Journal of Animal and Veterinary Advances 5 (12): 1080-1087, 2006

Comparative Influence of Sand and Wood Shavings Litter Replacement Frequency on the Performance of Broiler Chickens

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Abstract: A batch of five hundred day-old Arbor Acres broiler chicks was used to assess the influence of litter replacement frequency on performance of broiler-chickens reared on sand and wood shaving litter. The chicks were randomly grouped into ten treatments of litter replacement Frequencies for both wood shavings and sand litters under 2×5 factorial design experiment. Each of the litter type had replacements of seven times, thrice, twice, once and zero (without replacement) throughout the eight-week period. At the end of eight week, the birds on sand litter had significantly ($p<0.05$) higher overall weight gain (259.58±3.51 g/bird) to those on wood shaving (243.29±3.50 g/bird) due to litter type effect. Also, feed consumption and feed conversion ratio were significantly ($p<0.05$) affected at the end of 8th week, specifically due to litter type and interaction effect of litter type and litter replacement frequency respectively. However, birds on the sand litter replaced three times had the highest weight gain (267.40±4.65 g/bird) while birds on wood shaving replaced twice had the next weight gain (250.66±12.87 g/bird). Of the carcass traits measured only relative weight of lower back was significantly affected while pancreas alone was significantly affected ($p<0.05$) among the organs measured. The haematological variables were significantly ($p< 0.05$) affected by the interaction effect of litter types and litter replacement. Serum protein was not significantly ($p>0.05$) affected. In the main, it was recommended that sand litter can be replaced three times for broiler chickens raised on it while it could be replaced twice for those raised on wood shavings.

Key words: Sand, wood shavings, frequency of litter replacement

INTRODUCTION

Broilers are chickens reared for their meat to slaughter weight in eight weeks[1]. The deep litter system was traditionally found suitable for broiler production[2] and thus, the rearing of broilers under deep litter system requires the use of bedding materials, generally referred to as litter.

The importance of a good quality litter for floor reared birds is well recognized, although the birds' performance is unlikely to be severely affected by the type of litters[3,4]. Litters need to be very absorbent in having their moisture level maintained between 20-30% in a well-ventilated broiler house[5]. Poorly managed litter is an ideal environment for bacteria proliferation and ammonia production and is detrimental to both human and chickens health[5]. Ammonia concentration of 50 to 110 ppm can cause human eye to burn and tear inducing possible health risks among farm workers. Prolonged exposure of chickens to high levels of ammonia can cause kerato conjunctivitis (blindness)[5].

Caked litter can cause breast blisters in broiler-chickens and thus downgrading the carcass[1]. In addition, wet litters attract insect (particularly flies) and causes soiled feathers. The two factors that influence litter conditions most are manure and moisture. While manure influence is not readily under the producers' control; litter moisture can easily be controlled and this litter moisture control goes a long way in reducing ammonia concentration and other associated problems. Miles and Butcher[6] reported that it is common to find localized areas of caking near leaking watering cups, nipples, troughs or roofs; hence, suggested that such portions of the litter must be continually stirred, raked or replaced to correct the condition. Other causes of wet litters include watery droppings, moldy feed, disease, climate control and bedding type[6]. Therefore, good litter management practices must ensure the provision of high quality feed, disease organisms' free environment and adequate ventilation with good quality bedding materials.

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Butcher and Miles[6] emphasised that when high humidity accompanies high temperatures, the problem of wet litter can become so severe that it becomes very difficult to properly maintain the litter in a dry and friable condition. In a situation like this, coupled with possible failures to handle predisposing causes of wet litters; it is of necessity to establish a standard litter replacement schedule for broiler rearing. In-line with this, Laseinde[7] suggested that litter should be changed every two weeks or more frequently during rainy season, especially when ventilation is poor. This study was designed to determine the comparative influence of litter replacement frequency on performance and haematological indices in broilers. The two litter types compared in this investigation are the sand and wood shavings.

MATERIALS AND METHODS

Litter collection and preparation: The different litters used for the study were sands of the sandy loam type and wood shavings from the wood type named Afara (*Terminalia superba*). The sand was air dried by spreading them in an open and well ventilated room. The sand sample was crumbled into uniform granules and homogenised using sand sieve of 0.50cm^2 dimension to remove its rocky components and turned the clods into granules.

Management of chicks and experimental lay-out: The Five Hundred day-old Anak broiler chicks used for the trial were purchased from Avian Specialties Limited, Ibadan, Nigeria. The broiler chicks with average weight of 41.17 g were electrically brooded at the Teaching and Research Farm of the Federal University of Technology Akure Nigeria. The chicks were randomly divided into 10 treatments, each treatment having five replicates. Each replicate had 10 chicks in a 2×5 factorial completely randomized design experiment. The chicks were raised in 50 equi-dimensional pens randomly laid with sand or wood shavings litters at a uniform depth of 2 cm.

The five litter replacement frequencies for the two litter types, sand and wood shavings under study were 7, 3, 2, 1 and 0 time within the eight week rearing period. Thus, the litters were changed or replaced every week, every two-week, every three-week and every four-week while the zero week replacement served as the control treatment.

