

Original Research Article**Influence of bedding materials on organ weights, meat quality, breast and footpad dermatitis of broiler chickens under hot humid climate**

Oyegunle Emmanuel **Oke**¹, James Olamitibo **Daramola**¹, Victoria **Uyanga**¹,
Oluwaseun Serah **Iyasere**¹, Chiemeka Promise **Njoku**², Modinat Bukola **Babatunde**¹

¹Department of Animal Physiology, Federal University of Agriculture, Abeokuta, Nigeria

²Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria

Correspondence to

O. E. Oke, Department of Animal Physiology, Federal University of Agriculture, Abeokuta, Nigeria,
e-mail: emaoke7@yahoo.co.uk

Abstract

Wood shavings is the most common material used as litter in commercial broiler production in many areas in Nigeria. It is, however, becoming scarce and expensive. Therefore this study was conducted to determine and compare the effects of other bedding materials on organ weights, meat quality, footpad and breast dermatitis of Marshall broiler chickens under hot humid climate. One hundred and eighty broiler chicks of mixed sexes (Marshall strain) were randomly assigned to three treatments of wood shavings (WS), maize cobs (MC) and chopped *Panicum maximum* (PM) as bedding materials replicated four times with 15 birds each in a Completely Randomized Design. Feed and water were provided to birds *ad libitum* throughout the study. Data were collected on the relative body and organ weights, meat quality, breast and footpad dermatitis. The results showed that footpad and breast lesion of the birds were not significantly influenced ($P > 0.05$) by different litter materials. Similarly, most of the organ weights, including spleen and bursa of *Fabricius* were not influenced by litter materials. However, the relative weight of thigh of the birds reared on PM and MC were similar but higher ($P < 0.05$) than those raised on WS. The intestinal weight of the birds raised on PM was significantly higher than those of the other treatment groups whose weights were similar. Birds reared on chopped PM had higher ($P < 0.05$) relative weight of liver than those reared on MC. There was no significant ($P > 0.05$) effect of bedding materials on meat quality. It was concluded that chopped PM could serve as a replacement for WS as a bedding material for broiler chickens under hot humid climate.

Keywords: Litter; growth; poultry; organs; lesions; carcass.

INTRODUCTION

Environmental conditions where chickens are reared including the type of bedding material may affect the incidence of lesions on the birds. The type of bedding material significantly influences broiler performance and carcass quality (Malone et al., 1983). It has been stated that some bedding materials promote high humidity levels and may also increase the occurrence of lesions, mainly on chicken breasts and footpads (Godwin et al., 2000). Essentially, bedding materials are used in broiler production to prevent direct contact of the bird with the floor and to promote absorption of the fecal moisture to keep floor reasonably dry and to ensure comfortable conditions for birds (Garcia et al., 2010). It also gives birds a suitable medium on which feeding, watering and other management practices are carried out (Rao, 1986).

Various types of bedding materials are used in different countries with varying degree of success. Common types of bedding materials used in poultry houses throughout the world are sawdust, rice husks, sugarcane pulp, sugarcane bagasse, chopped straw, paper mill byproducts, sand, wood shavings, corn cobs, oat hulls, dried leaves, coffee husks (Rao, 1986). An ideal bedding material should be dry with high water-holding capacity, but should also be able to release the absorbed moisture quickly for venting to atmosphere (Torok et al., 2009). In Nigeria, wood shavings are conventionally used as a bedding material in broiler chicken production. However, there has been a stiff competition on wood shavings for other purposes. Wood-based bedding materials are now being diverted for the manufacture of other wood products. The implication of this is that farmers cannot secure enough good quality bedding materials for

Table 1. Meteorological observation during experiment

Weeks	Temperature °C	Relative humidity (%)
4 th	32 ± 0.35	82 ± 2.91
5 th	32 ± 0.21	87 ± 1.20
6 th	32 ± 0.56	81 ± 0.33
7 th	33 ± 0.29	85 ± 2.40
8 th	32 ± 0.58	77 ± 3.33

Table 2. Diet composition for the starter and finisher phase of broiler chicken

Ingredients	Starter phase (%)	Finisher phase (%)
Maize	47.00	50.00
Soya bean meal	18.50	12.00
Groundnut meal cake	15.00	11.00
Fish meal(72% CP)	2.10	2.10
Wheat offal	10.35	17.90
Bone meal	3.00	3.00
Oyster shell	3.00	3.00
Salt	0.25	0.25
*Premix	0.25	0.25
Methionine	0.30	0.30
Lysine	0.25	0.20
	100	100
Calculated		
Crude protein (%)	23.05	19.91
ME (MJ/Kg)	11.73	11.71
Ether extract (%)	3.93	3.89
Crude fibre (%)	3.67	3.79
Calcium (%)	1.75	1.74
Phosphorus (%)	0.43	0.41

