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(Original Article)

Impact of Chemically Treated Litter on Broiler Performance, Health, and Economic Viability

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Abstract

This study aimed to assess the impact of chemically treated litter on the growth performance, carcass traits, health status and economic efficiency of broilers. A total of 180 one-day-old Ross broiler chicks were distributed into six groups, each consisting of three replicates with 10 chicks per replicate. The control group (C) was raised on untreated wheat straw litter, while the other groups (T1, T2, T3, T4, and T5) were provided with litter amended with 10% sand, clay, zeolite, litter guard and biochar, respectively. Results regarding growth performance metrics such as body weight, gains, feed consumption and feed conversion ratio indicated significant differences ($P \leq 0.05$) among the various litter treatments at different stages. Broilers raised on litter treated with 10% biochar and 10% litter guard demonstrated notably higher body weights and improved feed conversion compared to those raised on untreated or chemically treated litters. No significant differences were observed in giblets, but birds raised on litter amended with 10% biochar exhibited the highest dressed carcass. Additionally, lower abdominal fat percentages were noted in broilers raised on litter treated with 10% sand, biochar and litter guard. Furthermore, birds raised on litter treated with 10% sand, biochar and litter guard showed significantly lower bursa percentages and fewer leg problems compared to those raised on other litter treatments. Considering cost-effectiveness and availability, certain chemical treatments may serve as beneficial supplements to conventional litter. In conclusion, chemically treated litter incorporating 10% sand, biochar and litter guard holds promise as effective litter amendments for managing broilers.

Keywords: *Broilers, Carcass, Growth, Health, Litter treatments*

Introduction

In broiler production, considerable attention is directed towards the housing, environment, and welfare of the broilers (Biesek *et al.,* 2023). The litter plays a pivotal role in safeguarding chickens against elevated moisture levels or low floor temperatures during their rearing phase, while also being expected to efficiently

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absorb toxic compounds and excreta fractions (Gerber *et al.,* 2020). Desirable litter characteristics include lightweight composition, medium particle size, excellent absorption properties, rapid drying capabilities, soft and compressible texture, low heat conductivity, affordability, and high efficiency in moisture absorption coupled with reasonable drying times (Munir *et al.,* 2019; Farghly *et al.,* 2021 and 2022). Moreover, bedding materials can significantly influence the composition of chickens' gut microbiota, their growth rates, and overall health status (Gomes *et al.,* 2022). Elevated moisture levels within the litter can lead to increased ammonia (nitrogen) accumulation, affecting microbial metabolism and subsequently impacting bird welfare and productivity, as well as causing damage to the birds' foot pads due to prolonged exposure to wet bedding (Diarra *et al.,* 2021).

The chemical composition of the litter may exert profound effects on its physical characteristics, such as absorption and moisture release rates (Elsherbeni *et al.,* 2024). Consequently, efforts are being made to explore alternative additives that not only enhance litter quality but also ensure sustainable production volumes, promote avian health, and mitigate environmental risks. Hence, research endeavors are increasingly focused on identifying chemical agents with beneficial effects on both the litter substrate and the well-being of the birds (Haque *et al.,* 2020). Various natural and chemical substances, including but not limited to zeolite, yucca schidigera, sepiolite, vermiculite, aluminum chloride, aluminum sulfate, and sodium bisulphate, can be incorporated into the litter within poultry housing facilities to regulate moisture levels, minimize ammonia emissions, and maintain optimal pH levels (Yildiz *et al.,* 2014).

An interesting solution lies in the utilization of natural materials or chemicals, which serve dual purposes: as agents ensuring optimal sanitary conditions, and as feed additives aimed at enhancing growth performance or meat quality (Andronikashvili *et al.,* 2014). Among the most prevalent dry acidifiers are sodium bisulfate, aluminum sulfate, and sulfuric acid clay, which are extensively employed as litter treatments. These acidifiers facilitate the conversion of ammonia into ammonium (Al-Jumaily and Al-Jumaily, 2022). Ritz *et al.* (2016) delineated three main categories into which these treatment products fall: 1) acidifying agents, which lower litter pH and consequently inhibit the bacteria responsible for converting manure nitrogen into ammonia; 2) clay-based products, which absorb odors and diminish ammonia release by absorbing moisture; and 3) products that function by impeding microbial growth and enzyme production through mechanisms such as competitive exclusion and enzyme inhibition. Various factors, including litter accumulation, moisture content, poultry species, brooding temperature regime, and disease challenges, influence the selection of treatment methods, their efficacy, and the subsequent return on investment. Presently, the most efficacious products appear to be those that chemically lower the litter pH (Elsherbeni *et al.,* 2024). The resultant low pH creates an inhospitable environment for most bacteria, including those responsible for ammonia volatilization. Additionally, acidifiers typically lower the litter pH to a range between 4.0 and 7.0, thereby inhibiting the proliferation of ammonia-producing bacteria and other potentially pathogenic microorganisms such as Clostridia, Salmonella, and *E. coli*. Moreover, sulfate binds with ammonia, preventing its release as a gas. However, the moisture content of the litter is a critical consideration when utilizing aluminum sulfate, which is commonly applied as a top dressing onto the litter surface 3–7 days prior to chick placement. The utilization of natural compounds in poultry production has garnered significant attention due to their potential to enhance growth performance while concurrently mitigating adverse effects on animal health and welfare (Sujiwo and Ariyadi, 2023).