The bird were fed *ad-libitum* with the same formulated diets containing 230 g kg^{-1} crude protein and 2850 kcal kg^{-1}ME at starter phase and 200 g kg^{-1} crude protein and 2989 kcal kg^{-1} ME at finisher phase. The routine veterinary services as outlined by the University Teaching and Research Farm were observed for the birds. The birds were raised on their respective litter for 8 weeks during which the record of average weekly weight gain and average daily feed consumption were kept.

Blood collection for analysis: At the end of the trial the randomly selected sample chickens per group/replicate were weighed and sacrificed by severing their jugular vein with a sharp surgical knife without anaesthesising. The blood was then allowed to flow freely into labelled bijour bottles; one set into which a speck of an anticoagulant, Ethylene Diamine Tetra-acetic Acid (EDTA) powder was introduced to prevent clotting while the other set were without EDTA. The blood in the EDTA - containing bijour bottles were used for the determination of haematological parameters while those in bottles without EDTA were processed for serum analysis.

Haematological and serum analysis: The Packed Cell Volume (PCV) was estimated by spinning about 75 μL of each blood sample in heparinized capillary tubes in a haematocrit micro centrifuge for 5 min while the total Red Blood Cell Count (RBC) was determined using normal saline as the diluting fluid. The haemoglobin concentration (HBC) was estimated using cyanomethaemoglobin method while the absolute values: Mean cell haemoglobin concentration (MCHC), Mean Cell Haemoglobin (MCH) and the Mean Cell Volume (MCV) were calculated as described by Lamb[8]. Similarly, the Erythrocyte Sedimentation Rate (ESR) of the blood as well as the total serum protein, albumin and globulin of the serum were determined as described by Lamb[8].

Carcass characteristics and organs measurements: After slaughtering and bleeding, the carcasses were scalded at 65°C in water bath for 30 sec before defeathering. The dressed chickens were later eviscerated. The carcass assessed/measured during this study include dressed weight (%), eviscerated weight (%), thigh, drumstic, shank, breast, upper back, lower back, wing, belly fat and head. The organs measured were the liver, kidneys, lungs, pancreas, heart, spleen, bursa of Fabricius and gizzard. All the carcass characteristics and organs measured were expressed as g kg^{-1} body weight except the dressed and eviscerated weights, which were expressed as percentages of the body weights.

Chemical and statistical analysis: Proximate analysis of the individual component ingredients and the formulated broiler diets were carried out according to the procedures of AOAC[9].

Data collected on performance, haematology and total serum protein were subjected to analysis of variance and the treatment means separated by Duncan's multiple range test using SPSS package[10].

RESULTS

General observation: In general, the replacement and turning of litters was observed to enhance dust bathing activities in the birds. However, such dust bathing and litter picking and pecking bahaviours were observed to be more frequent with birds o sand litter.

Performance record: The weekly cumulative Weight Gains (WG) of birds were significantly ($p<0.05$) affected by the litter types at 5, 7 and 8th weeks of age while the significant ($p<0.05$) effect on weight gain at 2nd week of age was due to litter replacement. However, the interaction effect of litter type and litter replacement frequency had no influence on weight gain as shown in Table 1. At the end of the 8th week, the birds on sand litter had a significantly ($p<0.05$) higher overall weight gain (259.58±3.51 g/bird) compared to 243.29±3.50 g/bird for those birds on wood shavings. Table 2 shows that cumulative Feed Consumption (FC) was significantly ($p<0.05$) affected by litter types at 8th week of age. Neither litter replacement frequency nor interaction effect of litter type and litter replacement frequency affected the feed consumption of the birds. Hence, overall feed consumption on both litters showed that birds on sand litter had a significant ($p<0.05$) higher feed consumption (680.83±9.39 g/bird) to those on wood shavings (648.44 ±8.07 g/bird). Table 3 shows that the birds had an identical value of Feed Conversion Ratio (FCR) except at 7 and 8th weeks where interaction effect of litter type and litter replacement frequency significantly ($p<0.05$) affected the FCR. This finding show that at the end of 8th, week birds on sand litter replaced once had the least FCR value (2.50±0.15), showing that they utilized feed most.

Carcasss traits and relative organ measurement: In Table 4, of all the carcass traits only the lower back was affected significantly, ($p<0.05$) by litter replacement frequency. Though, birds on litters without replacement had a significant ($p<0.05$) high value of lower back (100.18±5.83 g kg^{-1} body weight) to others still seems to have identical lower back weights with them as well. The organs showed an identical growth except the pancreas which was significantly ($p<0.05$) higher by the interaction effect of litter types and litter replacement. The birds on sand litter without replacement had the highest value (3.13±0.62 kg^{-1} body weight) as presented in Table 5.