* kg of premix contains: vitamin A: 10,000,000 IU; vitamin D3: 2,000,000 IU; vitamin E: 20,000 IU; vitamin K: 2,250 mg; thiamine B1: 1,750 mg; riboflavin B2: 5,000 mg; pyridoxine B6: 2,750 mg; niacin: 27,500 mg; vitamin B12: 15 mg; pantothenic acid: 7,500 mg; folic acid: 7,500 mg; biotin: 50 mg; choline chloride: 400 g; antioxidant: 125 g; magnesium: 80 g; zinc: 50 g; iron: 20 g; copper: 5 g; iodine: 1.2 g; selenium: 200 mg; cobalt: 200 mg.

poultry production (Adene, 1989). This has significantly contributed to the high cost of broiler chicken production in Nigeria. Availability of traditional wood-based bedding materials (wood shavings) will continue to decline as the competition for its use increases.

Limited availability and high demand for bedding materials have necessitated the search for alternative materials, such as peanut hulls, rice husks, corn cobs, coffee husks, and several types of grasses (Huang et al. 2009; Quio and Guo 2010). We hypothesised that MC and PM could serve as areplacement for wood shavings as litter materials for broiler chickens.

The driving force of the present study was therefore to investigate the effects of alternative materials capable of providing the same technical efficiency as wood shavings on footpad and breast dermatitis, organ weights and meat quality of broiler chickens under hot humid climate.

MATERIALS AND METHODS

Experimental location and meteorological observations

The research was carried out at the Poultry Unit of the Research Farm of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria (latitude 7°13'N; longitude 3°26'E and altitude 76 m above sea level) in a prevailing tropical climate with a mean annual rainfall of 1.03 cm, and annual mean temperature and relative humidity of 34 °C and 82%, respectively. The average weekly ambient temperature and relative humidity during the experiment is presented in Table 1.

Experimental birds and management

The litter materials used in this study were wood shavings, chopped *Panicum maximum* and maize cobs. Wood shavings were obtained from the sawmills while *P. maximum* were harvested from the University Farm and chopped to 1.5–2.0 cm and then sun-dried, and maize cobs were obtained from maize farmers and then

Table 3. Effect of litter materials on footpad and breast lesion of broiler chickens under hot humid climate

Variables	Litter materials			S.E.M.	P values
	n	<i>Panicum maximum</i>	Maize cobs		
Footpad lesion	30	0.75	0.92	0.157	0.915
Breast lesion	30	0.00	0.17	0.039	0.127

S.E.M.: Standard error of mean

Table 4. Effect of litter materials on meat quality of broiler chickens under hot humid climate

Variables	Litter materials			S.E.M.	P values
	n	<i>Panicum maximum</i>	Maize cobs		
Crude Protein (%)	8	58.04	57.98	0.751	0.254
Fat (%)	8	22.50	21.75	0.641	0.530
Fibre (%)	8	3.83	4.00	0.369	0.768
Ash (%)	8	11.83	11.67	1.271	0.195
Meat pH	8	7.27 ^a	7.30 ^a	0.10	0.001
Dried matter (%)	8	6.42	6.20	0.202	0.912

^{a,b}: Means within a row with different superscripts differ significantly ($P < 0.05$), S.E.M.: Standard error of mean

crushed roughly. The litter materials were air-dried and spread evenly to a depth of about 5 cm in each replicate.

A total of one hundred and eighty day-old broiler chicks of both sexes (Marshall strain) were purchased from a reputable hatchery in Nigeria and were randomly assigned to three treatment groups of bedding materials viz.: replicated four (4) times with 15 birds each. The birds were fed *ad libitum* with standard starter mash for the first 28 days and thereafter with finisher mash until day 56. Diets were formulated to meet NRC (1994) nutrient recommendations for each feeding phase as shown in Table 2. Water at ambient temperature was supplied *ad libitum* with the use of plastic drinkers throughout the period of the experiment. The birds were raised at 10 birds/m². The birds were in good health and no death was observed.