Numerous efforts have been undertaken to enhance or uphold litter quality, particularly in mitigating moisture levels and adjusting pH, throughout broiler production. One prevalent strategy involves incorporating minerals such as zeolite into the litter substrate. Zeolite's substantial porosity and expansive surface area render it advantageous for absorbing various liquids, including water, NH_3, organic compounds, as well as gases like volatile organic compounds and hydrocarbons (Brink *et al.,* 2022). Furthermore, Dharmaraj *et al.* (2023) observed that sand exhibits promise as an alternative litter material due to its relatively fine particle size, facilitating deep water absorption into the sand's surface and thus preventing surface moisture retention, thereby averting cake formation. Studies by Linhoss *et al.* (2019) have highlighted the beneficial effects of biochar in enhancing litter water retention without adversely affecting broiler performance, foot health, or overall health status. Biochar's extensive surface area and high porosity contribute to enhanced water absorption, potentially influencing water activity levels within commercial broiler litter. However, limited information is available regarding the growth performance of broilers reared on chemically treated litter substrates.

Hence, to address this gap in knowledge, the present study aims to investigate the effects of incorporating select chemicals into litter on the growth performance and health outcomes of broilers.

Material and Methods

The experiment was conducted at the Poultry Research Farm, Faculty of Agriculture, Assiut University, Egypt, during the period from October 2022 to January 2023, with the aim of assessing the impact of chemically treated litter on the growth performance, carcass traits, health status, and economic viability of broilers. A total of 180 one-day-old Ross broiler chicks were divided into six treatment groups, each with three replicates containing 10 chicks per replicate (Semi closed house). Chicks in the first group were raised on untreated wheat straw litter (thickness, 6-8 cm) and served as the control (C). Conversely, chicks in the remaining five groups (T1, T2, T3, T4, and T5) were raised on litter amended with 10% of sand, clay, zeolite, litter guard, and biochar, respectively. Each replicate was allotted a space of 1 square meter furnished with deep litter (6-8 cm). Litter guard (LG): is a commercial product (a natural bentonite was submitted to heating treatment at 550 and 750°C). Bentonites are mainly composed of montmorillonite, $(Na,Ca)\ 0.3\ (Al, Mg)\ 2Si_4O_{10}(OH)_2.n(H_2O)$, with a small amount of other clay minerals.

Sand: is a natural material contained (silica, followed by smaller amounts of alumina, iron oxide, and calcium oxide).

Zeolites: is a natural material contained (clinoptilolite) have a 3D structure made of alumina and silica that arranged in a tetrahedral microporous shape.

Clay: is a natural material contained (hydrous aluminium phyllosilicate minerals, composed of aluminium and silicon ions bonded into tiny, thin plates by interconnecting oxygen and hydroxide ions).

Biochar: is a solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment (2.9% ash, 0.82% nitrogen and 88.5% carbon).

The chicks were subjected to continuous lighting, humidity (55.7%) and vaccinated against Newcastle disease. Feed and fresh water were provided *ad libitum*, and management practices were consistent across all treatments throughout the experimental period. Temperature conditions were maintained at 32-33°C at one day of age, gradually decreasing to 23°C by the fourth week and thereafter. The birds were fed commercial diets: starter diet from 0-3 weeks of age (23% crude protein and 3000 Kcal ME/kg of diet) and grower diet from 3-6 weeks of age (21% crude protein and 3100 Kcal ME/kg of diet).

Body weights (BW) and feed consumption (FC) were recorded weekly from 0 to 6 weeks of age, while body weight gain (BWG) and feed conversion ratios (FCR; grams of feed per gram of weight gain) were also computed weekly. At 6 weeks of age, two broilers per pen, totaling six chickens per treatment, were randomly selected, fasted for 8 hours, and then slaughtered. Edible organs (spleen, bursa, thymus glands, empty gizzard, and spleen), as well as abdominal fat, were removed, weighed, and expressed as percentages of carcass weight. Dressing percentage was determined by dividing the carcass and giblet weights by the pre-slaughter live body weight of the birds. At 6 weeks of age, birds in each replicate were examined and scored (on a scale of 1 to 5) for leg problems, breast blisters, and body measurements (shank and keel bone lengths and body depth) were measured (cm). Economic efficiency was evaluated based on the average costs of feed consumed and litter utilized, along with the average income per bird. Net revenue per bird was calculated as the difference between the total sale price (LE) and the costs (LE) of feeds consumed and litter used, reflecting prevailing prices in the local Egyptian market during the experimental period.

Statistical Analysis

The collected data underwent analysis of variance using the General Linear Models Procedure of SAS software (SAS Institute, version 9.2, 2009). Duncan's multiple range test (Duncan, 1955) was employed to identify differences among the means of various groups at 5% and 1% level of probability. To facilitate analysis, the percentages of carcass and organ weights were initially transformed to Arcsin values, with subsequent re-transformation to their original values post-analysis. The analysis of variance was conducted using the following model:

$$Xij = \mu + \alpha i + \beta j + \epsilon ij$$

Where: Xij = an observation, μ= overall mean, αi= replicates effect, βj = treatment effect and Єij = experimental random error.

