Egypt. Poult. Sci. Vol. (39)(II): (405-421) (2019) (1901-1041)

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

POSSIBILITY OF BROILER PRODUCTION ON REUSED LITTER

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Received: 14/ 04 /2019 Accepted: 10 / 06 /2019

ABSTRACT: This study examined the possibility of raising broiler chicks on partially or totally used litter and its effect on broiler performance, economic efficiency, carcass traits, litter characteristics, FPD score and welfare. At 7 day old, 360 Cobb broiler chicks were randomly allocated in 12 pens till 6 weeks of age, with 3 replicates of 4 experimental treatments contained 30 birds per pen. The treatments included; T1: new litter (NL), T2: mixed litter (NU), T3: 100% used litter (UL) and T4: 100% used litter treated with alum (UT). The results indicated that differences in most traits; LBW, FC, FCR, livability %, EPEI, economic feasibility, carcass traits and behavior patterns were insignificant ($P>0.05$) between different litter type groups. Except that, litter characteristics, FPD and FS grades were significant ($P<0.05$) between all types of litter where FP and FS scores were higher on used litter. Overall data trended to be numerically higher in NL group and always followed by UT group. In conclusion, results suggesting that recycling litter had no adverse effect on broiler performance, survival %, carcass traits, economic consideration and broiler welfare. Beside of that, alum amendment to composted reused litter offered an additional improvement on productive performance, litter quality and welfare. Our results provided evidence that, broiler chicks raised on reused treated litter can grow, perform and have welfare equal to that of birds reared on new litter. But, complementary studies measuring the impact on immune response, antioxidant enzymatic activity as well as a bacterial count, would be useful and necessary.

Keywords: reused litter- alum-wood shaving- broiler.

INTRODUCTION

Poultry industry is one of the most important and fastest growing sectors of global agribusiness. This rapid growth of poultry production in recent years, led to an increase in demand for all production requirements, especially the variable stuffs. Litter is one of the necessary and indispensable production requirements, especially in floor housing production system, (Farghly et al., 2018).

Poultry litter, by definition, is a mixture of initial bedding material, feed, manure, feathers, and other detritus from the chicken (Hinkle, 2010). Litter plays a vital role in absorbing the fecal moisture, provides a warm, soft and spongy surface for optimum comfort of the birds and to maintain carcass quality as it reduces the incidence of breast and footpad lesions (Oliveira et al., 2004 & Karthiga and Sharmilaa, 2018). Different litter materials are used in poultry houses that include wood shavings, straw, sawdust, cane bagasse, recycled paper, rice hulls, maize cobs, etc. The litter should be easily available with a maximum moisture absorbing capacity, be non-toxic, porous and economical (Saravanan, 2018).

Nowadays, one of the main challenges of modern poultry production is limitation on the litter supply because of the increasing demand, limited natural resources and the competition for its use in other industries or use as energy source (Gonçalves, et al., 2013). This has resulted in an increased cost for poultry producers to obtain bedding materials.

This situation has led poultry producers and researchers to attempt to find alternatives to traditional bedding materials or to maximize the use of the available materials through many methods and practices. One of these practices is the reuse of litter for more than one cycle instead of complete cleanout of litter and the subsequent replacement with new and more costly bedding material after each cycle, which increases costs, wastes time and effort and help to reduce some of the environmental issues associated with litter.

Reuse of litter for multiple flocks is a widely accepted practice in current commercial poultry operations. The reuse of broiler litter for more than one crop is a common practice in the USA and Brazilian poultry industry, due to 4 fundamental aspects: reduce the cost of production, scarcity of litter sources, environmental sustainability and the difficulty of handling and disposing of used litter. Recycled litter has several economic and environmental benefits for the poultry industry such as decreasing the cost of bedding materials, disease spreading, improving the quality of bedding material used as fertilizer and decreasing phosphorous runoff into water bodies (Younis et al., 2016). But, the use of recycled litter could be increase coliform levels and coccidial outbreaks in poultry flocks and increase disease transmission within the farm from flock to flock.

Litter can be composted through windrow composting in-house to reduce the bacterial and viral loads. In this method, temperatures of 50 ^{o}C or greater are created to reduce bacterial numbers and kill or reduce most viral pathogens (Bernhart, et al., 2010). A period of three to five day in-house composting program between flocks would be a useful way to reduce the microbial load and improve bird performance (Saravanan, 2018). Also, numerous litter amendments products could be introduced in poultry houses with various mechanisms of action. These types of litter treatments are; alkaline, enzymes, bacteria, osmotic agents, windrowing and acidifiers (Karthiga and Sharmilaa, 2018). The most common 'on-farm' technique has been the use of aluminum sulfate [$Al_2SO_4)_3$], which is commonly known as alum. Alum used as a litter amendment through 3 main purposes: lower ammonia, reduce litter pH and reduce litter moisture (Turner, 2008). Aluminum sulfate, 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^+), (Madrid et al., 2012) .

