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Differences in bedding material could alter the growth performance of White Pekin ducks raised for 42 days

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Abstract

The effect of different commercially available bedding materials on the growth performance and carcass characteristics of ducks for 42 days was investigated. 336 one-day-old White-Pekin ducklings (60.48 ± 0.16 g) were randomly allocated into 24-floor pens with one of the three beddings namely i) coco peat, ii) rice husks, or iii) sawdust. 14 ducklings per pen and 8 replicate pens per bedding material were used. Birds were fed a starter diet from days 1–21 and a grower diet from days 22–42. Weekly growth performance evaluation was conducted for the average body weight, weight gains, daily feed intake, and feed conversion efficiency. One bird per pen was sacrificed on day 42 for the evaluation of carcass characteristics including the carcass, breast, and leg muscle percentages. Breast and leg muscle samples were then collected and analyzed for their proximate and pH values. Higher body weights ($p < 0.05$) were noticed with rice husks on day 42 only. Improved daily gains ($p < 0.05$) were also noticed for birds raised with rice husks over the entire period (days 1–42). Concerning feed intake, higher values ($p < 0.05$) were similarly noted with rice husks for the grower phase (days 22–42), and the entire experimental period (days 1–42). Marginally improved feed intake values were also noted with the use of rice husks as the bedding materials on day 42 ($p = 0.092$). Improved feed efficiency ($p < 0.05$) was noticed with rice husks on day 35, the grower period, and the entire 42-day period. However, no significant differences were noticed for most of the carcass characteristics that were evaluated. Nevertheless, higher ($p < 0.05$) pH values for the breast muscle were noticed with the use of coco peat and sawdust as the bedding. Conclusively, the bedding type could have a significant impact on the growth performance of ducks without adverse effects on carcass characteristics. The use of rice husks as bedding might be advantageous and is therefore recommended.

Keywords: Bedding, Carcass, Coco peat, Growth performance, Rice husks, Sawdust

INTRODUCTION

As a sub-sector of the larger growing poultry industry, the duck husbandry has undergone tremendous

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Availability of data and material
Upon reasonable request, the datasets of this study can be available from the corresponding author.

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Ethics approval and consent to participate
The experimental protocol and procedures for the current study were reviewed and approved by the Animal Ethics Committee of Chungnam National University (Protocol Number; 202109A-CNU-111).

progress, especially in Asia [1,2]. This change could be attributed to nutritional and genetic progress and to a better understanding of the management-oriented aspects such as housing and its accompanying factors, such as floor type, ventilation, and temperature control [3–5]. Despite being waterfowls like geese, ducks are reared mainly in intensive production systems that are characterized by indoor housing. As the preference for duck meat and eggs increases, the shift towards intensification allows for better environmental control and higher stocking densities [6].

Indoor housing necessitates the provision of bedding materials under deep-litter floor systems with potential impacts on productive indices, including growth performance, meat quality, and the health, well-being, and welfare of birds [7–9]. Bedding material cushions the birds from the cooling effects of the floors (mostly concrete), absorbs excess moisture from faecal droppings and drinkers, dilutes faecal compounds, and subsequently reduces the exposure of birds to manure by keeping the top layer of the bedding material dry [10,11]. Notably, bedding has been constantly referred to as litter as it is a mixture of bedding material, wasted feed, faecal matter, and feathers [12]. An effort has been made to ensure the accurate application of these two terms in this paper.

Several materials can be used for bedding, including pine shavings, wheat straw, wood sawdust, peanut shells, rice husks, sand, wood shavings, shredded and processed paper, corn stalks, coco peat, dried leaves, and peat moss [13–15]. During optimization of production systems, the bedding material could be decided largely based on availability and cost. Several factors should be considered when determining the suitability as ideal bedding materials. This includes low moisture content (MC), high water adsorbing/holding capacity, quick drying capacity, low thermal conductivity, and acceptability as fertilizer material [16,17].

Nevertheless, in addition to focusing on providing bedding materials, routine management must be performed to ensure bedding quality. Poor quality bedding, which can be characterized by abrasiveness, sharpness, caking, and wetness (above 25% MC), could lead to gait problems, higher ammonia emissions, the proliferation of pathogens, and increased incidences of footpad and hock dermatitis with detrimental impacts on welfare, growth performance, and carcass quality [18–20]. Different bedding materials could have varied responses in poultry production as has been previously reported [16,21,22].