Table 1: Weekly cumulative body weight gain (g/bird) of broilers reared on different frequency of replacement with wood shaving and sand litters

Litter type	Litter replacement frequency	Weeks 1	2	3	4	5	6	7	8
Wood shavings	0	9.17±1.03	32.74±0.97	66.07±2.38	94.88±2.52	131.55±1.26	131.55±1.26	209.36±2.91	245.64±2.26
	1	7.86±0.83	26.61±1.71	54.37±3.10	81.68±3.00	121.96±1.34	121.96±1.34	189.12±2.21	224.08±2.92
	2	7.97±0.43	28.83±1.69	51.70±1.99	82.54±5.03	129.05±6.93	129.05±6.93	204.36±13.29	250.66±12.87
	3	10.60±0.83	33.33±1.02	63.57±0.21	94.17±5.84	131.78±3.95	131.78±3.95	207.02±2.58	247.42±1.82
	7	8.57±1.45	32.01±0.94	58.64±2.14	95.66±14.64	134.47±2.65	134.47±2.65	215.10±3.15	248.65±3.07
Sand	0	10.75±0.66	34.63±1.48	63.36±4.89	95.32±3.30	143.89±5.38	143.89±5.38	218.21±6.04	264.30±5.87
	1	8.39±0.27	25.02±5.38	62.58±3.82	88.94±3.34	140.54±2.83	140.54±2.83	221.44±2.09	255.85±7.12
	2	10.72±0.74	32.75±1.05	63.51±4.38	88.78±1.24	133.86±5.93	133.86±5.73	207.77±11.09	245.38±10.02
	3	8.59±0.53	32.83±1.67	59.88±4.35	91.85±1.45	137.83±7.44	137.83±7.44	219.06±6.79	267.40±4.65
	7	8.08±1.12	29.29±2.01	58.93±2.73	114.99±15.13	128.42±7.05	128.42±7.05	217.59±5.57	264.99±7.76
Statistical significance									
Litter type		NS	NS	NS	NS	*	NS	*	*
Litter replacement frequency		NS	*	NS	NS	NS	NS	NS	NS
Litter type x frequency		NS	NS	NS	NS	NS	NS	NS	NS
Mean separation									
Litter type effect									
Wood shavings		8.90±0.44	30.70±0.85	58.87±1.66	89.79±3.33	130.09±1.79^{a}	178.28±2.75	204.99±3.36^{a}	243.29±3.50^{a}
Sand		9.31±0.42	30.90±1.40	61.65±1.63	95.98±3.76	136.91±2.66^{b}	187.20±4.13	216.80±2.91^{b}	259.58±3.51^{b}
Litter replacement freq. effect									
	0	9.96±0.65	33.69±0.90^{a}	64.72±2.50	95.10±1.86	137.72±3.70	184.98±3.53	213.79±3.59	254.97±5.03
	1	8.12±0.41	25.82±2.55^{b}	58.47±2.86	85.31±2.58	131.25±4.39	179.75±5.50	205.28±7.36	239.96±7.89
	2	9.52±0.63	30.79±1.25^{a}	57.60±3.41	85.66±2.71	132.29±3.91	181.69±8.55	206.03±7.78	248.02±7.39
	3	9.59±0.63	33.08±0.88^{a}	61.72±2.11	93.01±2.74	134.81±4.00	185.76±4.62	213.04±4.22	257.41±5.00
	7	8.33±0.83	30.65±1.16^{a}	58.78±1.55	105.30±10.40	131.44±3.63	181.50±7.06	216.35±2.92	256.82±5.22

Mean±SEM NS = Not significant ($p>0.05$), * = Significant ($p<0.05$), Means with different superscripts within the same column and for the same parameters are significantly different ($p<0.05$)

Table 2: Weekly cumulative feed consumption (g/bird) of broilers reared on different frequency of replacement with wood shaving and sand litters