However, litter recycling practice faces many challenges and difficulties, especially in Egypt, such as diseases caused by coccidial infections and viruses, shortage of experience, information and its uncommon practice. Unfortunately, the researchers did not give this practice enough attention and there is a lack of local studies has been reported in this aspect in Egyptian poultry industry. For these reasons, the objective of this investigation was to study the possibility and feasibility of raising broilers on reused wood shaving litter and evaluate its impact on broiler performance, welfare and litter characteristics.

MATERIALS AND METHODS

The present experiment was performed at the experimental Poultry Research Farm, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. A total 360 of one day-old broiler (*Cobb^{500}* strain) chicks were received from a local commercial hatchery. Chicks were placed and brooded together in an open-sided naturally ventilated broiler house covered with new wood shaving as bedding litter during the first week of age. After that, chicks were randomly distributed into four equal experimental treatments using 12 pens with 3 replicates contained 30 birds per pen (10 birds/m^2) in a completely randomized design. The 4 treatments were as follows: T1: new litter (NL) served as control, T2: mixed litter (50 % new + 50 % used litter; NU), T3: 100% used litter (UL) and T4: 100% used litter treated (UT) with 495 g of alum/m^2 litter according to (Forbes and Burns, 2015), respectively.

Litter preparation: Single batch used litter based on wood shavings was brought from previous broiler flock. Caked litter material and feathers were removed from the reused litter before the experiment. Used litter had been stored in a heap shape allowed to compost for 7 days to elevate its temperature between 50 –70 °C as it is standard practice in reuse litter between each flock of chickens described by (Bernhart et al., 2010 and Karthiga and Sharmilaa, 2018). Before placement of the subsequent batch of chicks, new and used litter was returned to the pens and spread on the floor at depth of 7 cm. Reused treated litter (T4) composted with alum using commercially available aluminum sulfate. Alum was applied to litter in application rates of 495 g of alum/m^2 (Forbes and Burns, 2015).

Birds husbandry: All experimental groups were raised under similar environmental and managerial conditions in 12 floor pens with 7 cm thickness of wood shaving as litter. The house was equipped with round bell drinkers, plastic feeders and side curtains to control the house internal temperature. Chicks were brooded under electric brooder at 33 °C that was gradually decreased 3 ^{o}C weekly up to 25 °C by the end of 3rd week. Birds had *ad-libitum* access to feed and water. The diet was formulated to fulfill the nutritional requirements of broiler as recommended by strain guide recommendations. The feeding program included the 3 phases: a starter diet (days 1-17), a grower diet (days 18-35), and a finisher diet (days 36-42). Chicks were vaccinated against Newcastle disease and Gumboro disease in the drinking water after following all precautions recommended by the vaccine manufacturers and no health problems were observed. The experiment was designed to last for six weeks (42 days).

Data collection: All chicks in each replicate were weighed individually from 1 to 6 weeks of age using electrical balance. The estimated growth performance indexes were: average body weight (BW), feed consumption (FC), feed conversion ratio (FCR), mortality % and European production efficiency index (EPEI). Economical efficiency of each treatment was calculated according to the actual prices prevailing in the Egyptian market during the experiment. Slaughter test was done at the end of the trial (42 d.), three birds per replicate were randomly selected, fasted for 6 hrs, slaughtered and eviscerated.

Behavioral observations were recorded for 3 consecutive days at 3rd and 5th week of bird's age. Most common behaviors performed by broilers (eating, drinking, resting, dust bath, preening, agonistic and flapping) were evaluated in the morning from 08:00 to 10:00 h. Scan sampling method at the pen floor level was used for behavioral data for 10 minutes intervals for each pen. Behaviors were recorded by 0:1 measurement (presence or absence) of each one. It was recorded the number of birds in each experimental unit engaged in each of the activity as clearly defined by Senaratna et al., (2011).

Litter quality: temperature, moisture and pH of litter were took place also at 7, 21 and 42 d of birds' age, respectively. Moisture content and pH of litter samples were analyzed by using methods adopted by Brake et al. (1992). Also, physiological parameters respiration rate (R.R) and skin temperature (Ts^{o} C) were done at 20 and 35 days of age.