Results and discussion

1. Body weight (BW) and body weight gain (BWG)

Significant differences ($P \leq 0.05$) were observed in the body weight (BW) of birds reared on various treated litters at 4, 5, and 6 weeks of age (Table 1). At 5 and 6 weeks of age, broilers raised on litter treated with 10% biochar and 10% litter guard exhibited significantly higher BW compared to those grown on litter treated with 10% clay and untreated litter. Conversely, broilers reared on litter treated with 10% sand and 10% zeolite displayed intermediate values. Regarding body weight gain (BWG), birds raised on litter treated with 10% biochar exhibited the highest BWG at 3-4 weeks of age, which differed from those raised on control and 10% clay litter. At 4-5 weeks of age, birds raised on litter treated with 10% litter guard gained more weight than those raised on other litters, except for broilers reared on 10% biochar litter (Table 2).

The observed improvements in growth for birds reared on litter treated with 10% biochar and 10% litter guard may be attributed to decreased moisture and ammonia levels, thereby creating a healthier environment and potentially reducing leg disorders (Farghly *et al.,* 2022). Al-Jumaily and Al-Jumaily (2022) noted significant differences in body weight between the biochar-added groups and the control group, suggesting that the addition of biochar resulted in the best live weight. This could be attributed to biochar's pivotal role in enhancing gastrointestinal health by improving the microbiome and facilitating nutrient digestion.

Babu *et al.* (2023) and Elsherbeni *et al.* (2024) reported that chemical manipulation by acidification of litter material altered the litter pH and had a beneficial effect on the overall growth performance of broilers. This alteration prevented the growth of coccidia and microbial load in the litter, thereby rendering the litter more conducive to bird welfare. Sujiwo and Ariyadi (2023) reported that limestone treatment yielded significantly higher results in broilers compared to other treatments such as 10% zeolite, 10% charcoal, 5% quicklime, and untreated rice husk. Ezenwosu *et al.* (2022) observed significant differences among treatment means in total weight gain, final body weight, and average daily weight gain following treatment with zeolite in litter. Additionally, Flores *et al.* (2021) reported that the inclusion of 20% biochar in the litter led to increased body weight (BW) and body weight gain (BWG) of turkey. These findings are partly consistent with those of Guo and Song (2009), Shao *et al.* (2015), Flores *et al.* (2021), and Emam *et al.* (2023), who noted improved weight gain in broilers and JQ raised on manipulated litter compared to those raised on untreated litter. Conversely, Farghly *et al.* (2020) reported no significant differences in the BW of broilers raised on different litter materials, while Kuleile *et al.* (2019) found that litter material treatment had no significant influence on body weight gain of broilers.

Table 1. Means ±SE of body weight (g) as affected by chemically treated litters

Age (wks)	Body weight						
Treatments	1 day	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk
Control, C	42.2	161.9	458.3	899.3	1370.1 ^{b}	1746.9 ^{b}	2091.2 ^{b}
T1	41.9	162.7	453.1	919.2	1468.2 ^{ab}	1822.3 ^{ab}	2188.6 ^{ab}
T2	42.4	159.6	449.5	914.5	1361.6 ^{b}	1751.6 ^{b}	2085.4 ^{b}
T3	41.5	164.2	460.6	909.6	1452.4 ^{ab}	1825.6 ^{ab}	2190.6 ^{ab}
T4	42.1	168.0	473.2	934.5	1469.2 ^{ab}	1902.8 ^{a}	2254.5 ^{a}
T5	41.3	170.4	469.1	940.8	1523.3 ^{a}	1930.6 ^{a}	2280.4 ^{a}
SEM	1.35	8.36	17.55	23.31	30.12	39.32	44.66
P value	0.7014	0.5133	0.4512	0.1254	0.0254	0.0149	0.0351

a and b: Means within columns followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

Table 2. Means ±SE of body weight gain (g/bird/day) as affected by chemically treated litters

Age (wks)	Body weight gain						
Treatments	0-1	1-2	2-3	3-4	4-5	5-6	Mean
Control, C	17.1	42.3	63.0	67.3 ^{b}	53.8 ^{b}	49.2	48.8
T1	17.3	41.5	66.6	78.4 ^{ab}	50.6 ^{b}	52.3	51.1
T2	16.7	41.4	66.4	63.9 ^{b}	55.7 ^{b}	47.7	48.6
T3	17.5	42.3	64.1	77.5 ^{ab}	53.3 ^{b}	52.1	51.2
T4	18.0	43.6	65.9	76.4 ^{ab}	61.9 ^{a}	50.2	52.7
T5	18.4	42.7	67.4	83.2 ^{a}	58.2 ^{ab}	50.0	53.3
SEM	2.56	4.11	4.91	5.32	4.15	5.67	3.72
P value	0.5121	0.3855	0.1524	0.0402	0.0144	0.4452	0.2564

a and b: Means within columns followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

2. Feed consumption (FC) and feed conversion ratio (FCR)

The impact of litter manipulation on the FC of broilers is outlined in Table 3. No significant differences were noted in FC among the experimental groups from 1 to 3 weeks of age. However, by the fourth week, broilers raised on 10% biochar and 10% litter guard exhibited lower feed intake compared to those in other treatment groups (P < 0.05). Similarly, in the fifth week, broilers raised on 10% biochar consumed less feed than those in the control, 10% clay, and 10% zeolite groups. Moreover, in the fourth week, broilers raised on litter treated with 10% sand, 10% biochar, and 10% litter guard demonstrated significantly improved feed conversion ratios (FCR) of turkey (P ≤ 0.05) in comparison to those of birds raised on litter treated with 10% clay and untreated litter. Conversely, by the fifth week, the FCR of birds raised on litter treated with 10% guard was notably superior (P ≤ 0.05) to that of birds raised on litter treated with 10% sand, 10% zeolite, and untreated litter. Nevertheless, birds raised on litter treated with 10% clay and 10% biochar displayed intermediate values (Table 4).