Litter type	Litter replacement frequency	Weeks 1	2	3	4	5	6	7	8
Wood shavings	0	18.45±0.93	58.21±1.76	117.26±1.76	186.79±2.73	283.93±1.56	396.62±5.21	524.52±11.69	653.74±21.47
	1	16.55±0.48	57.61±4.24	111.04±5.64	183.00±6.57	283.02±5.10	394.27±9.66	514.45±14.65	641.53±16.85
	2	16.55±1.55	56.89±4.13	110.12±5.60	183.60±9.50	284.19±15.51	387.75±21.21	508.71±22.75	640.8±21.71
	3	20.24±1.19	59.17±2.85	116.19±5.06	190.00±8.57	291.78±10.11	412.38±19.60	538.93±22.81	668.67±26.90
	7	17.86±1.07	60.47±4.03	114.81±4.57	190.82±4.13	292.02±1.98	399.32±3.25	517.67±7.90	638.16±3.40
Sand	0	18.61±0.24	56.83±0.86	119.56±3.13	194.35±6.02	299.90±6.38	413.82±8.05	539.14±14.00	672.65±16.48
	1	17.16±1.20	55.68±2.12	111.32±4.10	185.52±5.98	277.78±6.78	386.32±14.83	516.62±17.59	638.64±22.98
	2	17.38±0.59	57.65±1.20	119.65±2.15	194.09±4.03	304.91±9.98	422.82±23.30	544.38±34.09	673.52±40.43
	3	18.00±0.34	63.27±6.28	122.20±7.04	203.77±12.36	312.95±19.37	429.97±16.21	567.46±16.59	717.31±14.07
	7	16.80±0.95	59.46±3.90	124.58±10.64	204.13±13.70	279.00±15.71	390.22±16.55	524.53±11.40	668.72±4.21
Statistical significance									
Litter type		NS	NS	NS	NS	NS	NS	NS	*
Litter replacement frequency		NS	NS	NS	NS	NS	NS	NS	NS
Litter type x frequency		NS	NS	NS	NS	NS	NS	NS	NS
Mean separation									
Litter type effect									
Wood shavings		17.93±0.56	58.43±1.37	113.88±1.93	186.84±2.74	287.05±3.44	398.07±5.68	520.85±7.01	648.44±8.07[a]
Sand		17.59±0.34	58.58±1.50	119.46±2.64	196.37±3.96	294.91±6.11	408.63±7.79	538.29±9.03	680.83±9.39[b]
Statistical significance									
`	0	18.53±0.43	57.52±0.93	118.41±1.50	190.57±3.40	291.92±4.62	405.22±5.76	531.49±8.84	663.20±12.80
	1	16.85±0.59	56.65±2.16	111.18±3.12	184.26±4.01	280.40±3.97	390.29±8.11	515.50±10.20	656.80±11.30
	2	16.97±0.76	57.17±1.90	114.88±3.43	188.85±5.18	294.70±9.43	405.30±16.10	526.50±20.00	656.80±21.80
	3	19.12±0.75	61.22±3.22	119.19±4.10	196.88±7.40	302.40±10.90	421.21±12.00	553.20±14.10	693.00±17.40
	7	17.33±0.68	59.97±2.52	119.70±5.62	197.48±7.15	285.51±7.66	394.77±7.81	521.10±6.39	653.44±7.25

Mean ± SEM, NS = Not significant (p>0.05), * = Significant (p<0.05), Means with different superscripts within the same column and for the same parameters are significantly different (p<0.05)

Table 3: Weekly feed conversion ratio of broilers reared on different frequency of replacement with wood shaving and sand litters

Litter type	Litter replacement frequency	Weeks 1	2	3	4	5	6	7	8
Wood shaving	0	2.05±0.15	1.78±0.02	1.78±0.70	1.97±0.07	2.16±0.02	2.18±0.06	2.51±0.09	2.66±0.08
	1	2.14±0.19	2.17±0.13	2.06±0.19	2.24±0.03	2.32±0.02	2.32±0.08	2.72±0.05	2.86±0.04
	2	2.11±0.32	2.00±0.27	2.13±0.06	2.23±0.05	2.20±0.04	2.16±0.03	2.50±0.05	2.56±0.07
	3	1.92±0.09	1.78±0.06	1.83±0.07	2.03±0.11	2.22±0.11	2.30±0.10	2.60±0.09	2.70±0.11
	7	2.21±0.39	1.89±0.14	1.97±0.15	2.07±0.24	2.17±0.04	2.22±0.06	2.41±0.00	2.57±0.03
Sand	0	1.74±0.10	1.65±0.09	1.92±0.19	2.05±0.10	2.09±0.11	2.20±0.05	2.47±0.02	2.54±0.01
	1	2.05±0.13	2.56±0.78	1.79±0.09	2.10±0.15	1.98±0.09	2.06±0.14	2.33±0.06	2.50±0.15
	2	1.64±0.09	1.76±0.05	1.91±0.18	2.19±0.04	2.28±0.07	2.31±0.10	2.62±0.08	2.74±0.08
	3	2.12±0.18	1.94±0.23	2.07±0.21	2.22±0.14	2.28±0.13	2.23±0.07	2.60±0.12	2.68±0.06
	7	2.14±0.26	2.05±0.21	2.12±0.17	1.83±0.24	2.18±0.12	2.17±0.24	2.42±0.09	2.53±0.08
Statistical significance									
Litter type		NS	NS	NS	NS	NS	NS	NS	NS
Litter replacement frequency		NS	NS	NS	NS	NS	NS	NS	NS
Litter type x frequency		NS	NS	NS	NS	NS	NS	*	*
Mean separation									
Litter type effect									
Wood shavings		2.09±0.10	1.92±0.07	1.95±0.06	2.11±0.06	2.22±0.03	2.24±0.03	2.55±0.04	2.67±0.40
Sand		1.94±0.08	1.99±0.17	1.96±0.07	2.08±0.07	2.17±0.05	2.20±0.06	2.48±0.04	2.60±0.04
Statistical significance									
	0	1.90±0.11	1.71±0.05	1.85±0.09	2.01±0.06	2.13±0.05	2.19±0.04	2.49±0.04	2.60±0.04
	1	2.10±0.10	2.37±0.37	1.93±0.11	2.17±0.08	2.16±0.09	2.19±0.10	2.52±0.09	2.68±0.10
	2	1.87±0.18	1.88±0.14	2.02±0.10	2.21±0.03	2.24±0.04	2.24±0.06	2.55±0.05	2.65±0.06
	3	2.02±0.10	1.86±0.11	1.95±0.11	2.13±0.09	2.24±0.08	2.24±0.06	2.59±0.07	2.69±0.06
	7	2.18±0.21	1.97±0.12	2.04±0.11	1.95±0.16	2.18±0.06	2.20±0.11	2.41±0.04	2.55±0.04