At 6 week of age, all birds' Foot pad burn (dermatitis) and feather condition score were performed by visual evaluation during bird harvesting and slaughtering. Foot pads scores were assigned using the four-point scale (from 0 to 3) where; 0, no sign of damage to 3 = extended burn and inflammation using the scoring method described in detail with photos by Eichner et al., (2007).

Statistical analysis: All data were expressed as mean ± SE, by one-way ANOVA with litter condition as a main factor using statistical software of SPSS Ver., 24. (2015) Comparisons of means when the factor had a significant effect were obtained using Duncan test. A probability of $P < 0.05$ was required for statements of significance.

RESULTS AND DISCUSSION

Productive performance:

Results presented in Table (1) showed that, non-significant differences were found in body weight of broiler chicks reared on new, mixed or reused litter at all ages. But, body weight numerically higher for broiler raised on a new litter (T1) followed by mixed (T2), used treated with alum (T4) and totally used but not treated (T3), respectively especially at 4th, 5th and 6th week of age. Results of this study clearly indicate that, broiler reared up to 42 days of age on UL and UT litters showed non-significant differences in the final body weight as compared to birds reared on NL. These results are in full 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. Also, Taboosha, (2017) and Garcés-Gudiño et al., (2018) are in agreement with the present results, where the chickens were reared on recycled and new litter showed a same productive performance.

Moreover, data in Table (2) showed that, there were no significant differences were found in the final BW, total FC, FCR, livability % and EPEI among all experimental groups of broiler at the end of the production period. While, the difference between groups in FC, mortality and livability % were insignificant, there were though numerical higher FC, mortality % and lower FCR were found in the chicks raised on a used litter (T3) followed by mixed litter group (T2). On the same way, NL group recorded better FCR (1.68), higher livability % (99.05) and EPEI (335) number.

There were no differences in mortality rates between new and used litter groups. But, mortality rates were numerically higher in used litter (2.85%) than new one (0.95%), but the difference was insignificant. Overall, survivability % was insignificant, indicating that even new, untreated used and used treated litter had good physical and chemical conditions. This could be due to the good housing conditions, low microbial challenge, and optimal stocking density used in this study, (Oliveira et al., 2015).

The most important measure of growth traits, as a term of EPEI, was numerically higher in NL group (335) followed by UT (330), ML (323) and UL (314) respectively. Non-significant differences found in BW, FC, FCR, mortality and livability % of broilers raised on fresh and reused litter was also reported by Taboosha, (2017). Similar observations were also found by Kalita et al., (2012) who reported that there was no significant difference in the average body weight and survivability % of the broilers raised on fresh and reused type of litter. Moreover, these results are in accordance with Yamak et al., (2014 and 2016) and Younis et al., (2016) who found that FCR was better in new litter treatment than used one but without significant differences.

In this study, recycled litter did not seem to be a hazard for the broiler productive performance. Moreover, chickens reared up to 42 days of age on a recycled treated litter (T4) achieved the same BW, FC, FCR and EPEI in comparison with the control group (NL). Soliman and Hassan (2017) found that, broilers' performance traits (BW, FCR and PI) were improved in groups raised on treated litter than in used untreated litter. Improvement in broiler growth performance could be associated with the immunity raised by the early exposition to oocysts in the litter (Garcés-Gudiño et al., 2018). Also, 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) or benefit might be similar to that of birds that are inoculated with a mixed culture probiotic and experience improved feed conversion and BW gain.

Adding to this, used litter needs a previous treatment before the introduction of the new chicks into the house. It has been found that recycled litter treated with alum induces a better broiler performance and carcass characteristics and better intestinal immune response than fresh and used non treated litter (Oliveira et al., 2015; Younis et al., 2016 and Taboosha, 2017). This agrees with the present results, where the chickens were reared on recycled litter treated with alum showed a better productive performance in compare with untreated used litter (T3).

Carcass characteristics:

Results presented in Table (3) indicate that, there were non-significant differences were found in fasted BW at slaughter age and all carcass traits (carcass g or %, giblets %, edible parts % and abdominal fat %). These results indicated that, overall carcass yields did not vary significantly among all groups either new, mixed or reused litter exerted similar effects on the carcass yields. Similar trend of results was also reported by Kalita et al. (2012). Used treated litter with alum (UT) seemed to numerically improve carcass weight (g), dressing %, giblet % and edible parts % in compare with other treatments especially fresh litter one (NL). Birds in UT group recorded higher carcass weight (1816 g), dressing % (75.79) of BW and total edible parts (79.51). Results in this study were fully agreement with Yamak et al., (2014) who observed non-significant differences in slaughter and carcass characteristics among chickens raised on new or used litter. Also, Taboosha, (2017) observed non-significant differences of dressing % between fresh and used litter treatments.