Ezenwosu *et al.* (2022) observed a significant increase in feed consumption with zeolite treatment in litter, correlating with the elevated levels of zeolite in the litter. This observation suggests a notable reduction in high ammonia production, which is recognized for its adverse impacts on feed intake, weight gain, and overall productivity, particularly evident when comparing treatment groups to the control. Similarly, Flores *et al.* (2021) noted enhanced feed conversion ratio (FCR) with the inclusion of 20% biochar in the litter, consistent with the findings of Farghly *et al.* (2022), who also reported significant differences in broilers' FC. Furthermore, Farghly *et al.* (2022) and Elsherbeni *et al.* (2024) underscored the potential of litter treatment in mitigating litter-related issues and thereby enhancing FCR. However, Flores *et al.* (2021) found no significant variances in FC, a result aligned with those of Sujiwo and Ariyadi (2023) and reiterated by Emam *et al.* (2023), who observed improvements in various performance metrics, including FCR of JQ. In contrast, Kuleile *et al.* (2019) concluded that litter type had no discernible impact on FCR of broilers, diverging from our findings. Babu *et al.* (2023) presented conflicting results, reporting notable improvements in both FC and FCR of broilers.

Table 3. Means ±SE of feed consumption (g/bird/day) as affected by chemically treated litters

Age (wks)	Feed consumption						
Treatments	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**Mean**
Control, C	30.95	61.79	92.69	118.31	130.12 ^{a}	138.52 ^{a}	95.40 ^{a}
T1	31.16	61.80	91.66	112.52	126.43 ^{a}	136.11 ^{ab}	93.30 ^{ab}
T2	30.63	62.00	93.14	114.11	128.72 ^{a}	141.04 ^{a}	94.94 ^{a}
T3	31.45	61.04	91.75	117.32	130.45 ^{a}	139.53 ^{a}	95.26 ^{a}
T4	29.32	60.11	88.16	108.29	118.56 ^{b}	135.02 ^{ab}	89.91 ^{b}
T5	30.12	59.65	88.45	109.31	120.18 ^{b}	133.51 ^{b}	90.20 ^{b}
SEM	2.45	3.01	3.85	4.51	3.45	3.45	2.25
P value	0.8231	0.9512	0.1254	0.7102	0.0188	0.0259	0.0342

a and b: Means within row followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

Table 4. Means ±SE of feed conversion ratio (g feed/g gain) as affected by chemically treated litters

Age (wks)	Feed conversion						
Treatments	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**Mean**
Control, C	1.81	1.46	1.47	1.76 ^{a}	2.42 ^{a}	2.82	1.96
T1	1.81	1.49	1.38	1.43 ^{b}	2.50 ^{a}	2.60	1.87
T2	1.83	1.50	1.40	1.79 ^{a}	2.31 ^{ab}	2.96	1.96
T3	1.79	1.44	1.43	1.51 ^{ab}	2.45 ^{a}	2.68	1.88
T4	1.63	1.38	1.34	1.42 ^{b}	1.91 ^{b}	2.69	1.73
T5	1.63	1.40	1.31	1.31 ^{b}	2.07 ^{ab}	2.67	1.73
SEM	0.08	0.11	0.11	0.06	0.05	0.08	0.04
P value	0.9112	0.1542	0.4021	0.0351	0.9521	0.4221	0.5613

a and b: Means within row followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

3. Carcass characteristics

The data presented in Table 5 revealed no significant differences in giblets, spleen, and thymus percentages, which could be attributed to the chemical treatments applied. The highest dressed carcass weight was observed in broilers raised on litter treated with 10% biochar, contrasting with those raised on litter treated with 10% zeolite and 10% clay, while other groups exhibited intermediate values. Conversely, the lowest percentage of abdominal fat was found in birds reared on litter treated with 10% sand, 10% biochar, and 10% litter guard. Regarding immune organs, broilers raised on litter treated with 10% sand, 10% biochar, and 10% litter guard displayed significantly lower bursa percentages than those raised on untreated litter.

