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Effect of Reusing Litter on Productive Performance, Carcass Characteristics and Behavior of Broiler Chickens

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ABSTRACT

This study examined the effect of adding acidifier amendment (aluminum sulfate (alum)) to the used litter on broiler growth performance, carcass characteristics, physical and chemical characteristics of litter, physiological parameters of broiler and behavior. Three hundred and sixty (One-day-old) broiler chicks (Cobb 500) were reared collectively on new wheat straw as bedding material during the first week of age. The chicks were randomly allocated to 12 pens to a density of 10 bird/m^2 till 6 weeks of age, with 3 replicates of 4 experimental treatments contained 30 birds per pen as a completely randomized design. The groups included (1) new wheat straw litter (NL) (control), (2) used wheat straw litter (UL), (3) mixed wheat straw litter (ML) (50% new+50% used) and (4) treated wheat straw litter (UTL) (wheat straw supplied with 495g) of alum /m^2 litter. Differences in live weight, feed intake and livability percentage of broilers raised on four litter types were insignificant. Feed conversion ratio was better for broiler raised on new litter than other groups. Different kinds of litter had different moisture contents, this differences were high ($P < 0.01$) significant between all types of litter at 0 and 35 days. Results indicated that pH increasing from 0 day to 35 days in all the litter types, differences in pH among all treatments were high ($P < 0.01$) significant. Differences among treatment in behavior patterns were insignificant at 20 and 35 days, except eating and resting patterns were influenced at 35 days of age. Broiler chicks raised on UTL were significantly higher in fasted body weight, carcass weight and edible parts weight than broiler chicks raised on UL, while broiler chicks raised on ML and NL were intermediate. Also, broiler raised on UTL achieved highest net revenue and economical efficiency compared with broiler raised on other groups.

Key words: Reused litter, aluminum, Behavior, Moisture, Broiler

Introduction

Poultry litter is defined in the Nitrates Action Programme Regulations (NAP Regulations) as: “a mixture of bedding material and poultry manure arising from the housing of poultry and with a dry matter content not less than 55%.”

Broiler litter is a mixture of a substrate with the feces of birds where many undesirable bacteria may develop, such as Salmonella spp., Campylobacter spp., Escherichia coli, Clostridium perfringens, and Staphylococcus aureus. The accumulation of these pathogens raises concerns about the flock itself and, especially, about consumer health. For this reason, it is important to know the microfloral composition present in poultry litter (Lu *et al*., 2003).

Re-use of litter is an established practice in broiler production. Generally, live performance of broilers grown on re-used litter is not affected when compared with those on new litter (Kennard and Chamberland, 1951; McCartney, 1971 and Jones and Hagler, 1983). However, microorganisms accrue with used litter (Schefferle, 1965; Collins *et al*. 1989 and Kelley *et al*. 1995), and an increased threat seems likely when chicks are stressed after a long posthatch holding time.

However, unsuitable use of recycled litter can lead to many problems as increase ammonia emission into atmosphere which adversely affects bird performance and health, as well as workers health, leading to loss of profits. Also unsuitable use of recycled litter could be increasing coliform

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levels and coccidial outbreaks in poultry flocks (Stanley *et al*., 2004) and increasing disease transmission within the farm from flock to flock.

Effective litter management is one of the most critical aspects of poultry production. Poor quality litter can have a significant negative impact on bird health and performance. Wet or caked litter can lead to elevated ammonia levels, increased incidence of pododermatitis and increased numbers of pathogenic organisms including bacteria, viruses, coccidia, intestinal worms and molds. Where reuse of litter is necessary effective litter management is vital if bird health is not to be compromised. To complement basic management practices, numerous litter treatment products and strategies have been developed.

Indeed, the reuse of litter has been used in poultry for a long time, with performance results that did not differ from chickens reared on new litter (Kennard and Chamberland, 1951; McCartney, 1971; Jones and Hagler, 1983). Moreover, the reuse of the litter has an inhibitory effect on the development of Salmonella (Olesiuk *et al*., 1971). Finally, Lu *et al*. (2003) assert that poultry litter microflora comparison from farms with different management practices can identify the conditions that decrease or eliminate pathogenic bacteria.