Physiological parameters:

Results of physiological parameters (respiration rate and skin temperature) of broilers as affected by litter condition (new, used or used treated) at different ages (20 and 35 days of age) are presented in Table (4). It's very noticeable that, there was no significant effect ($P>0.05$) of recycling litter in physiological thermoregulation (R.R and T.s) of broilers raised on all types of litter at 20 and 35 days of age. All values of R.R and T.s at all ages were ranged in the normal range without any differences or abnormal readings.

This is a good indicator since reuse litter practice did not affect the productive or physiological performance of the broiler. Birds showed complete relaxing during follow up physiological and thermoregulation response. This may be due to good management of ventilation, litter condition, ammonia emission and no differences in litter characteristics especially litter temperature. Similar observations were also reported by Taboosha, (2017) who found no significant differences in physiological parameters of broilers (Respiration rate and skin temperature of broilers) rose on all types of litter at 20 and 35 days of age.

Broiler behaviors:

Results of behavioral patterns (eating, drinking, resting, dust bath, feather preening, agonistic and flapping) at 20^{th} and 35^{th} days of age as affected by litter condition are presented in Table (5). The differences among broiler raised on a new, mixed, used and used treated litter were not significant in most of the behavioral patterns studied (eating, drinking, resting, agonistic and flapping) at 20^{th} days of age. Except that, litter condition affects significantly ($P<0.05$) dust bathing and preening behaviors. This is a logic result, because physicochemical characteristics of fresh litter (low moisture, less manure content and lighter weight) encourage birds to express dustbathing behavior and also preening which always appeared when birds in resting or dust bathing activities. For this reason, broilers raised in NL get higher dust bathing (12.50 %) and higher preening (13.54) behaviors in compare with other groups and the reason were due to loose litter. These results fully agree with Shields et al., (2004) who mentioned that the birds readily dust bathing in finer and lighter material. Birds probably prefer it because finer materials are superior at penetrating the feathers to reach the downy portion of plumage.

Furthermore, some behavioral patterns in birds were influenced significantly as affected by litter type (eating, drinking and resting) at 35th days of broiler age. Resting behavior was significantly affected at the 5th week of age and this may be due to correlated with increased moisture and manure content of the bedding or litter pH value. These results agreed with Toghyani et al. (2010) and Villagra et al., (2014) who found a significant difference in feeding, drinking, preening and dust bathing behaviors on the different litter types. Also, similar result found by Taboosha (2017) who reported that, the different of behavioral patterns in birds did not influenced by the litter types except eating and resting patterns were influenced at 35 days of age.

Foot pad burn and feather score:

Footpad burn and feather score were performed at the end of the trial at 42 days (during slaughtering) and the FP and FS scores are presented in Table (6). The result shows that, high significant differences ($P<0.01$) were found in FPD and FS scores were found between chickens reared in different litter types. For both traits, the results show a uniform trend, as the broilers reared on a fresh litter got better scores for FP and FS where it obtained higher grades (0 level) for healthier footpad (less dermatitis) and cleaner feathers (less dirt) followed by mixed and used litter groups. This is a logicresult, because it's well known that the condition of the litter become worse with the end of a production cycle as result of waste (feces, feed and water) accumulation especially for mixed (T2) and totally used (T3 and T4) litter. A similar result was found by Santos, (2009) who worked with new litter and reused ones and noted that broilers reared on reused litter showed higher rates of injuries of FPD. Also, results of this study were in agreement with Cressman, (2014) and Vieira et al., (2015). But, these results differ from those found by Traldi et al., (2007), who found that the scores of lesions on footpad and knee were higher in chickens reared on new wood shavings litter than those reared on reused ones.

In the same context, it is clear that, the incidence of FP dermatitis in UT group was significantly higher than in untreated UL group where FP2 was (9.17 vs 6.13) and FP3 was (2.50 vs 0.90), respectively. This is an unexpected result, especially with low moisture content in UT litter with alum (20.83) at the end of the production cycle. According to Nagaraj et al., (2007), litter moisture is considered a predisposing factor for contact dermatitis. Ammonia released from the litter can also irritate bird skin, causing footpad dermatitis and hock and breast burns. But this may be due to the corrosion effect of alum sulfate litter amendment. Inorganic litter amendments like sodium bisulfate and aluminum sulfate are corrosive to structures and may be harmful to handlers (Senyondo, 2012).