Babu *et al.* (2023) concluded that chemical litter amendments positively influenced overall growth performance, carcass characteristics, and the health and welfare of broiler chicks. Litter moisture content was identified as a factor influencing carcass yield (Traldi *et al.,* 2007), a conclusion supported by the findings of Sekeroglu *et al.* (2013), Varol Avcılar *et al.* (2018), Farghly *et al.* (2021 & 2022), and Emam *et al.* (2023). Elsherbeni *et al.* (2022 & 2024) observed that laying birds raised on litter treated with zeolite at a level of 2 kg/m2 exhibited the most significant improvement in carcass traits compared to other treatments. Emam *et al.* (2023) reported that litter treated with 20% zeolite had a significant effect on gizzard percentage, favoring treated quails (1.93%) over those from the untreated group (1.75%). Additionally, these results indicated numerically and preferably higher dressing percentages for the treated group (74.49%) compared to the untreated groups (72.20%). Sujiwo and Ariyadi (2023) reported that the addition of different compounds to broiler litter significantly affected the relative weight of the liver but had no significant effect on the spleen, thymus, and bursa Fabricius. Conversely, Toghyani *et al.* (2010), Hoshimoto *et al.* (2013), and Hafez and Attia (2020) suggested that carcass parameters of broilers were not influenced by litter composition. Abougabal and Taboosha (2023) found that broilers reared on different litter types showed non-significant differences in relative carcass traits (dressing, giblets, edible parts, and abdominal fat) or immune organs (spleen and bursa).

Table 5. Means ±SE of carcass traits and immune organs (%) as affected by chemically treated litters

Traits	Carcass traits, %			Immune organs, %		
Treatments	**Dressing**	**Giblets**	**Abd. fat**	**Spleen**	**Bursa**	**Thymus**
Control, C	76.11^{ab}	5.11	2.11^{ab}	0.261	0.496^{a}	0.207
T1	76.10^{ab}	4.89	1.62^{b}	0.252	0.360^{b}	0.216
T2	74.75^{b}	5.02	2.44^{a}	0.238	0.442^{ab}	0.192
T3	74.82^{b}	4.96	2.02^{ab}	0.245	0.437^{ab}	0.210
T4	76.18^{ab}	5.12	1.56^{b}	0.260	0.358^{b}	0.214
T5	77.11^{a}	5.09	1.62^{b}	0.256	0.352^{b}	0.221
SEM	1.10	0.10	0.38	0.041	0.042	0.038
P value	0.0365	0.7003	0.0155	0.1254	0.0500	0.1750

a and b: Means within columns followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

4. Body measurements and health status

Bedding material profoundly influences the life, health, and production of broiler chickens as they are in direct contact with the litter. Results presented in Table 6 demonstrate that birds raised on litter treated with 10% zeolite, 10%

biochar, and untreated litter exhibited significantly longer keel bones compared to those on litter treated with 10% clay, while birds on litter treated with 10% sand and 10% litter guard displayed intermediate values. Furthermore, broilers reared on litter treated with 10% sand, 10% biochar, and 10% litter guard showed the lowest leg problem scores, contrasting with those raised on untreated litter and litter treated with 10% clay. Birds on litter treated with 10% zeolite exhibited intermediate leg problem values.

Babu *et al.* (2023) concluded that chemical litter amendments positively impacted the health and welfare of broiler chicks. Animal welfare scientists have emphasized the significance of controlling microclimate and air quality, pertinent aspects for the housing of various farmed animals (Dharmaraj *et al.,* 2023). Adler *et al.* (2020), Farghly *et al.* (2021), and Jan and Peter (2023) emphasized that broiler management heavily relies on the quality of litter, which directly influences broiler health. Hashimoto *et al.* (2013) demonstrated a negative correlation between footpad dermatitis and health performance of broilers, indicating that improving litter quality can reduce the occurrence of footpad dermatitis and enhance overall health status. Varol Avcılar *et al.* (2018) reported that high litter moisture increases ammonia levels in the litter, leading to hock, footpad, and breast dermatitis. Flores *et al.* (2021) found that rearing turkey on sand-type material resulted in better footpad dermatitis scores and healthier footpads compared to other litter materials. Bilgili *et al.,* (2009) suggested a strong association between poor litter quality and leg problems. Foot and hock burns can reduce walking activity due to the pain they cause. The present results align with those of Adler *et al.* (2020), Farghly *et al.* (2022), and Babu *et al.* (2023), they found that litter manipulations significantly affected leg health and walking ability of broilers. Similar results regarding breast blister scores of turkey were observed by Farghly (2012). However, Ramadan *et al.* (2013), Kaukonen *et al.* (2017), and Durmus (2023) indicated that litter treatments did not affect tonic plumage scores, footpad lesions, hock burns, and leg disorders of broilers.

Table 6. Means ±SE of body measurements (cm) and health status (score) as affected by chemically treated litters

Treatments	Body measurements			Health status	
	Body depth	**Keel bone**	**Shank**	**Breast blisters**	**Leg problems**
Control, C	16.03	13.80 ^{a}	6.22	1.90	2.48 ^{a}
T1	16.22	13.12 ^{ab}	5.92	2.00	1.20 ^{b}
T2	15.56	12.36 ^{b}	6.05	2.00	2.52 ^{a}
T3	16.35	13.80 ^{a}	5.89	2.00	2.00 ^{ab}
T4	16.46	13.84 ^{a}	6.02	1.80	1.26 ^{b}
T5	16.45	13.00 ^{ab}	6.11	1.80	1.22 ^{b}
SEM	1.75	1.00	0.42	0.48	0.24
P value	0.7031	0.421	0.1012	0.7142	0.0234

a and b: Means within columns followed by different superscripts are significantly different (P≤ 0.05).
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

5. Economic efficiency

The results presented in Table 7 indicate that birds raised on litter treated with 10% sand, 10% biochar, and 10% litter guard exhibited higher economic efficiency compared to those raised on other types of litter. Specifically, the relative economic efficiency values were 119.8, 137.1, and 141.5 for litter treated with 10% sand, 10% biochar, and 10% litter guard, respectively. Management strategies should prioritize poultry welfare and growth performance of duck (Mohammed *et al.,* 2019). Farghly *et al.,* (2022) in broilers, Emam *et al.* (2023) in JQ and Elsherbeni *et al.* (2024) in laying hens, have also reported that litter treatments significantly impact economic efficiency.