The use of alum (aluminum sulfate) in broiler litter management can improve profitability while reducing some of the environmental threats posed by litter.

Research has demonstrated that the use of alum by the poultry industry can significantly improve production.

The most common 'on-farm' technique has been the use of aluminum sulfate, which is commonly known as alum. Aluminum sulfate (Al_2 [SO4])$_3$, as an amendment for poultry litter, acidifies the litter to convert the volatile ammonia(NH_3)produced in litter to nonvolatile ammonium ions (NH_4^+). There have been several studies about the use of alum and its benefits:alum reduced ammonia levels in the house (makes it safer for both farm workers and the birds), reduced pathogen levels in litter and on birds (improving bird health and food safety), improved bird performance (due to less ammonia and fewer pathogens), reduced propane use (less ventilation required in cooler months), higher forage yields (due to increased nitrogen content of the litter) and reduced phosphorus runoff (binds phosphorus in manure to reduce pollution). Alumreduces NH_3 emissions from poultry houses and decreases the loss of P and trace metals in runoff from litter-amended soils (Moore *et al*., 2000; Moore and Edwards, 2007).

The objective of this study was to investigate the effects of reused wheat straw litter with or without aluminum sulfate (Alum) on broiler performance, litter quality, behavior and carcass traits.

Materials and Methods

Three hundred and sixty (One-day-old) broiler chicks (Cobb 500) were taken directly from alocal commercial hatchery (Dakahlia Poultry Company) and transported over one hour to the Al-AzharUniversity, Faculty of Agriculture, Poultry Experimental Station, Nasre City Cairo, Egypt.

Birds Management and Experimental Design:

At arrival chicks were reared collectively on new wheat straw as bedding material during the first week of age. Then chicks were randomly allocated to 4 groups (90 chicks each) with 3 replicates (30 chicks each) according to the type of litter as follows: (1) new wheat straw litter (control), (2) used wheat straw litter, (3) mixed wheat straw litter (50% new+50% used) and (4) treated wheat straw litter (wheat straw supplied with 495g of alum/m^2 litter according to (Forbes Walker and Robert Burns, 2015).

The used litter was collected from a poultry house used to raise one flock of broilers to 6 week of age. 2 days after the birds were removed, moisture content of litter was high, but it was not caked. Litter was composited with alum for one week to decrease its moisture and ammonia content, then thorough mixed and sift to remove any caked parts from it. New and used litter was spread on the floor at depth of 5 cm. Artificial light supplied continuously during the first week of life then reduced to 23 hoursLight:1 hour Dark/day. Chicks brooded under electric brooder supplies 34 C^o at the first week reduced 3C^o weekly till 24 C^o. Chicks were fed starter diet (23% protein and 2900 ME Kcal/kg) from 0 to 21 days, grower diet (21% protein and 3000 ME Kcal/kg) from 22 to 35 days and finisher diet (19% protein and 3350 ME Kcal/kg) from 36 to 42 days. Also, the vaccination program was HB1 at 7 th days of age, gumboro at 12 and 22 days of age and Lasota at 18 and 28 days of age and all vaccines were applied through drinking water after following all precautions.

All chicks in each replicate were weighed individually from 1 to 6 weeks of age using electrical balance. The average body weight, feed intake, feed conversion and body weight gain were computed. At the end of experiment (6 weeks of age) three birds from each group (one bird from each replicate) were randomly slaughtered to estimate carcass traits which were: carcass, giblets, edible parts and inedible parts weight. Also, physiological parameters(respiration rate and skin temperature), behavior [eating (When the bird ate, regardless of whether it was standing, sitting or resting), drinking (When the bird drank, regardless of whether it was standing, sitting or resting), resting (When the bird sat or lay down on the floor, without any other activity), dust bath (When the bird forced the material into the plumage by squatting on the ground and making appropriate movements with the body, wings and legs), preening (When the bird arranged its feathers with its beak) and agonistic (is any social behavior related to fighting)] of broilers at 20 and 35 days of age were recorded. Behavioral observations were performed as follow: each group was observed two times at day 20 and 35 (30 min/time) (8.00-9.00 A.M, and 4.00-5.00 P.M) at circularly determined time from 8 A.M to 5 P.M for recording the different behavioral patterns. The observer stood directly in front of the pen and waited five minutes before recording to avoid any disturbance in the behaviors