On the contrary, feather condition scores (FS) grades for broiler in UT group was better (more cleanly) in compare with the same group (UL). This is may be due to for the same reason (low moisture content) which was reflected on the cleanliness and whiteness of feathers.

Litter quality measurements:

The physicochemical characteristics (Litter temperature, moisture content and pH) in various litter types (NL, NU, UL and UT with alum) at different times of production cycle (7th, 21St and 35th) are presented in Table (7). The results indicate that, a NL was significantly higher (P<0.01) in temperature degree at zero-day (7th day) than NU, UL and UT, respectively. With the time, at 21 and 35 days of age, temperature degree increased in all litter types but the differences became insignificant. But, NU and untreated UL recorded the higher degree of temperature (29.85 and 29.67, respectively) in compare with NL (28.92) and UT one (28.83) at 35 days of broiler age.On the opposite, moisture % content and pH during different periods of the experiment showed high significant (P<0.01) differences between various litter types. It's very clear that, the average moisture % for all the litter types increased almost 2 - 3 times throughout the rearing cycle from an initial value (from 8.29 to 28.98) because of waste accumulation, water spillage, the birds' respiration, and air humidity. But, moisture contents % observed in UT litter (20.83) was ideal, 20 – 25 % at 35 days, while moisture contents for NL, NU and UL were higher than the ideal moisture content (>25 %) at 35 days.

In this study, Litter moisture levels varied significantly between new and used litter; but, in both cases, levels were within acceptable limits and were not considered to adversely affect performance. Moisture content % varied significantly between untreated UL (28.98) and treated UT (20.83) litter. These results agree with Madrid et al., (2012) who found that DM content of the used litters amended with alum was higher than that of the control. Avoiding litter wetting is the most important step for controlling ammonia problems, as it has been reported that wet litter can lead to high ammonia levels in broiler housing. These results agree with Youins et al., (2016) and Taboosha (2017) who found the same result.

Moreover, Table (7) shows that there were high (P<0.01) significant differences in acidic pH values among all treatments. NL was more acidic than UL and UT on day 7. But after that, there was a trend of increasing pH from 7 day to 35 days in all the litter types may be due to fecal accumulation. But it's important to note that, treated used litter with alum (T4) brings a considerable decrease in litter pH value (6.13) especially at 35 days of broiler age in compare with all another litter type. Aluminum sulfate treated recycled litter showed lower pH levels during the different period of sampling when compared with new and reused untreated groups. These results are in accordance with those of (Madrid *et al.*, 2012 and Taboosha, 2017) who found alum lowered the litter pH during the first 4 weeks, at least. This acidic litter, in turn, was related to lower ammonia volatilization (Moore *et al.*, 1995). The pH of the litter increased with the amount of manure produced.

Litter moisture was affected by different factors including the type of diet, water intake, type of drinkers, ambient temperature and ventilation system in the farm (Oliveira et al., 2004). Litter amendments are often used in poultry production to reduce litter pH to control ammonia and as an intervention method in houses with a recurring disease issue such as gangrenous dermatitis (Shepherd, 2010). In the present study, litter treatments with alum were able to significantly reduce pH and litter moisture. The reduced ability of alum sulfate in lowering moisture content was recorded in (Nagaraj et al., 2007). Also, results of Madrid et al., (2012) showed that litter treatments with chemical or microbiological products have positive effects on litter condition by lowering pH value or litter moisture.

Economical efficiency:

Results of economic considerations (inputs and outputs) of broilers as affected by litter condition (new, used or used treated) are presented in Table (8). It's very interesting to note that, there was no significant effect of recycling litter in broiler economic performance except litter cost where litter cost significantly reduced when it was recycled. This is logic result when broiler reared on new litter (0.39 L.E/bird) is more costly than mixed (0.20 L.E) or totally reused (0.00 L.E) litter (T3 and T4). However, in our study, litter cost didn't reflect a significant difference in total cost of broiler production investment. This may be due to it was calculated as monetary inputs and outputs for one bird only. But when this practice of recycling litter was applied on a big scale of production (10,000 bird or more) it will be a very useful method for reducing production cost and saving money. Also, the low effect of reused litter practice in total cost of this study may be due to some numerical differences in total FC. It is very well known that, the cost of nutrition represents about 65 - 75 % of total broiler projects investments. Even though, broiler raised on used treated litter (UT) recorded lower total cost (35.85 LE) in compare with other groups.