Mean±SEM, NS = Not significant (p>0.05), * = Significant (p<0.05), Means with different superscripts within the same column and for the same parameters are significantly different (p<0.05)

Haematological variables and serum metabolites: Table 6 shows that Packed Cell Volume (PCV), Red Blood Cell (RBC), haemoglobin concentration (Hbc) and Mean Cell Volume (MCV) were significantly (p<0.05) different by the interaction effect of litter types and litter replacement. Serum metabolites were not significantly (p<0.05) different in any form by the litter types or litter replacement or interaction effect of both as presented in Table 7.

Table 4: Carcass traits of broilers reared on different frequency of replacement with wood shaving and sand litters

Traits (g kg^{-1} body weight litter type	Litter replacement frequency	Dress weight (%)	Eviscerated weight (%)	Head	Neck	Wing	Chest
Wood shavings	0	89.47±1.62	82.84±1.00	20.55±0.96	60.89±2.26	39.21±2.53	176.68±8.72
	1	89.56±1.21	81.82±1.82	26.87±1.74	56.23±1.87	40.78±0.66	160.99±5.93
	2	88.27±0.87	81.11±1.87	26.78±1.96	56.78±2.86	35.98±5.94	162.37±16.15
	3	88.80±1.00	83.07±3.15	25.68±2.18	56.08±4.06	37.37±1.93	153045±2.20
	7	89.09±0.59	83.08±1.22	23.94±0.24	54.75±3.45	38.34±2.58	167.40±10.38
Sand	0	89.61±1.57	84.03±1.57	24.77±3.07	57.72±4.25	39.63±0.94	174.93±4.09
	1	89.27±0.39	82.30±0.10	24.80±1.77	57.34±1.14	39.47±0.30	157.25±5.45
	2	88.60±2.00	80.25±1.81	25.36±0.92	51.07±2.10	41.10±0.79	135.50±9.20
	3	89.48±1.20	82.43±1.00	22.41±0.75	56.86±2.76	38.47±2.17	175.04±6.74
	7	88.35±0.89	81.67±0.59	28.16±3.21	55.06±0.55	39.01±1.89	150.85±7.52
Statistical significance							
Litter type		NS	NS	NS	NS	NS	NS
Litter replacement frequency		NS	NS	NS	NS	NS	NS
Litter type x frequency		NS	NS	NS	NS	NS	NS
Mean separation							
Litter type effect							
Wood shavings		89.02±0.44	82.38±0.77	24.76±0.87	56.95±1.26	38.33±1.30	164.18±4.25
Sand		89.06±0.52	82.13±0.55	25.14±0.98	55.61±1.16	39.33±0.58	158.71±4.78
Statistical significance							
	0	89.54±1.01	83.43±0.87	22.66±1.72	59.31±2.27	39.42±1.21	175.81±4.32
	1	89.42±0.57	82.06±0.82	25.92±1.24	56.78±1.01	40.12±0.44	159.12±3.70
	2	88.43±0.98	80.68±1.18	26.07±1.02	53.92±2.04	38.54±2.92	148.90±10.30
	3	89.14±0.72	82.75±1.48	24.05±1.26	56.47±2.21	37.92±1.32	164.24±5.78
	7	88.67±0.48	82.38±0.68	26.05±1.72	54.91±1.57	38.68±1.44	159.13±6.83