Conclusion

Our findings underscore the importance of litter management in optimizing broiler production systems for enhanced performance, welfare, and profitability. By selecting and implementing suitable litter treatments, poultry producers can effectively improve broiler growth, carcass quality, and economic returns while simultaneously addressing health and environmental concerns associated with poultry production. Further research and field trials are warranted to validate these findings and explore additional strategies for enhancing broiler production efficiency and sustainability.

Table 7. Economical efficiency of broilers as affected by chemically treated litters.

Items		Treatments					
		C	T1	T2	T3	T4	T5
Total costs/ bird/L.E	Litter costs/bird (L.E)	2.60	2.08	2.18	3.02	3.33	2.39
	Feed costs (L.E/bird)	88.15	86.21	87.72	88.02	83.08	83.34
	Total costs/ bird/L.E.	90.75	88.29	89.91	91.04	86.40	85.74
Selling price of live bird at 6 weeks of age (L.E)		144.29	151.01	143.89	151.15	155.56	157.35
Net revenue/ bird/L.E (without *constant costs=25%)		53.54	62.72	53.98	60.12	69.16	71.61
Economical efficiency/bird (EE)		0.61	0.73	0.62	0.68	0.83	0.86
Relative economical efficiency/bird (REE)		100.00	119.78	101.31	112.44	137.05	141.45

Cost of 1 kg live body weight = 69.00 L.E., Price of 1 kg ration = 22 L.E., L.E = Egyptian pound.
*Constant costs include: housing, labour, heating, cooling, lighting and treatment regimens.
C: Birds were reared on un treated litter, T1: Birds were reared on 10% sand treated litter, T2: Birds were reared on 10% clay treated litter, T3: Birds were reared on10% Zeiolite treated litter, T4: Birds were reared on 10%litter guard treated litter, T5: Birds were reared on10% biochar treated litter.

References

Abougabal, M.Sh. and Taboosha, M.F. (2023). Effect of different types of available litter materials on the performance and welfare of broiler chickens. Al-Azhar J. of Agri. Res. (48) 1:139-152.

Adler, C., Tiemann, I., Hillemacher, S., Schmithausen, A.J., Müller, U., Heitmann, S., Spindler, B., Kemper, N., and Büscher, W.(2020). Effects of a partially perforated flooring system on animal-based welfare indicators in broiler housing. Poult. Sci., 99: 3343–3354.

Al-Jumaily, O.I.A. and Al-Jumaily, T.Kh.H. (2022). Effect of adding biochar to the diet and litter on the rate of diet consumption, relative humidity and gut health of broilers (Ross308). Tikrit J. for Agri. Sci., 22 (4): 16-23. https://doi.org/10.25130/tjas.22.4.3.

Andronikashvili, T.G., Urushadze, T.F., Eprikashvili, L.G., Kordzakhia, T.N., Zautashvili, M.G., Pirtzkhalava, N.V., and Dzagania, M.A. (2014). Natural zeolites in poultry farming. Ann Agra Sci 12:1–17.

Babu, R.N., Kaur, D., Uniyal, S., Kaur, P., Singh, Y., Kaur, P. and Malik, D.S. (2023). Physico-chemical litter amendments and their impact on broiler chicks' performance. Indian J. of Anim. Sci., 93 (3): 293–297.

Biesek, J., Banaszak, M., Wlaźlak, S. and Adamski, M. (2023). Use of coffee husks – comparison of pellet bedding quality, performance features, and some welfare indicators of broiler chickens. BMC vet. research. (19)182: 1-14.

Bilgili, S.F., Hess, J.B., Blake, J.P., Macklin, K.S., Saenmahayak, B. and Sibley, J.L. (2009). Influence of bedding material on footpad dermatitis in broiler chickens. J. Appl. Poult. Res. 18: 583-589.

Brink, M., Janssens, G.P.J., Demeyer, Bağci, P., and Delezie, E. (2022). Ammonia concentrations, litter quality, performance and some welfare parameters of broilers kept on different bedding materials. Bri. Poult. Sci., 63:768–778.

Dharmaraj, G.Y., Chandra Naik, M. and Kiran, M. (2023). Effects of using different litter material on performance and welfare of birds. The Pharma Innovation J. 2023; 12(3): 4355-4359.

Diarra, S., Lameta, S., Amosa, F. and Anand S., (2021). Alternative bedding materials for poultry: Availability, efficacy, and major constraints. Front. Vet. Sci., 8, 669504.

Duncan, D.B. (1955). Multiple range and multiple F tests. Biometrics Longman, New York, NY, USA.