On the same way, there were no significant differences found in total revenue, net revenue, economic efficiency and in relative economic efficiency for all broiler groups. Although of that, some numerical differences were found between all treatments where broiler reared on NL obtained higher net revenue and economic efficiency (16.51 LE and 0.45 %) followed by ML (14.94 LE and 0.41), UT (14.73 LE and 0.41) and UL (13.93 LE and 0.37), respectively. But these difference were still not significant ($p>0.05$) this may be due to small numerical difference found in final BW which inverted in numerical excess in total revenue for broiler raised in new litter. These results partially agree with Taboosha (2017) who reported, performance of broilers raised on used treated litter was better than other groups.

CONCLUSION AND RECOMMENDATION

In conclusion, recycling litter for multiple flocks is a widely accepted practice in poultry production and highly recommended in several areas around the world, due to these aspects: reducing litter costs, shortening downtime, seasonal availability or scarcity of bedding material, environmental sustainability and the difficulty of handling and disposing of used litter.

Our results provided evidence suggesting that, reuse of litter under Egyptian conditions for a second time has no adverse effect on broiler performance, survival %, carcass traits, economic consideration and broiler welfare. Except FP incidence increases with reuse of litter, it can be easily treated or avoided. In addition, the acidifier alum amendment added to composted reused litter offered additional improvement on productive performance, litter quality and welfare.

Briefly our results demonstrated that, broiler chicks raised on reused treated litter can grow, perform and have welfare equal to that of birds reared on new litter. Complementary studies that include measuring the impact of reusing litter on immune organs' weight, immunoglobulin concentration, antioxidant enzymatic activity as well as a bacterial counts, would be useful and necessary.

Table (1): Live body weight (g) of broilers at different ages as affected by litter type.

Age / Treatment	1stWk	2ndWk	3rdWk	4thWk	5thWk	6thWk
T1: NL	181.66±5.21	498.44±7.68	944.19±19.54	1400.16±25.19	1937.67±32.78	2425.18±29.52
T2: NU	181.19±2.67	486.88±4.57	936.25±9.49	1350.17±14.93	1884.38±23.87	2360.52±41.31
T3: UL	184.63±3.12	488.03±6.26	926.41±11.35	1326.82±18.42	1845.61±27.61	2332.26±37.94
T4: UT	182.84±3.04	485.76±6.46	933.91±14.77	1352.12±16.94	1867.81±30.58	2339.68±43.85
P.	0.912	0.473	0.852	0.061	0.148	0.334

Table (2): Productive traits of broilers as affected by litter type.

Traits / Treatment	Final BW (kg)	Total FC (g)	FCR	Mortality%	Livability %	EPEI
T1: NL	2.43±0.02	3683.17±24.15	1.68±0.01	0.95±0.95	99.05±0.95	335.06±4.94
T2: NU	2.36±0.04	3670.49±88.65	1.70±0.04	1.91±0.95	98.09±0.95	323.39±11.92
T3: UL	2.33±0.06	3750.17±42.35	1.73±0.03	2.86±0.00	97.14±0.00	314.71±6.25
T4: UT	2.34±0.08	3658.07±19.90	1.68±0.01	1.91±0.95	98.09±0.95	330.67±3.19
P.	0.607	0.613	0.488	0.487	0.487	0.294

Table (3): Slaughter test of broilers as affected by litter type.

Traits / Treatment	LBW (g)	Carcass (g)	Carcass (%)	Giblets (%)	E.parts (%)	A.fat (%)
T1: NL	2392.00±10.38	1783.26±10.28	74.56±0.51	3.63±0.09	78.19±0.54	0.88±0.03
T2: NU	2373.00±9.00	1786.00±17.35	75.27±0.45	4.01±0.01	79.28±0.61	1.05±0.16
T3: UL	2357.00±15.42	1772.79±13.26	75.21±0.12	3.73±0.21	78.94±0.25	0.75±0.14
T4: UT	2397.00±13.45	1816.71±14.48	75.79±0.49	3.72±0.03	79.51±0.58	1.03±0.25
P.	0.117	0.079	0.267	0.126	0.096	0.55

Table (4): Physiological parameters of broilers as affected by litter type.

Traits / Treatment	At 20^{th} days		At 35^{th} days	
	R.R (R./min.)	Skin Temp. (˚C)	R.R (R./min.)	Skin Temp. (˚C)
T1: NL	66.33±3.09	40.15±0.33	57.00±2.44	40.25±0.20
T2: NU	64.17±2.51	40.52±0.28	56.83±1.56	40.65±0.10
T3: UL	71.33±3.93	40.30±0.20	59.00±3.44	40.62±0.26
T4: UT	66.00±2.44	40.15±0.18	58.33±1.71	40.70±0.14
P.	0.300	0.536	0.902	0.061

Table (5): Behavioral patterns (%) of broilers as affected by litter type.