Also, litter quality (temperature, moisture and pH of litter at 0 and 35 days) were recorded. livability percentages were recorded daily.

Statistical analysis:

Data were subjected to analysis of variance using SPSS software program package (SPSS, 2005, version 16.0). All data were analyzed by using one way ANOVA and presented as means ± SE. Duncan,s multiple range test was applied to identify significant differences among groups, (Duncan, 1955).

Results and Discussion

Growth performance:

There were no significant differences in body weights of broilers raised on four litter types (new, used, mixed and used treated) at all ages studied. However body weight gain (2018.5g) of broilers raised on used litter treated with alum (UTL) was significantly (P<0.01) higher than body weight gain of broiler raised on used litter (1871g), while body weight gain of broilers raised on new litter (NL) and mixed litter (ML) were intermediate Tables (1 and 2). Results in (Table 2) clearly indicates that chicks raised either on used treated litter (UTL) or mixed litter (ML) derive additional advantage in terms of better body weight and weight gain than the broilers raised on new and used litter (NL and UL).These results are agreement with Younis *et al*. (2016) who reported that there were no significant differences in body weight of broilers raised on fresh and reused type of litter.

The differences between groups in feed intake and livability percentage were insignificant, Though numerically heavier feed intake were recorded in the broilers raised on used litter (UL) followed by UTL, ML and NL, respectively. There was no significant (P>0.05) difference in the percentage of livability between broilers raised on all litter types studied though numerical differences among the four litter types existed. The numerically lower livability (96.19%) observed in broiler raised on reused litter group than broilers raised on new litter (99.05%) group may be due to disintegration of litter particles. Decrease in particle size of litter with the age of litter was also reported by Howes *et al*. (1967), Lien *et al*. (1992). Non-significant difference in the livability of broilers raised on fresh and reused litter was also reported by Jones and Hagler (1983) and Lien *et al* (1992). These results are agreement Kalita *et al*. (2012) who reported that there were no significant (P>0.05) difference in the average body weight and survivability of the broilers raised on fresh and reused type of litter. On the other hand, these findings are in agreement with the same above author, who found that body weight was significantly (P<0.01) higher body in favour of mixed litter group over the fresh litter group.

Table 1: Effect of wheat straw litter types on weekly body weight of broilers:

Groups	Age (week)					
	1*	2	3	4	5	6
New Litter (NL)	182.75 ±2.87	483.91 ±4.91	869.06 ±11.79	1288.59 ±16.51	1752.19 ±24.20	2126.90 ±33.97
Mixed Litter 50%New + 50% Used (ML)	180.63 ±2.79	475.63 ±6.65	880.48 ±13.37	1321.25 ±21.25	1773.50 ±31.02	2125.56 ±43.07
Used Litter (UL)	187.28 ±2.36	480.81 ±4.28	885.31 ±11.30	1292.67 ±16.88	1728.33 ±24.87	2058.33 ±37.96
Used Treated litter (UTL)	181.53 ±2.12	483.75 ±5.35	900.94 ±12.18	1283.13 ±20.85	1785.65 ±38.35	2197.93 ±55.90
Sig.	0.265	0.669	0.317	0.492	0.559	0.172

**Zero time*
a. b. c: According to Duncan Test, different letters in the same column indicate significant differences

Table 2: Effect of wheat straw litter types on body weight gain (g), feed intake (g), feed conversion (g/g) and livability percentage of broiler chickens:

Groups	Parameters			
	BWG	FI	FCR	Livability %
New Litter (NL)	1942.00^{ab} ±34.90	3351.40 ±57.26	1.73^{b} ±0.05	99.05 ±0.95
Mixed Litter 50%New + 50% Used (ML)	1945.00^{ab} ±53.05	3492.40 ±44.30	1.79^{b} ±0.02	98.09 ±0.95
Used Litter (UL)	1871.00^{b} ±41.90	3579.40 ±21.99	1.91^{a} ±0.01	96.19 ±0.95
Used Treated litter (UTL)	2018.50^{a} ±36.16	3509.50 ±69.18	1.74^{b} ±0.05	98.09 ±0.95
Sig.	0.022	0.071	0.027	0.268

a. b. : According to Duncan Test, different letters in the same column indicate significant differences

There was no significant difference in feed conversion ratios between NL, ML and UTL groups, respectively. The results in Table (2) observed that feed conversion ratio for broiler raised on used litter (UL) was significantly higher compared with other groups. This is logic result to higher feed intake and lower weight gains observed in used litter groups (Table 2).The reasons for the beneficial effects might be due to synthesis of certain vitamins of the B-complex group in used litters due to microbiological activity and breakdown (Kalita *et al*., 2012). Used litter poses fewer hazards to health because its chemical composition has a stabilizing effect on the microbiological population, therefore (Phelps, 1971; Lokanath *et al*., 1984; Poyraz *et al*., 1990) have advocated raising chicks on used litter to promote growth, similar to the findings of the present investigation. These results are agreement with Younis *et al*. (2016) who found that Feed conversion ratios were better in fresh litter treatment than used litter. On the contrary, results in this study are in agreement with Kalita *et al*. (2012 and Yamak *et al*. (2016) who found that feed conversion ratios did not vary significantly between chickens reared on new and used litter. Non significant differences in the feed conversion ratio of broilers raised on fresh and reused litter were also reported by Malone *et al*. (1990) and Lien *et al*. (1992).

Physical and chemical properties of different litter type:

The physicochemical characteristics of the various types of litter which were estimated at the beginning and the end of the experiment are shown in Table (3). Results indicate that a new litter had significantly ($P < 0.01$) higher temperature at zero day than UTL and ML, respectively. Also the differences were insignificant between NL and UL and between NU and UL at the same time (0 day). With the time (at 35 days), litter temperature increased in all types but the differences were insignificant. Wet litter provides a favorable environment for microbial proliferation and this may be the reason for temperature increased. An ideal litter substrate should not only be able to absorb the moisture of feces and spilled water from the drinkers, but should also release moisture quickly.

Table 3: Physical and chemical properties of wheat straw litter types:

Groups	Parameters					
	Litter temperature at		Moisture at		pH at	
	Zero day	35 days	Zero day	35 days	Zero day	35 days
New Litter (NL)	28.62[a] ±0.03	28.88 ±0.25	7.85[d] ±0.06	27.81[b] ±0.29	6.52[b] ±0.07	8.14[a] ±0.04
Mixed Litter 50% New + 50% Used (ML)	27.93[b] ±0.05	28.95 ±0.31	9.43[c] ±0.07	24.28[c] ±0.42	6.81[c] ±0.02	7.92[a] ±0.02
Used Litter (UL)	28.05[ab] ±0.04	28.82 ±0.39	10.19[b] ±0.10	21.58[d] ±0.41	6.97[d] ±0.03	7.96[a] ±0.18
Used Treated litter (UTL)	26.57[c] ±0.39	28.82 ±0.28	12.73[a] ±0.20	29.72[a] ±0.32	5.37[a] ±0.25	7.10[b] ±0.08
Sig.	0.000	0.507	0.000	0.000	0.000	0.000
a. b. c. : According to Duncan Test, different letters in the same column indicate significant differences						

The average moisture for all the litters increased almost 2.5 times throughout the rearing cycle because of waste accumulation, water spillage, the birds' respiration, and air humidity. Different litter types had different moisture contents, this differences were high ($P < 0.01$) significant between all types of litter at 0 and 35 days. Moisture contents observed in ML and UL were ideal, 20 - 25% at 35 days. While moisture contents for NL and UTL were higher than the ideal moisture content at 35 days.