Durmus M., Kursun, K., Polat, A.I., Tufan. K.M., Kutay, H., Benli, H., Baylan, M., and Kutlu, H.R. (2023). Effect of different litter materials on growth performance, the gait score and footpad dermatitis, carcass parameters, meat quality, and microbial load of litter in broiler chickens. Poult. Sci., 102:102763 https://doi.org/10.1016/j.psj.2023.102763.

Elsherbeni A.I., Youssef, I.M., Hamouda, R.E., Kamal, M., El-Gendi, G.M., El-Garhi, O.H., Alfassam, H.E., Rudayni, H.A., Allam, A.A., Moustafa, M., Alshaharn, M.O., El Kholy, M.S. (2024). Performance and economic efficiency of laying hens in response to adding zeolite to feed and litter. Poult. Sci., (103)7.

Elsherbeni, A.I.; EL-Gendi, G.M.; El-Ggarhy, O.H. and Okasha, H.M. (2022). Effect of Zeolite Addition to Diets and Litter on Carcass Traits and Blood Biochemistry Parameters of Laying Hens (Silver Montazah). Annals of Agric. Sci., Moshtohor ISSN 1110-0419 Vol. 60(4) (2022), 1051 – 1062.

Emam, A.M., Elnesr, S.S., El-Full, E.A., Mahmoud, B.Y. and Elwan, H. (2023). Influence of improved microclimate conditions on growth and physiological performance of two Japanese quail lines. Anim., 13, p. 1118.

Ezenwosu, C., Udeh, V.C. and Onyimonyi, A.E. (2022). Litter Treatment Using Zeolite as a Management Protocol to Enhance Broiler Performance and Control Ammonia

Emission in Broiler Production in the Humid Tropics. Asian J. of Res. and Review in Agri. 4(1): 58-72.

Farghly, M.F.A., Fayz, G.H. and El-Kelawy, M.I. (2022). Housing conditions of broilers as affected by charcoal treated litter. NVJAS. 2 (6): 349-356. DOI: 10.21608/NVJAS.2022.167141.1098.

Farghly, M.F.A., El-Kelawy, M.I., Kassab, A.Y. and Hashem, A.M. (2020). Use of some available plant residues in new valley as alternative litter materials for managing broiler chickens. 5th International Conference on Biotechnology Applications in Agriculture, April 8-11, 2020, Moshtohor and Hurghada, Egypt.

Farghly, M.F.A. (2012). Evaluation of clover and corn stalks straw as alternative bedding materials to wheat straw for raising local turkey. Egypt. J. Anim. Prod. 49:161-172.

Farghly, M.F.A., Mahrose, Kh.M., Cooper, R.G., Metwally, Kh.A., Abougabal, M.Sh. and El-Ratel, I.T. (2021). Use of available crop by-products as alternative bedding materials for rearing broilers. Animal. 15(7):100260.

Flores, K.R., Fahrenholz, A., and Grimes, J.L. (2021). Effect of pellet quality and biochar litter amendment on male turkey performance. Poultry Science, 100(4): 101002.

Gerber, P.F., Gould, N. and McGahan, E. (2020). Potential contaminants and hazards in alternative chicken bedding materials and proposed guidance levels: A review. Poult. Sci. 99: 6664–6684

Gomes, B., Pena, P., Cervantes, R., Dias, M. and Viegas, C., (2022). Microbial contamination of bedding material: One health in poultry production. Int. J. Environ. Res. Public Health 19: 16508.

Guo, M. and Song, W. (2009). Nutrient value of alum-treated poultry litter for land application. Poult. Sci., 88:1782–1792.

Hafez, H.M. and Attia, Y.A. (2020). Challenges to the poultry industry: current perspectives and strategic future after the COVID-19 outbreak. Front Vet Sci 7:516. https://doi.org/10.3389/fvets.2020.00516

Haque, Md.H., Sarker, S., Islam, Md.S., Islam, Md.A., Karim, Md.R., Kayesh, M.E.H., Shiddiky, M.J.A., and Answer, M.S. (2020). Sustainable antibiotic-free broiler meat production: current trends, challenges, and possibilities in a developing country perspective. Biology 9:411. https://doi.org/10.3390/biology9110411

Hashimoto, S., Yamazaki, K., Obi, T., and Takase, K., (2013) Relationship between severenity of foodpad dermatitis and carcass performance in broiler chickens. J. of Vet. Med. Sci., 13-0031. DOI: https://doi.org/10.1292/jvms.13-0031

Jan, S. and Peter, J. (2023). The effect of a bedding materials on performance, welfare and behavior of broiler chickens: A review. J. of Central European Agriculture, 2023, 24(2):311-321.

Kaukonen, E., Norring, M., and Valros A., (2017). Evaluating the effects of bedding materials and elevated platforms on contact dermatitis and plumage cleanliness of commercial broilers and on litter condition in broiler houses. Bri. Poult. Sci., 58 (5): 480-489. DOI: https://doi.org/10.1080/00071668.2017.1340588.

Kuleile, N., Metsing, I., Tjala, C. and Jobo, T. (2019). The effects of different litter material on broiler performance and feet health. Online J. Anim. Feed Res., 9(5): 206-211.

Linhoss J., Purswell, J., Street, J. and Rowland, M.R. (2019). Evaluation of biochar as a litter amendment for commercial broiler production. J. of Applied Poult. Res., 28 (4): 1089-1098.