Treatment	Behavioral (%) of broiler at 20thdays						
	Eating	**Drinking**	**Resting**	**Dust bath**	**Preening**	**Agonistic**	**Falpping**
T1: NL	19.79±7.51	11.46±1.04	51.04±3.76	12.50^{a}±4.77	13.54^{a}±1.04	0.00±0.00	0.00±0.00
T2: NU	19.79±2.08	12.50±1.80	51.04±5.80	3.13^{b}±1.80	10.42^{ab}±1.04	0.00±0.00	1.04±1.04
T3: UL	21.88±3.13	9.38±1.80	57.29±10.88	4.17^{b}±1.17	5.21^{b}±2.76	0.00±0.00	0.00±0.00
T4: UT	18.75±4.77	12.50±1.80	68.75±11.27	1.04^{b}±1.04	7.29^{b}±1.04	0.00±0.00	0.00±0.00
P.	0.972	0.528	0.460	0.022	0.032	-----	0.441
Treatment	**Behavioral (%) of broiler at 35thdays**						
	Eating	**Drinking**	**Resting**	**Dust bath**	**Preening**	**Agonistic**	**Falpping**
T1: NL	15.63^{b}±1.80	8.33^{ab}±1.04	71.88^{ab}±3.61	2.08±1.04	2.08±2.08	1.04±1.04	2.08±1.04
T2: NU	23.96^{a}±1.04	4.17^{b}±1.04	61.46^{b}±2.76	2.08±1.04	3.13±3.13	1.04±1.04	2.08±1.04
T3: UL	25.00^{a}±1.80	8.33^{a}±1.04	83.33^{a}±2.76	6.25±1.80	2.08±2.08	1.04±1.04	1.04±1.04
T4: UT	20.83^{a}±1.04	12.50^{b}±1.80	81.25^{b}±4.77	3.13±1.80	0.00±0.00	0.00±0.00	0.00±0.00
P.	0.008	0.012	0.009	0.227	0.775	0.802	0.363

Table (6): Footpad burn and feather score of broilers as affected by litter type.

Treatment	Footpad burn (%)				Feather Score (%)			
	FP 0	**FP 1**	**FP 2**	**FP 3**	**FS 0**	**FS 1**	**FS 2**	**FS 3**
T1: NL	79.33^{a}±0.38	11.20^{c}±0.17	9.47^{a}±0.20	0.00^{b}±0.00	20.43^{a}±1.49	43.65^{a}±1.64	27.45^{c}±1.06	8.47^{d}±1.27
T2: NU	83.30^{b}±1.10	11.70^{c}±0.12	4.20^{c}±0.52	0.83^{b}±0.49	12.95b±1.26	31.65^{b}±0.64	38.87^{b}±1.49	16.53^{c}±1.31
T3: UL	74.57^{c}±0.49	18.40^{a}±0.52	6.13^{b}±0.49	0.90^{b}±0.52	3.52^{d}±0.74	17.50^{c}±0.85	52.41^{a}±1.35	26.57^{a}±0.62
T4: UT	72.50^{c}±0.46	15.83^{b}±0.49	9.17^{a}±0.49	2.50^{a}±0.46	7.30^{c}±0.70	31.37^{d}±1.24	40.14^{b}±0.63	21.19b±1.62
P.	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000

Table (7): Litter quality of different litter types.

Treatment	Litter Temperature (°C)			Litter Moisture (%)			Litter pH		
	7 d.	**21 d.**	**35 d.**	**7 d.**	**21 d.**	**35 d.**	**7 d.**	**21 d.**	**35 d.**
T1: NL	28.90^{a}±0.11	28.42±0.35	28.92±0.49	8.29^{c}±0.33	20.13^{a}±0.38	26.32^{b}±0.48	5.08^{c}±0.09	8.11^{a}±0.06	8.51^{a}±0.26
T2: NU	28.42^{b}±0.03	29.40±0.30	29.85±0.36	9.57^{b}±0.14	17.79^{b}±0.26	27.28^{b}±0.30	6.89^{a}±0.20	7.47^{b}±0.10	8.63^{a}±0.25
T3: UL	28.20^{b}±0.07	29.30±0.31	29.67±0.33	10.08^{b}±0.15	17.65^{b}±0.28	28.98^{a}±0.17	6.93^{a}±0.18	7.19^{c}±0.04	8.21^{a}±0.18
T4: UT	26.23^{c}±0.26	28.62±0.37	28.83±0.43	12.30^{a}±0.14	15.90^{c}±0.33	20.83^{c}±0.17	6.06^{b}±0.05	5.89^{d}±0.05	6.13^{b}±0.43
P.	0.000	0.130	0.215	0.000	0.000	0.000	0.000	0.000	0.001

Table (8): Economical efficiency of broilers as affected by litter type.

