0.80	104.25 \pm 7.17	112.22 \pm 8.35	NS
Shank (g/kg body weight)	40.61 \pm 2.97	40.62 \pm 2.97	43.86 \pm 0.9	48.44 \pm 3.26	45.76 \pm 1.69	NS
Belly fat (g/kg body weight)	20.58 \pm 5.19a	25.18 \pm 1.75a	22.85 \pm 1.60a	8.37 \pm 2.15b	15.37 \pm 2.81ab	*

Treatments: Litter materials used as beddings for poultry pen floors. * Significantly different (P < 0.05), NS = No significant difference (P > 0.05). Means with different letters are significantly different (P < 0.05).

Table 5. Relative organ weights of broiler chickens reared on different litter materials.

Parameter	Treatment					Statistical significance
	Wood shavings	Rice husks	Saw dusts	Sand	Grass	
Heart (g/kg body weight)	4.47 ± 0.09	4.14 ± 0.26	4.47 ± 0.10	5.82 ± 1.25	4.83 ± 0.22	NS
Lungs (g/kg body weight)	5.85 ± 0.18	5.42 ± 0.52	6.09 ± 1.22	4.66 ± 0.58	6.94 ± 1.58	NS
Kidneys (g/kg body weight)	3.06 ± 0.43	2.39 ± 1.28	3.25 ± 0.50	4.56 ± 0.50	4.00 ± 1.64	NS
Spleen (g/kg body weight)	1.04 ± 0.37	0.95 ± 0.19	0.73 ± 0.16	0.95 ± 0.14	0.53 ± 0.13	NS
Pancreas (g/kg body weight)	1.43 ± 0.14	1.56 ± 0.23	2.17 ± 0.28	2.21 ± 0.48	1.67 ± 0.14	NS
Liver (g/kg body weight)	13.30 ± 0.42	15.31 ± 2.29	14.42 ± 1.71	14.42 ± 1.71	11.23 ± 0.50	NS
Bursa of Fabricius (g/kg body weight)	1.56 ± 0.66	0.94 ± 0.34	1.22 ± 0.56	2.15 ± 0.18	1.28 ± 0.09	NS
Gizzard (g/kg body weight)	18.80 ± 0.56	18.11 ± 1.50	18.46 ± 1.63	21.89 ± 2.34	19.75 ± 1.15	NS
Proventriculus (g/kg body weight)	5.31 ± 0.55	4.23 ± 0.37	5.42 ± 0.99	5.42 ± 0.99	3.96 ± 0.489	NS

Treatments: Litter materials used as bedding for poultry pen floors. NS = No significant difference ($P > 0.05$).

(CFU) on those reared on woodshavings (control) and grass respectively (Table 6). This suggests that the organs (heart and liver) were not affected by the litter materials used as they were free of any bacterial colonies.

Biochemical tests on the bacterial isolates from the duodenum of broilers reared on the different study litter materials were *Streptococcus faecalis*, *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella* and *Salmonella* species (Table 7).

These bacteria are normal flora of the intestinal tract of animals and may not produce disease if restricted within the confines of the intestine under appropriate pH and health conditions.

Table 6. Total bacterial counts from the various organs of broiler chickens reared on different litter materials.

Treatments	Liver	Heart	Duodenum
Wood-shavings	0.0×10^3	0.0×10^3	7.5×10^3
Rice-husks	0.0×10^3	0.0×10^3	7.0×10^3
Saw-dusts	0.0×10^3	0.0×10^3	3.5×10^3
Sand	0.0×10^3	0.0×10^3	3.9×10^3
Grass	0.0×10^3	0.0×10^3	3.4×10^3

Values are expressed as colony formed per unit (cfu).

Table 7. Biochemical characterization of bacterial isolates from duodenum of broilers reared on different litter materials.

Test	Isolate				
	1	2	3	4	5
Gram reaction	+	-	+	-	-
Shape of cell	S	R	S	R	R
Motility	-	+	-	-	+
Catalase	-	+	+	+	-
Oxidase	-	-	-	-	-
Spore	-	-	-	-	-
Indole	-	+	-	-	-
Coagulase	-	-	+	-	-
<i>Sugar fermentation</i>					
Glucose	A	AG	A	AG	AG
Sucrose	+	+	+	+	-
Lactose	+	+	+	+	-
Mannitol	+	A	+	+	A
Galactose	A	+	AG		
Fructose	-	-	+	+	-
Oxidation/fermentation	-/F	-/F	-/F	OF	-/F

Key: Probable organisms. 1 = *Streptococcus faecalis*, 2 = *Escherichia coli*, 3 = *Staphylococcus aureus*, 4 = *Klebsiella* sp., 5. *Salmonella* sp., 6. R = rod, S = sphere, + = positive, N = negative, F = fermentation, A = acid, G = gas.

Conclusions

This study showed that wood-shavings, rice-husks, sawdust, sand and grass can be used as bedding materials in rearing broiler chickens as they do not significantly affect ($P > 0.05$) the weight gain, feed consumption, feed conversion ratios, carcass and organ measurements of the birds.

Meat from broilers reared on these different litter materials can be claimed to be safe and wholesome for human consumption as the bacterial isolates from the duodenum of the experimental chickens were the normal gut flora of animals.

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