Table 4: Continued

Traits (g kg^{-1} body weight litter type	Litter replacement frequency	Upper back	Lower back	Thigh	Drumstick	Belly fat	Shank
Wood shavings	0	60.11±6.15	96.13±10.71	48.62±5.46	49.11±3.87	20.94±1.40	19.43±0.48
	1	46.98±1.15	88.96±0.80	52.11±3.72	50.73±3.27	13.77±2.26	25.05±2.32
	2	49.58±3.85	85.54±2.49	55.74±1.20	50.26±3.54	14.22±2.59	24.54±2.59
	3	69.18±5.19	103.80±9.91	53.03±4.86	46.32±3.26	12.58±6.50	25.51±2.92
	7	59.83±5.74	102.44±1.45	50.68±2.71	48.28±1.20	22.70±3.14	21.19±3.78
Sand	0	63.63±3.59	104.22±6.25	47.45±4.23	48.24±4.99	23.56±4.25	19.00±2.69
	1	55.17±1.09	84.10±2.08	56.13±1.29	49.92±1.47	14.52±3.55	22.44±1.47
	2	59.77±15.64	82.38±10.07	57.68±5.39	47.34±2.85	14.70±4.55	23.69±0.85
	3	48.25±2.02	99.98±7.29	53.47±3.37	48.94±2.42	18.31±1.72	21.48±1.93
	7	54.84±5.50	91.63±6.08	53.32±1.37	52.53±2.17	9.92±3.84	23.90±2.28
Statistical significance							
Litter type		NS	NS	NS	NS	NS	NS
Litter replacement frequency		NS	*	NS	NS	NS	NS
Litter type x frequency		NS	NS	NS	NS	NS	NS
Mean separation							
Litter type effect							
Wood shavings		57.14±2.80	95.37±3.17	52.04±1.60	48.94±1.27	16.84±1.76	23.18±1.20
Sand		56.33±3.21	92.46±3.46	53.62±1.62	49.45±1.24	16.20±1.86	22.10±0.88
Statistical significance							
	0	61.87±3.28	100.18±5.83^{a}	48.05±3.09	48.68±2.83	22.25±2.09	19.21±1.23
	1	51.08±1.96	86.53±1.47^{b}	54.12±1.97	50.32±1.61	14.15±1.89	23.751±1.36
	2	54.67±7.55	83.96±4.69^{b}	56.71±2.51	48.93±2.13	14.46±2.34	24.20±1.29
	3	58.72±5.30	101.89±5.57^{a}	53.25±2.65	47.63±1.91	15.44±3.27	23.49±1.81
	7	57.33±3.72	97.03±3.69^{ab}	52.00±1.48	50.40±1.46	16.31±3.62	22.55±2.06

Mean±SEM, NS = Not significant ($p>0.05$), * = Significant ($p<0.05$), Means with different superscripts within the same column and for the same parameters are significantly different ($p<0.05$)

Table 5: Relative organ weights (g/kg body weight) of broilers reared on different frequency of replacement with wood shaving and sand litters

Litter type	Litter replacement frequency	Heart	Lung	Pancreas	Spleen	Liver	Kidney	Bursa	Gizzard
Wood shavings	0	4.78±0.21	6.01±0.25	1.29±0.38	1.21±0.08	15.28±1.26	4.41±1.11	1.63±0.64	22.27±0.95
	1	4.90±0.29	4.91±0.40	1.44±0.28	0.75±0.12	14.37±1.18	6.44±0.35	1.08±0.17	26.28±2.19
	2	5.39±0.64	6.33±0.41	2.93±0.30	0.90±0.21	15.23±1.34	6.25±0.85	1.22±0.23	23.84±3.50
	3	5.75±1.89	7.11±0.69	1.24±0.00	0.86±0.21	15.80±1.54	4.16±0.44	-	20.79±1.28
	7	5.04±0.43	5.84±0.27	1.65±0.38	0.82±0.08	15.46±0.94	5.09±0.84	2.15±0.90	20.85±2.26
Sand	0	4.69±0.26	6.47±0.45	3.13±0.62	0.82±0.12	15.88±1.25	6.27±0.99	1.13±0.26	24.24±2.89
	1	4.46±0.13	6.43±1.26	1.06±0.26	0.92±0.15	14.96±0.85	5.77±0.43	1.50±1.23	24.44±2.48
	2	5.39±0.09	6.49±0.41	0.91±0.08	0.81±0.17	15.00±0.48	5.86±0.38	2.23±1.19	25.72±2.78
	3	4.50±0.48	7.37±0.28	1.65±0.22	1.22±0.18	15.71±1.35	4.95±0.68	1.54±0.44	21.90±0.95

Table 5: Continued

Litter type	Litter replacement frequency	Heart	Lung	Pancreas	Spleen	Liver	Kidney	Bursa	Gizzard
	7	4.30±0.71	4.46±1.51	1.58±0.39	1.00±0.21	15.35±0.48	4.28±0.83	1.91±0.94	23.98±2.28
Statistical significance									
Litter type		NS	NS	NS	NS	NS	NS	NS	NS
Litter replacement frequency		NS	NS	NS	NS	NS	NS	NS	NS
Litter type x frequency		NS	NS	*	NS	NS	NS	NS	NS
Mean separation									
Litter type effect									
Wood shavings		5.17±0.36	6.04±0.25	1.65±0.20	0.88±0.07	15.23±0.50	5.27±0.38	1.55±0.30	22.81±1.00
Sand		4.67±0.18	6.25±0.43	1.71±0.28	0.95±0.08	15.38±0.38	5.43±0.33	1.68±0.34	24.06±0.96
Statistical significance									
	0	4.74±0.15	6.24±0.25	2.21±0.52	0.97±0.12	15.58±0.80	5.34±0.79	1.39±0.33	23.26±1.43
	1	4.68±0.17	5.67±0.68	1.29±0.20	0.83±0.10	14.67±0.66	6.10±0.29	1.25±0.41	25.36±1.54
	2	5.39±0.29	6.41±0.26	1.72±0.50	0.85±0.12	15.11±0.64	6.05±0.42	1.83±0.70	24.78±2.04
	3	5.12±0.92	7.24±0.34	1.45±0.15	1.04±0.15	15.76±0.92	4.55±0.40	1.54±0.44	21.35±0.76
	7	4.67±0.41	5.15±0.75	1.62±0.25	0.91±0.11	15.41±0.47	4.69±0.56	2.03±0.58	22.41±1.60