Treatment	LBW kg	FC kg	Litter Cost	T. Cost[1]	T. Revenue[2]	Net Revenue[3]	E. efficiency
T1: NL	2.43±0.02	3.68±0.03	0.39[a]±0.02	36.33±0.17	52.84±0.26	16.51±0.33	0.45±0.01
T2: NU	2.36±0.04	3.67±0.09	0.20[b]±0.01	36.05±0.57	50.99±0.99	14.94±1.50	0.41±0.05
T3: UL	2.33±0.06	3.75±0.04	0.00[d]±0.00	36.37±0.28	49.77±1.39	13.39±1.12	0.37±0.03
T4: UT	2.34±0.08	3.66±0.02	0.07[c]±0.00	35.85±0.13	50.59±1.68	14.73±1.78	0.41±0.05
P.	0.607	0.618	0.000	0.667	0.381	0.456	0.536

Litter cost = (Price of Kg New litter * Litter quantity/M^2) /Density
Litter cost = (1.20 LE * 3.3 kg)/ 10 birds
Price of alum = 0.10 L.E/bird

Chick price = 6LE/chick
Medical and management = 6 LE/bird
Feed price= 6.5 L.E/kg
Meat price= 22 L.E

T.cost = Feed cost + check + mange + litter
T. Rev. = LBW * Liav.% * 22
Net Rev. = 2 – 1
E. efficiency= 3/1

reused litter- alum-wood shaving- broiler.

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إمكانية إنتاج دجـاج اللحم على الفرشة المستخدمة

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يهدف هذا البحث إلى إمكانية تربية دجاج التسمين على الفرشة المستخدمة جزئياً أو كلياً وتأثير ذلك على أداء النمو والكفاءة الإقتصادية وصفات الذبيحة وجودة الفرشة وصحة الطيور وسلوكها. إستخدم فى هذه الدراسة 360 كتكوت (كوب 500 غير مجنس) وعند عمر 7 أيام تم تقسيم وتوزيع الطيور عشوائيا إلى أربعة معاملات تجريبية متساوية (4 معاملات * 3 مكررات * 30 طائر). المعاملة الأولى تم إستخدام فرشة جديدة 100 % (NL) بينما فى الثانية استخدم 50 % فرشة جديدة مع 50 % فرشة مستعملة (NU) واستخدمت فرشة مستعملة بنسبة 100 % للمعاملة الثالثة (UL) وفى المعاملة الرابعة إستخدمت فرشة مستعملة 100 % ولكن تم معاملتها بالكمر (كمبوست) وإضافة الشبة (UT).

أظهرت النتائج أن معظم الصفات المدروسة كوزن الجسم الحى والغذاء المأكول ومعامل تحويل الغذاء وحيوية الطيور ومعامل كفاءة الإنتاج الأوروبى والجدوى الإقتصادية وصفات الذبيحة وسلوك الطيور لم تكن الفروق معنوية (P>0.05) بين المعاملات المختلفة. ولكن بالنسبة لجودة الفرشة والتهابات القدم وجودة الريش كانت الفروق معنوية (P<0.05) بين المجموعات حيث كانت التهابات القدم ورداءة الريش أعلى فى الطيور المرباة على الفرشة المستخدمة.

وختاما تشير النتائج إلى أن إعادة إستخدام الفرشة لم يكن لها تأثير سلبي بصورة معنوية على أداء النمو لدجاج التسمين ونسبة الحيوية والجدوى الإقتصادية وصفات الذبيحة وسلوكيات الطيور. إضافة إلى ذلك، فإن تعديل الفرشة بالكمر (كمبوست) وإضافة الشبة لها قد أظهر تحسينًا إضافيًا على الأداء الإنتاجي ، وجودة الفرشة ورفاهية وسلوكيات الطيور. وفى النهاية قدمت هذه النتائج دليلاً واضحا على أن كتاكيت التسمين التي تربى على الفرشة المعالجة والمعاد استخدامها يمكن أن تنمو وتعيش بصورة طبيعية وتنتج إقتصاديا مثل الطيور التى تربى على فرشة جديدة ومع ذلك بعض الدراسات المكملة لهذه الدراسة التي تقيس الإستجابة المناعية والنشاط الإنزيمي ومضادات الأكسدة والعد البكتيري ستكون مفيدة وضرورية.