DATA COLLECTION

Breast and footpad lesions

The classification of footpad lesions was done using the scores of McWard and Taylor (2000). In brief, the footpad lesions were assigned to one of 4 classes viz.: 0 – normal (no burns, scab or lesion); 1 – pad burn (dermis only); 2 – pad scab (healing) on one or both feet; and 3 – pad lesion (open sore) on one or both feet while breast lesion was scored using the classification of Angelo et al. (1997) – No lesion; 1 – presence of lesion without inflammation; and 2 – presence of lesion and inflammation.

Body weight and organ weight

The birds were weighed and two birds per replicate were slaughtered at 56 days of age. The birds were dissected and the weights of breast, gizzard, drum stick, shank, thigh, tibia, *proventriculus*, gastrointestinal tract, liver, bursa of *Fabricius*, thymus, heart, lungs and spleen

were taken and relative weights were determined as a percentage of bodyweights of the birds.

Meat quality

Meat (muscle) samples were taken from breast and minced through a 5 mm plate meat-grinding machine. The minced meat was sampled, vacuum packed and frozen for subsequent chemical analysis. Chemical composition analysis of the meat samples was performed by proximate analysis as described by AOAC (2007) to determine moisture, ash, crude protein and fat content as percentage of dried matter.

Determination of meat pH

The pH of meat samples was determined according to the method described by Bendall (1973). pH of the fresh meat was measured by immersing the pH meter into the breast muscle using checker pH meter.

Statistical analysis

Data were analyzed by ANOVA with bedding material as the independent variable in a Completely Randomized Design. When differences among bedding materials were significant ($P < 0.05$), means (arithmetic mean) were separated using Duncan's multiple range test (SAS, 2008).

RESULTS

Breast and footpad lesions

Table 3 shows the effect of bedding materials on footpad and breast lesion of broiler chickens under hot humid climate. The use of different bedding materials did not have significant effect on the footpad and breast lesions of the birds.

Table 5. Effect of litter materials on carcass characteristics of broiler chickens under hot humid climate

Variables	Litter materials			S.E.M.	P values	
	n	<i>Panicum maximum</i>	Maize cobs			Wood shavings
Body Weight (g)	8	1862.00	1849.17	1685.33	51.34	0.310
Proventriculus (%)	8	0.57	0.56	0.61	0.03	0.836
Gizzard (%)	8	3.60	3.43	3.58	0.12	0.826
Lungs (%)	8	0.69	0.55	0.51	0.04	0.086
Breast (%)	8	18.69	18.51	16.56	0.79	0.497
Thigh (%)	8	5.76 ^a	5.59 ^a	4.73 ^b	0.18	0.035
Drumstick (%)	8	5.15	5.20	4.80	0.16	0.592
Heart (%)	8	0.58	0.48	0.50	0.02	0.202
Asipose tissue (%)	8	1.55	1.29	1.03	0.16	0.420
Intestinal weight (%)	8	6.74 ^a	5.77 ^b	5.30 ^b	0.22	0.018
Intestinal length (cm)	8	190.83	192.00	175.33	4.12	0.188
Crop (%)	8	1.41	0.42	0.59	0.21	0.112
Shank (%)	8	2.36	2.27	2.13	0.07	0.432

^{ab}Means within the same row with different superscripts differ significantly, S.E.M.: Standard error of mean

Table 6. Effect of litter materials on lymphoid organ weights of broiler chickens under hot humid climate

Variable	Litter materials			S.E.M.	P values	
	n	<i>Panicum maximum</i>	Maize cobs			Wood shavings
Spleen	8	0.12	0.10	0.11	0.01	0.085
BF	8	0.18	0.16	0.20	0.01	0.614
Liver	8	3.10	2.53	2.80	0.10	0.061

^{ab}Means within a row with different superscripts differ significantly, BF: Bursa of Fabricius, S.E.M.: Standard error of the mean

Meat quality

Table 4 shows the effect of bedding materials on proximate meat quality of broiler chickens during hot humid climate. There was no significant effect of bedding material on crude protein, adipose tissue, fibre, dried matter and ash ($P > 0.05$). Breast pH of birds reared on chopped *Panicum maximum* and maize cobs was similar but higher than those reared on wood shavings ($P < 0.05$).

Carcass characteristics

Table 5 shows the effect of bedding materials on carcass characteristics of broiler chickens under hot humid climate. There was a significant effect of bedding materials on thigh and intestinal weights but not on body weight, *proventriculus*, gizzard, drumstick, heart, adipose tissue, intestinal length, crop, shank and breast weights ($P > 0.05$). The relative weight of thigh of the birds raised on *Panicum maximum* and maize cobs were higher weight than those raised on wood shavings ($P < 0.05$). The intestinal weight of broilers reared on *Panicum maximum* was significantly higher than those reared on maize cobs and wood shavings whose weights were similar.