Mean ± SEM, NS = Not significant ($p>0.05$), * = Significant ($p<0.05$), Means with different superscripts within the same column and for the same parameters are significantly different ($p<0.05$)

Table 6: Haematological variables of broilers reared on different frequency of replacement with wood shavings and sand litters

Litter type	Litter replacement frequency	PCV (%)	RBC ($\times 10^6$ mm^{-3})	Hbc (g 100 mL)	MCH (Pg)	MCV (μ^3m)	MCHC (%)	ESR (mm h^{-1})
Wood shavings	0	26.67±0.33	2.14±0.07	9.14±0.32	42.84±1.88	125.01±3.83	34.26±0.77	3.17±0.17
	1	27.00±1.16	2.38±0.28	9.24±0.44	40.23±6.19	117.09±16.29	34.22±0.55	4.17±0.17
	2	26.67±1.45	2.49±0.18	9.25±0.45	37.32±0.87	107.50±2.17	34.71±0.27	5.50±1.04
	3	25.67±0.33	2.18±0.22	8.51±0.05	39.91±3.98	118.98±12.76	33.16±0.30	4.33±0.44
	7	25.67±0.67	2.41±0.26	8.71±0.23	36.99±3.74	109.21±11.98	33.94±0.30	3.67±0.44
Sand	0	23.00±1.16	2.29±0.26	8.08±0.26	36.19±3.99	107.54±11.66	33.65±0.29	4.00±0.29
	1	25.33±0.33	2.29±0.09	8.40±0.02	36.87±1.55	111.16±4.77	33.18±0.43	4.67±0.17
	2	24.67±0.33	2.12±0.07	8.27±0.13	39.13±1.64	116.62±4.26	33.54±0.18	3.83±0.17
	3	32.00±3.79	3.34±0.47	11.00±1.43	33.03±0.65	96.46±2.48	34.26±0.47	4.33±1.30
	7	26.33±0.67	1.87±0.07	9.00±0.46	48.41±4.07	141.45±8.50	34.12±0.92	4.67±0.88
Statistical significance								
Litter type		NS	NS	NS	NS	NS	NS	NS
Litter replacement frequency		NS	NS	NS	NS	NS	NS	NS
Litter type x frequency		*	*	*	NS	*	NS	NS
Mean separation								
Litter type effect								
Wood shavings		26.33±0.37	2.32±0.09	8.97±0.15	39.46±1.55	115.56±4.46	34.06±0.23	4.17±0.30
Sand		26.27±1.07	2.38±0.16	8.95±0.39	37.06±2.44	114.64±4.82	33.75±0.22	4.30±0.29
Statistical significance								
	0	24.83±0.98	2.21±0.13	8.61±0.30	39.52±2.47	116.28±6.74	33.96±0.39	3.58±0.24
	1	26.17±0.66	2.34±0.13	8.82±0.27	38.55±2.95	114.12±7.71	33.70±0.39	4.42±0.15
	2	25.67±0.80	2.30±0.12	8.76±0.30	34.06±4.30	112.06±2.95	34.13±0.30	4.67±0.60
	3	28.83±2.21	2.76±0.35	9.75±0.85	36.47±2.37	107.72±7.69	33.71±0.35	4.33±0.62
	7	26.00±0.45	2.14±0.17	8.85±0.24	42.70±3.55	125.33±9.76	34.03±0.44	4.17±0.49

Mean±SEM, NS = Not significant ($p>0.05$), * = Significant ($p<0.05$), PCV = Packed cell volume, RBC = Red blood cell, Hbc = Haemoglobin concentration; MCHC = Mean cell haemoglobin concentration, MCH = Mean cell haemoglobin; MCV = Mean cell volume; ESR = Erythrocyte sedimentation rate. Means with different superscripts within the same column and for the same parameters are significantly different ($p<0.05$)

Table 7: Serum metabolites (g 100 mL^{-1}) of broilers reared on different frequency of replacement with wood shavings and sand litters

Litter type	Litter Replacement frequency	Total serum protein	Albumin	Globulin
Wood shaving	0	6.28±0.38	2.56±0.56	3.73±0.36
	1	6.23±0.09	2.11±0.29	4.12±0.37
	2	6.28±0.59	2.56±0.29	3.73±0.30
	3	5.90±0.10	2.28±0.15	3.63±0.19
	7	5.14±0.11	2.11±0.11	3.03±0.11
Sand	0	5.14±0.25	1.89±0.40	3.25±0.18
	1	5.00±0.71	2.45±0.22	2.57±0.62
	2	5.71±1.01	1.89±0.44	3.83±0.56
	3	6.24±0.62	2.89±0.40	3.35±1.02
	7	6.10±0.63	2.56±0.29	3.54±0.38
Statistical significance				
Litter type		NS	NS	NS
Litter replacement frequency		NS	NS	NS