These results are agreement with Senaratna *et al*. (2007) who found that moisture contents observed in his experiment, irrespective of the type of litter were higher than the ideal moisture content, 20 - 25%.Excess moisture in the litter increases the incidence of breast blisters, skin burns, scabby areas, bruising, condemnation and downgrades (Casey *et al*., 2005). The wetter the litter, the more likely it will promote the proliferation of bathogenic bacteria and moulds. Wet litter is also primary cause of ammonia emission, one of the most serious environmental pollutants of broiler production. The litter that is excessively dry and dusty can also lead to problems such as dehydration of new chicks, respiratory diseases and increase condemnations (Senaratna *et al*. (2007).The highest moisture content (29.72%) at the day 35 did not adversely affect the performance and health of the birds in the experiment, because wheat straw litter had large particles size. Ruszler and Carson (1968) reported that litter of small particles size absorbed less moisture than large particles size.

Table (3) shows that though there was high ($P < 0.01$) significant differences in pH among all groups . In general, there was a trend of increasing pH from 0 day to 35 days in all the litter types and may be due to faecal accumulation. pH in used treated litter was lowest at 0 and 35 days than the other groups. It is an advantage if litter material has a low pH, because the conversion of excretory uric acid into ammonia is decreased at acidic pH levels (Moore *et al*. 1995). Also, as pH rises above 7, the NH_3 shifts from the ionized to the un-ionized form and is thus more available for volatilization (Elliott and Collins, 1982). There were no significant ($P>0.05$) differences in physiological parameters of broilers (Respiration rate and skin temperature of broilers) raised on all types of litter at 20 and 35 days of age (Table 4).

Broiler behavior:

The differences among broiler raised on a new, mixed, used and used treated litter were non-significant in all behavioral patterns (Eating, drinking, resting, dust bath, feather preening and agonistic) at 20 days of age. Also, the performance of different behavioral patterns in birds did not influenced by the litter types except eating and resting patterns were influenced at 35 days of age (Table 5). These results agreed with Anisuzzaman and Chowdhury (1996) and El-Laithy (2003). In contrary, these results were contradicted partially with Toghyani *et al*. (2010) who stated a significant difference in feeding, drinking, preening and dust bathing behaviors on the different beddings.

Table 4: Physiological parameters of broilers raised on wheat straw litter types:

Groups	Physiological parameters at 20th days		Physiological parameters at 35th days	
	R.R R./min.	Skin Temp. °C	R.R R./min.	Skin Temp. °C
New Litter (NL)	65.00±2.16	40.87±0.12	53.00±1.29	40.27±0.33
Mixed Litter 50% New + 50% Used (ML)	68.33±3.89	40.98±0.19	58.33±2.99	40.48±0.09
Used Litter (UL)	68.00±2.14	40.55±0.10	60.67±2.19	40.90±0.13
Used Treated litter (UTL)	66.67±1.91	40.63±0.25	59.50±2.79	40.33±0.33
Sig.	0.805	0.304	0.149	0.292

Table 5: Behavioral of broiler raised on wheat straw litter types:

	Behavioral of broiler raised on different litter at 20 days					
Groups	Eating	Drinking	Resting	Dust bath	Preening	Agonistic
New Litter (NL)	20.83	8.33	57.29	4.17	13.54[a]	5.21[a]
Mixed Litter 50% New + 50% Used (ML)	17.71	9.38	69.79	2.08	5.21[b]	0.00[b]
Used Litter (UL)	18.75	6.25	69.79	2.08	8.33[ab]	0.00[b]
Used Treated litter (UTL)	19.79	5.21	70.83	0.00	12.50[ab]	0.00[b]
Sig.	0.777	0.460	0.444	0.375	0.124	0.067[b]
	Behavioral of broiler raised on different litter at 35 days					
	Eating	Drinking	Resting	Dust bath	Preening	Agonistic
New Litter (NL)	20.83[a]	8.33	82.29[ab]	1.04	1.04	1.04
Mixed Litter 50% New + 50% Used (ML)	12.50[b]	7.29	75.00[b]	1.04	0.00	1.04
Used Litter (UL)	17.71[ab]	7.29	76.04[b]	2.08	1.04	0.00
Used Treated litter (UTL)	14.58[b]	10.42	86.46[a]	0.00	3.13	1.04
Sig.	0.050	0.193	0.052	0.487	0.647	0.802
a. b. : According to Duncan Test, different letters in the same column indicate significant differences						

Carcass Characteristics:

Results of Table (6) indicate that broiler chicks raised on used treated litter with alum (UTL) were significantly higher in live body weight, carcass weight and edible parts weight than broiler chicks raised on used litter (UL). While broiler chicks raised on a mixed and new litter were intermediate. On the other hand, giblets weight was significantly lower in broiler raised on ML than other groups, and the differences between them were insignificant. Also, broiler chicks raised on used treated litter were high significant in inedible parts weight compared with broiler raised on a mixed and used litter groups, while broiler chicks raised on new litter was intermediate. The differences between groups in carcass traits may be due to differ between groups in live body weight. Results in this study were partially agreement with Younis *et al*. (2016) who found that used litter significantly ($P<0.01$) improved carcass weight, dressing%, breast muscle weight and gizzard weight over fresh litter. In contrary (Lien *et al*., 1992; Brake *et al*., 1993; Kalita *et al*., 2012 and Yamak *et al*. (2016) observed non-significant differences of dressing % between fresh and used litter treatments.

Table 6: Carcass characteristics as affected by wheat straw litters types:

Groups	Parameters				
	L.B.W (g)	Carcass[1] (g)	Giblets[2] (g)	E.parts[3] (g)	In E. part[4] (g)
New Litter (NL)	2132.0[ab] ±12..51	1631.6[ab] ±23.64	79.79[a] ±0.92	1711.4[ab] ±13.74	420.61[ab] ±12.52
Mixed Litter 50% New + 50% Used (ML)	2130.0[ab] ±14.32	1651.9[ab] ±21.34	72.60[b] ±0.35	1724.5[a] [b]±21.02	405.47[b] ±6.98
Used Litter (UL)	2091.0[b] ±28.87	1572.5[b] ±30.99	82.26[a] ±1.62	1654.7[b] ±31.78	436.26[b] ±6.53
Used Treated litter (UTL)	2182.0[a] ±24.63	1657.9[a] ±21.48	83.81[a] ±2.08	1741.7[a] ±23.27	440.30[a] ±3.47
Sig.	0.057	0.051	0.000	0.072	0.029

1:Carcass empty, 2:Giblets (gizzard, liver and hart), 3:E. parts (Edible parts) and 4:In E. parts (in edible parts)
a. b. : According to Duncan Test, different letters in the same column indicate significant differences

Economical efficiency:

Results of monetary inputs and outputs of broilers as affected by litter types are presented in Table (7). Total cost was affected by different litter types. Broilers raised on used litter had higher total cost than mixed, used treated and new litter, respectively. The difference among treatment in total cost were caused increased total feed intake. Broiler raised on used treated litter achieved highest net revenue (16.49LE) and economic efficiency (51.68%) compared with broiler raised on other groups (new (15.26LE and 48.62%), mixed (14.86LE and 46.44%) and used litter (13.05LE and 40.44%), respectively). This increase in profit for broiler raised on used treated litter group is due to the increase in weight gain and lower cost of bedding. Generally, performance of broilers raised on used treated litter was better than other groups.