Mohammed, H.H., Asmaa I. Abdelaty, Al-Sadik Y. Saleem, Mohamed I. Youssef, Shereen and EL. Abdel-Hamid (2019). Effect of bedding materials on duck's welfare and growth performance. Slov. Vet. Res.; 56 (Suppl 22): 149–56.

Munir, M.T., Belloncle, C., Irle, M. and Federighi, M. (2019). Wood-based litter in poultry production: a review. Worlds Poult. Sci. J. 75:1-12.

Ramadan, S.G.A., Mahboub, H.D.H., Helal, M.A. and Gaafar, K.M. (2013). Behaviour, welfare and performance of broiler chicks reared on different litter materials. Assiut Vet. Medical J. 59(138):9-18.

Ritz, C.W., Kiepper, B.H., and Fairchild, B.D. (2016). Evaluation of a cellulose-based industrial wastewater byproduct as broiler bedding. J. of Applied Poult. Res., 25 (2): 182-190. DOI: https://doi.org/10.3382/japr/pfv096.

SAS (2009). SAS User's Guide, statistics (9.2 ed.) Cary NC: SAS Institute Inc.

Sekeroglu, A., Eleroglu, H., Sarca, M. and Camc, O. (2013). Based materials and base material management used in production on the ground. Poult. Res. J. 10:25–34.

Shao, D., He, J., Lu, J., Wang, Q., Chang, L., and Shi, S.R. (2015). Effects of sawdust thickness on the growth performance, environmental condition and welfare quality of yellow broilers. Poult., 94:1-6. DOI: 10.3382/ps/peu003.

Sujiwo, J. and Ariyadi, B. (2023). Effect of the additional natural compound in litter on performance and health parameter of broiler. J. Sain Peternakan Indonesia 18(3):127-133.

Toghyani, M., Gheisari, A., Modaresi, M., Tabeidian, S.A., and Toghyani, M. (2010). Effect of different litter material on performance and behavior of broiler chickens. Applied Anim. Behaviour Science. 122:48-52. DOI: 10.1016/j.applanim.2009.11.008.

Traldi, C., Durate, K.F., and Moraes, V.M. (2007). Avaliação de probióticos na dieta de frangos de corte criados em cama nova ou reutilizada. Rev. Bras. Zootec. 36:660-665.

Varol Avcılar, O., Kocakaya, A., Onbaşılar, E.E. and Pirpanahi, M. (2018). Influence of sepiolite additions to different litter materials on performance and some welfare parameters of broilers and litter characteristics. Poult. Sci., 97:3085–3091 http://dx.doi.org/10.3382/ps/pey185.

Yildiz, A., Yildiz, K., and Apaydin, B. (2014). The effect of Vermiculite as bedding material on some health and stress parameters in broilers. Kafkas Üniversitesi Vet. Fakultesi Dergisi 20:129-134.

تأثير الفرشة المعاملة كيميائياً على اداء وصحة والكفاءة الاقتصادية لدجاج التسمين

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الملخص

استهدفت الدراسة تقييم تأثير الفرشة المعاملة كيميائيا على اداء النمو، صفات الذبيحة، الكفاءة الصحية والاقتصادية لدجاج التسمين. 180 كتكوت تسمين (روس) عمر يوم قسمت لـ 6 مجاميع (3 مكررات /مجموعة- 10 طيور/مكررة). كتاكيت مجموعة المقارنة ربيت على فرشة من تبن القمح بدون معاملة، أما المعاملات الأولى، الثانية، الثالثة والرابعة والخامسة، فربيت الكتاكيت على فرشة معاملة بـ 10 % رملة , 10 % طفلة، 10 % زيوليت , 10 % ليتر جارد، 10 % بيوشار على التوالي. نتائج اداء النمو (وزن الجسم، والزيادة بالجسم، استهلاك الغذاء والكفاءة التحويلية) تعرض اختلافات معنوية بين معاملات الفرشة في بعض الاعمار عدم وجود اختلافات معنوية بين جميع المعاملات في نسبة الحوائج، بينما اعلى نسبة تصافى للذبيحة وجدت في الطيور المربأة على فرشة معاملة بـ 10 % بيوشار وكانت اقل نسبة دهن بطني في الطيورالمرباة على فرشة معاملة بـ 10 % رملة , 10 % ليتر جارد، 10 % بيوشار. كتاكيت التسمين التي ربيت على فرشة معاملة بـ 10 % رملة , 10 % ليتر جارد، 10 % بيوشار اعطت انخفاض معنوي في البرسا عن الكتاكيت المرباه على فرشة غير معاملة. اقل حدوث مشاكل الارجل لوحظت في الكتاكيت المرباه على فرشة معاملة بـ 10 % رملة , 10 % ليتر جارد و10 % بيوشار مقارنة بالكتاكيت بالمعاملات الاخرى. بناءا على التكلفة والاتاحة والمواد الكيميائية المختبرة التى يمكن ان تستخدم كإضافة لمواد الفرشة. نخلص من النتائج ان معاملة الفرشة بـ 10 % ليتر جارد، 10 % بيوشار يمكن ان تطبق بنجاح كإضافات مناسبة للفرشة لرعاية كتاكيت التسمين.