Lymphoid organs

The effect of bedding materials on lymphoid organs of broiler chickens under hot humid climate is shown in Table 6. Spleen, liver and bursa were not significantly affected by bedding materials.

DISCUSSION

The type of bedding material has been reported to significantly influenced broiler performance (Malone et al., 1983). Limited literature has been published on the effects of *Panicum maximum* and maize cobs on broiler chickens. The similarity in the body weights of the birds in the present study is in agreement with the observation of Smith (2002) who compared pine shavings, chopped bermuda grass hay as bedding material for turkey hens. Other studies (Bilgili et al., 2009; Davis et al., 2010) also reported that chopped straw and wood shavings as bedding materials did not have significant effect on the body weights. On the contrary, findings of Farhadi (2014) indicated that bedding material type had significant effect on body weight at 4, 5, and 6 weeks of age and that rice husks due to its favourable properties could be successfully used as alternative poultry bedding material. This study also showed that lungs, thigh, intestinal weight were significantly affected by bedding material

types. This result is contradictory with Atapattu and Wickramasinghe (2007) and Grimes (2004) who did not find any significant effect of the type of bedding material on the carcass characteristics. Intestinal weight has been reported to be influenced by environmental factors and that its reduction could be linked to a reduction in T_3 production (Garriga et al., 2006). The similarity in the intestinal weights of the birds raised on wood shavings and chopped *Panicum maximum* may therefore suggest that *Panicum maximum* is a suitable replacement. The contradiction in the findings of different authors on weights may be due to factors such as particle size, moisture content and buildup, rate of caking, and other physical characteristics of the material used which have been reported to be factors that can influence the efficiency of a type of bedding materials (Toghyani et al., 2010).

In accordance to the findings in the present study, Torok et al. (2009) reported that there was no significant difference in the breast blisters of birds reared on wood shavings and chopped straws. However, the similarity in the footpad dermatitis of the birds in the present trial is at variance with the observation of Bilgili et al. (2009) who evaluated eight different bedding materials and reported that birds reared on chopped straw showed a higher incidence and severity of footpad dermatitis when compared to pine shavings. However, Smith (2002) reported that there was a difference in the footpad dermatitis of the birds reared on chopped bermuda grass hay and pine shavings.

Consistent with the observation of Smith (1956), who investigated the influence of corn cobs as bedding material on the incidence of breast lesions in broilers and reported that birds raised on corn cobs had the same degree of lesions as birds raised on wood shavings. This may be an indication that these alternative materials are suitable for bedding materials. The similarity in breast and footpad dermatitis could therefore be attributed to bedding material conditions (Martland, 1984).

Ammonia in a poultry house is known to negatively influence meat quality of chickens (Beker et al., 2004). The similarity in most of the carcass characteristics of the birds in the present study corroborates the findings of Renden et al. (1992) and Atapattu and Wickramasinghe (2007) who observed that there was no significant effect of the type of bedding material on the carcass characteristics. The absence of variation in the relative weights of spleen and bursa of *Fabricius* of the birds across the treatments in the present study are consistent with the findings of Toghyani et al. (2010) who reported that different bedding materials did not have significant effects on lymphoid organs.

Bedding material types (*Panicum maximum*, maize cobs and wood shavings) did not have effect on meat quality of broiler chicken. This agrees with the report of Bilgili et al. (2009) that the rearing system has a minor importance when it comes to the quality of poultry meat

and that the rearing system does not affect the proximate chemical composition and physicochemical properties of breast muscles. The breast muscle pH of birds reared on chopped *Panicum maximum* and maize cobs were similar but were higher than in birds reared on wood shavings.

CONCLUSIONS

Chopped *Panicum maximum* appeared to be better than maize cobs as a bedding material for broiler rearing among the alternative bedding materials to save cost and to promote intensive poultry production system.