Table 7: Economical efficiency of broiler raised on wheat straw litter types:

Groups	New Litter (NL)	Mixed Litter 50% New + 50% Used (ML)	Used Litter (UL)	Used Treated litter (UTL)
L.B.W(kg)	2.12[ab]±0.04	2.13[ab]±0.04	2.06[b]±0.03	2.20[a]±0.05
Total FC (kg)	3.35	3.49[ab]	3.58[a]	3.51
Price of kg feed/LE	6.50	6.50	6.50	6.50
Cost of FC/LE	21.78	22.70	23.27	22.81
Cost of chick + management/LE	9.00	9.00	9.00	9.00
Cost of Litter/LE	0.60	0.30	0.00	0.10
Total cost/LE	31.38	32	32.27	31.91
Sale price of kg meat/ LE	22.00	22.00	22.00	22.00
Total revenue/LE	46.64	46.86	45.32	48.40
Net revenue/LE	15.26	14.86	13.05	16.49
Economical Efficiency %	48.62	46.44	40.44	51.68

*Chick price = 6 LE/chick, Medical and management = 3 LE/bird, Litter cost = (Price of Kg New litter * Litter quantity/M^2) /Density, Litter cost = (1.40 LE * 4.3 kg)/ 10 birds= 0.602 LE, Price of alum = 0.10 LE/bird*

Conclusion

Recycled litter treated with alum induced better broiler performance, carcass characteristics, litter quality and economical efficiency than treatment fresh non-treated litter. The use of alum (aluminum sulfate) in broiler litter management improved feed conversion ratio (FCR), increased weight gain, decreased feed intake, increased livability, reacts with the moisture in the litter to reduce ammonia volatilization, and reduced pH of litter (acidic pH levels) for reduce the conversion of excretory uric acid into ammonia.

References

Anisuzzaman, M. and S.D. Chowdhury, 1996. Use of four types of litter for rearing broilers. Br. Poult. Sci., 37: 541-545.

Brake, J.D., M.J. Fuller, C.R. Boyle, D.E. Link, E.D. Peebles, M.A. Latour, 1993. Evaluation of whole chopped kenafandkenaf core used as a broiler litter material.Poult. Sci., 72: 2079-2083.

Casey, W., Brain, Ritz., D. Fairchild and M.P. Lacy, 2005. Litter quality and broiler performance. Cooperative extension Service Bulletin, pp: 1267.

Collins, M.S., R. Gough, D. Alexander and D. Parsons, 1989. Virus-like particles associated with a "wet litter" problem in chickens. Vet. Rec. 1x641.

Duncan, P.B., 1955. Multiple range and multiple F-test. Boimetrics, 1: 1-42.

El-Laithy, S.M.M., 2003. Effect of some managerial factors on turkey performance and behavior. Ph. D. Thesis, Fac. Vet. Med., Zagazig Univ., Egypt.

Elliott, H.A. and N.E. Collins, 1982. Factors affecting ammonia release in broiler litter. Trans. ASAE 25: 413-424.

Forbes, W. and R. Burns, 2015. Treating Broiler Litter with Alum. Report of Agricultural Extension Service, University of Tennessee.

Howes, J.R., C.A. Rollo and W. Crub, 1967. The production of dust from various litter materials.Poult. Sci., 46: 1273.

Jones, F.T. and W.M. Hagler, 1983. Observations on new and reused litter for growing broilers. Poultry Sci., 62: 175-179.

Kalita, K.P., R. Saikia and J.D. Mahanta, 2012. Performance of commercial broilers raised on reused and mixed type of litters. Indian Journal of Hill Farming, 25(2): 33-36.

Kelley, T.R, O.C. Pancorbo, W.C. Merka, S.k. Thompson, M.L Cabrera and H.M. Barnhart, 1995. Bacterial pathogens and indicators in poultry litter during re-utilization. J. Appl. Poultry Res., 4: 366-373.

Kennard, D.C. and J.D. Chamberland, 1951. Growth and mortality of chickens as affected by the floor litter. Poultry Sci., 30: 47-54.