Table 7: Continued

Litter type	Litter Replacement frequency	Total serum protein	Albumin	Globulin
Litter type x frequency		NS	NS	NS
Mean separation				
Litter type effect		5.97±0.17	2.32±0.13	3.65±0.14
Wood shaving		5.64±0.29	2.33±0.17	3.31±0.26
Sand				
	0	5.71±0.33	2.22±0.34	3.49±0.21
	1	5.62±0.42	2.28±0.18	3.35±0.47
	2	6.00±0.54	2.22±0.28	3.78±0.29
	3	6.07±0.29	2.58±0.24	3.49±0.47
	7	5.62±0.35	2.33±0.17	3.29±0.21

Mean ± SEM, NS = Not significant ($p>0.05$), * = Significant ($p<0.05$), Means with different superscripts within the same column and for the same parameters are significantly different ($p<0.05$)

DISCUSSION

The enhancement of dust bathing through litter replacement and rolling could be attributed to the freshness of the beddings at the instance of replacement and uniformly loose texture achieved during the turning of litters. These jointly promote dust bathing behaviours as comfort activities in the broiler chickens, thus corroborating the report of vestergaard[11] that lack of loose materials in some systems is often assessed as a welfare problem in broiler rearing. However, the picking and pecking of litter could be exploratory behaviours to ascertain the newness of the litter with the turning. Frequency exhibition of these behaviours by those broiler chickens on sand litters could be linked with loose and granular nature of sand.

The weekly cumulative Weight Gains (WG), Feed Consumption (FC) and Feed Conversion Ratio (FCR) were found to be more affected significantly by both litter types and interaction effect of litter type and litter replacement than singular effect of litter replacement. Also the birds on sand litter had higher overall weight gain, feed consumption and correspondingly lower FCR value than birds raised on wood shavings, hence better feed utilization, which implies good performance as reflected by weight gain. This corroborates the report of[12] that the materials used as litter could significantly affect birds' performance. This further confirms sand as potential litter material in Nigeria, thus corroborating the earlier report by Bilgili[13] that broilers raised on sand performed as well as or better than those raised on pine shavings. Though, singular effect of litter replacement was not significant on birds performance still at the end of eight weeks period of the study, the birds reared on sound litter that was replaced three times had the highest weight gain while those on wood shaving that was replaced twice had the highest weight gain. This implies that broiler chicken performed best on sand litter replaced three times in eight weeks rearing period while on wood shaving, they performed best on those replaced two times in eight weeks life period. This result is an indication that durability of litter can be affected by different factors[14]. Eventhough Grimes[15] reported that sand litter can be used for a longer period of time before clean out this necessary, it however depend on the particle size content of such sand litter. Also, the sand litter replaced three times at every two weeks of eight weeks life period agreed with the suggestion of Laseinde[7] that litter should be changed every two weeks.

Except the relative weight of lower back that was significantly affected by litter replacement, this study showed that different litter materials had no significant influence on the carcass traits, indicating that identical carcass traits could be attained by raising broilers on sand or wood shavings Bilgili[13]. Of all the organs measured, only the relative weight of pancreas was significantly influenced by the interaction effect of litter type and litter replacement. This could be attributed to unequal pancreatic activities in the digestive system of the birds due to interaction effect of litter type and litter replacement. However the organs still showed identical organ growth.

The significant difference observed in Packed all Volume (PCV), Red Blood Cell count (RBC), haemoglobin concentration (Hbc) and Mean Cell Volume (MCV) was due to the interaction effect of litter type and litter replacement among the birds reared on differently replaced litters and between two litter types showed that all blood samples collected for analysis had different haemoglobin content. However birds on sand litter replaced three times seems to show better optimum access to iron via sand picking as reflected on their significant PCV and RBC values. The haematological values however fall within the normal range for chickens[16,17] and also, the erythrocyte indices of the haematological values compared favourably with values obtained by Awoniyi[18]. The overall haematological variables outcomes of the birds under this study suggest possible relative difference in anaemic situation of the broilers[19] and hence difference healthy growth.

The replacement of litter and litter type did not significantly affect total serum protein, albumin and globulin synthesis among the birds. This could be attributed to the fact that the birds though on different types of litters and differently replaced they were fed on the same diet which contain similar crude protein.

CONCLUSION

The study showed that broiler chickens performed optimumly on sand litter replaced three times at every two-weeks interval within eight weeks life period than those raised on wood shaving litter replaced twice at every three weeks interval within eight weeks life period with respect to weight gain, feed consumption and feed conversion ratio.

Therefore, it is recommended that sand litter should be replaced at every two weeks interval for broiler chickens raised on it while three weeks replacement interval was suggested for broiler chickens reared on wood shaving litter. Eventhough litter is to be replaced routinely, attention should be paid on hygiene and sanitary condition of the litter and the whole broiler environment. However, further study aimed at determining the optimum performance of broiler chickens on varying litter depths and stocking densities of broiler chickens under these litter replacement intervals is undergoing research attention.

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