REFERENCES

- Adene D. F. (1989): An appraisal of the health management problems of rural poultry stock in Nigeria. Proceedings of the International Workshop on Rural Poultry in Africa. November 13–16, 1989, Ile Ife, Nigeria, pp. 989–999.
- Angelo J. A., Gonz ales E., Kondo N. (1997): Material de cama: qualidade, quantidade e efeito sobre o desempenho de frangos de corte. Revista Brasileira de Zootecnia 26: 121–130.
- AOAC (2007): Official methods of analysis. 18th ed. Association of Official Analytical Chemists; Arlington, VA, USA.
- Atapattu N. S., Wickramasinghe B. M. (2007): The use of refused tea as litter material for broiler chickens. Poultry Science 86: 968–972.
- Bendall J. R. (1973): Postmortem changes in muscle. In: The Structure Function of Muscle. (Bourne G. H. ed.) Academic Press, New York. NY.
- Beker A., Vanhooser S. L., Swartzlander J. H., Teeter R.G. (2004): Atmospheric ammonia concentration effects on broiler growth and performance. Journal of Applied Poultry Research 13: 5–9.
- Bilgili S. F., Hess J. B., Blake J. P., Macklin K. S., Saenmahayak B., Sibley J. L. (2009): Influence of bedding material on footpad dermatitis in broiler chickens. Journal of Applied Poultry Research 18: 283–589.
- Davis J. D., Purswell J. L., Columbus E. P., Kiess A. S. (2010): Evaluation of chopped switch grass as a litter material. International Journal of Poultry Science 9: 39–42.
- Farhadi D. (2014): Evaluation of the physical chemical properties of some agricultural wastes as poultry litter material. Global Journal of Animal Science Research 2: 270–276.
- Garcia R. G., Almeida P. I. C. L., Caldara F. R. N as I. A., Pereira D. F., Freitas L. W., Schwingel, A. W., Lima N. D. S., Graciano J. D. (2010): Effect of the litter material on drinking water quality in broiler production. Brazilian Journal of Poultry Science 12: 165–169.

- Garriga C., Hunter R. R., Amat C., Planas J. M., Mitchell M. A., Moreto M. (2006): Heat stress increases apical glucose transport in the chicken jejunum. *American Journal of Physiology* 290: R195–R201.
- Godwin J. L., Carter T. A., Grimes J. L. (2000): The use of litter plus as a bedding material for broilers. *National Poultry Waste Management Symposium*; Auburn, Alabama; United States of America, pp. 344–351.
- Grimes J. L. (2004): Alternative litter material for growing poultry. *North Carolina Poultry Industry Newsletter*, pp. 1–4.
- Huang Y., Yoo J. S., Kim H. J., Wang Y., Chen Y. J., Cho J. H., Kim I. H. (2009): Effect of bedding types and different nutrient densities on growth performance, visceral organ weight, and blood characteristics in broiler chickens. *Journal of Applied Poultry Research* 18: 1–7.
- Malone G. W., Chaloupka G. W., Saylor W. W. (1983): Influence of litter type and size on broiler performance: Factors affecting litter consumption. *Poultry Science* 62: 1741–1746.
- Martland M. F. (1984): Wet litter as a cause of plantar pododermatitis, leading to foot ulceration and lameness in fattening turkeys. *Avian Pathology* 13: 241–252.
- McWard G. W., Taylor D. R. (2000): Acidified clay litter amendment. *Journal of Applied Poultry Research* 9: 518–529.
- Quio G., Guo M. (2010): Quality of poultry litter-derived granular activated carbon. *Biological Research Technology* 101: 379–386.
- Rao V. S. R. (1986): Litter – Its management and utility in broiler. *Poultry Advisory* 19: 31–40.
- Renden J. A., Bilgili S. F., Kinkaid S. A. (1992): Live performance and carcass yield of broiler strain crosses provided either sixteen or twenty-three hours of light per day. *Poultry Science* 71: 1427–1435.
- SAS User's Guide (2008): Version 9.02 ed., SAS Institute Inc., Cary, NC.
- Smith J. C. (2002): Chopped bermuda grass hay as an alternative bedding material for rearing market turkey hens. *North Carolina State University, Raleigh, NC*.
- Smith R. C. (1956): Kind of litter and breast blisters on broilers. *Poultry Science* 35: 593–595.
- Toghyani M., Gheisari A., Modaresi M., Tabeidian S. A., Toghyani M. (2010): Effect of different litter material on performance and behavior of broiler chickens. *Applied Animal Behavioural Science* 122: 48–52.
- Torok V. A., Hughes R. J., Ophel-Keller K., Ali M., MacAlpine R. (2009): Influence of different litter materials on cecal microbiota colonization in broiler chickens. *Poultry Science* 88: 2474–2481.

Received: November 29, 2018
Accepted after revisions: May 31, 2019