Lien, R.J., D.E. Conner, S.F. Bilgili, 1992. The use of recycled paper chips as litter material for rearing broiler chickens. Poult. Sci., 71(1): 81-87.

Lokanath, G.R., K.P. Kalita, B.S. Ramappa, R.B.S. Venkatarami and V. Mangunath, 1984. Raising broilers on used litter. Poult. Pun., 1(2): 37-44.

Lu, J., S. Sanchez, C. Hofacre, J.J. Maurer, B.G. Harmon and M.D. Lee, 2003. Evaluation of broiler litter with reference to the microbial composition as assessed by using 16S rRNA and functional gene markers. Appl. Environ. Microbiol., 69: 901-908.

Malone, G.W., H.D. Tilmon and R.W. Taylor, 1990. Evaluation of kenaf core for broiler litter.Poult. Sci., 69(12): 2064-2067.

McCartney, M.G., 1971. Effect of type of housing and litter on production of broilers.Poultry Sci., 50: 1200-1202.

Moore, P.A. Jr., and D.R. Edwards, 2007. Long-term effects of poultry litter, alum treated litter and ammonium nitrate on phosphorus availability in soils. J. Environ. Qual., 36: 163-174.

Moore, P.A. Jr., T.C. Daniel and D.R. Edwards, 2000. Reducing phosphorus runoff and inhibiting ammonia loss from poultry manure with aluminum sulfate. J. Environ. Qual., 29: 37-49.

Moore, P.A. Jr., T.C. Daniel, D.R. Edwards and D.M. Miller, 1995. Effects of chemical amendments on ammonia volatilization from poultry litter. J. Environ. Qual., 24: 293-300.

Olesiuk, O.M., G.H. Snoeyenbos and C.F. Smyser, 1971. Inhibitory effect of used litter on Salmonella typhimurium transmission in the chicken. Avian Dis., 15: 118-124.

Phelps, A., 1971. Should you reuse litter? Poult. Adv., 4(1): 43-49.

Poyraz, O., Y. Deloimeroglu, K. Iscan and A. Nazligul, 1990. The effect of litter type and reusing litter on broiler performance 111 Economics of used litter. Veteriner Fakultesi Dergisi Universitesi. Ankara. 37(2): 260-268.

Ruszler, P.L. and J.R. Carson, 1968. Physical and biological methods of evaluating the potential usefulness of selected litter materials. Poultry Sci., 41: 249-254.

Schefferle, H.E., 1965. The microbiology of built up poultry litter. J. Appl. Bacterial., 28: 403-411.

Senaratna, D., N.S.B.M. Atapattu and D.U. Belpagodagamage, 2007. Saw dust and refuse tea as alternative litter materials for broilers. Tropical Agricultural Research, 19: 238-289.

SPSS, 2005. SPSS user's guide statistics version 16. Copyright SPSS Inc., USA.

Stanley, V.G., C. Gray, M. Daley, W.F. Krueger and A.E. Sefton, 2004. An alternative to antibiotic-based drugs in feed for enhancing performance of broilers grown on Eimeria spp. infected litter. Poult. Sci., 83: 39-44.

Toghyani, M., A. Gheisari, M. Modaresi, S.A. Tabeidian and M. Mehdi Toghyani, 2010. Effect of different litter material on performance and behavior of broiler chickens. Appl. Anim. Behav. Sci., 122: 48-52.

Yamak, U.S., M. Sarica, M.A. Boz and Ahmet UÇAR, 2016. Effect of reusing litter on broiler performance, foot-pad dermatitis and litter quality in chickens with different growth rates.Journal of the Faculty of Veterinary Medicine, Kafkas University, 22(1): 85-91.

Younis, M., E. Bazh, H.A.A. Ahmed and A.R. Elbestawy, 2016. Growth performance, carcass characteristics and litter composition of broilers raised on used litter managed by two types of acidifier amendments. J. Anim. Sci. Adv., 6(9): 1756-1765.