It was hypothesised that ducks raised on different bedding materials could exhibit variable responses even when stocked at the same rate and raised in the same indoor housing unit. Therefore, the current experiment was conducted to determine the effect of different commercially available bedding materials, including i) coco peat, ii) rice husks, and iii) sawdust, on indices of growth performance, including mortality, body weight, daily weight gain, feed intake, and conversion efficiency. Additionally, the potential effects of dissimilar bedding materials on carcass characteristics such as the carcass, leg, and breast percentages, muscle pH, and proximate composition of ducks were analyzed for 42 days.

MATERIALS AND METHODS

The experimental protocol and procedures were reviewed and approved by the Animal Ethics Committee of Chungnam National University (Protocol Number; 202109A-CNU-111). The experiment was conducted at the Cheongyang Animal Research Unit for Chungnam National University.

Birds, diets, and housing

A total of 336 White Pekin ducklings (60.48 ± 0.16 g) were raised for 42 days under the same feeding and environmental conditions except for the different bedding materials that were being

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investigated. The birds were weighed on arrival and randomly allocated to 24-floor pens (8 replicate pens per treatment). 14 birds were used per pen (1.7 m × 1.3 m × 1.0 m) and raised with one of the three bedding materials. Each pen was fitted with six nipple drinkers and a feed trough for the efficient provision of water and feed, respectively. Birds were allowed free access to fresh drinking water and feed throughout the entire experimental period. Regularly, the environmental conditions were monitored and adjusted according to the birds' behavior and age. The birds were fed over two phases with standard starter (days 1–21, 22% crude protein [CP]) and grower diets (days 22–42, 17.5% CP), that were pellet in form.

Bedding materials

Three bedding materials including cocopeat, rice husks, and sawdust were evaluated in the current study for their effect on growth performance and some carcass characteristics. All the bedding materials were supplied at a depth of approximately 8–10 cm which was presumed to be deep enough to avoid the need for a constant replacement that could be noticed by thinner bedding [23] but also not too thick to avoid potential wastages.

Cocopeat is a reddish-brown colored spongy biowaste from the processing of coir fibers from coconut husks [24]. Consisting primarily of lignin and cellulose, cocopeat is known to readily absorb water and dust due to the presence of hydroxyl, carboxyl, ether, phosphate, and amino groups [25]. Alongside being lightweight, and thus easy to handle, coco peat is also known to be pathogen-free, highly renewable with a slow decay rate, and a slightly acidic pH of around 5.5–6.5 which could be vital in the prevention of microbial proliferation [24,26]. Aimed at utilizing its great absorptive qualities, it has been widely used for agronomic purposes as well as other roles [25,27].

Rice husks are the hard protective coverings derived from the milling process of rice grains. As outlined by Casas [28], rice husks constitute about 20% of the weight of the rice grain, with high cellulose, lignin, arabinoxylans, and ash percentages (25, 30, 15, and 21, respectively). The ash is composed mainly of silica (over 85%) and could be used for a wide variety of industrial applications [29]. Rice husks could also be used for poultry feeding [30]. Wood shavings are small wood chippings that could result from woodworking processes such as sawing, milling, planning, and sanding. It has been widely used as a common bedding material for poultry production [31] even though it could pose respiratory problems to ducks due to dust [6].

Growth performance evaluation

Weekly assessments for the growth performance were done using individual bodyweight measurements and feed consumed data that was recorded on days 7, 14, 21, 28,35, and 42. Further measurements were conducted for the evaluation of the growth performance within the starter (days 1–21) and the grower period (days 22–42). Using the feed consumed and recorded body weights, the average daily gain (ADG), mortality-corrected average daily feed intake (ADFI), and the feed conversion ratio (FCR) to depict the efficiency of converting feed supplied to lean muscle was conducted.

Carcass evaluation

Carcass evaluation was done on day 42 after a 12-hour fasting period. One duck was selected based on closeness to the mean body weight of the birds in the respective pen, and the resulting weight was recorded as the live body weight. The bird was then sacrificed using carbon dioxide for the evaluation of some carcass characteristics. The head and the shanks were then separated at the first cervical vertebra and the ankle joint, respectively [32]. The birds were then weighed, and the resulting value was recorded as the hot carcass weight [33]. The carcass percentage was

then calculated using the hot carcass weight as a percentage of the live body weight. Subsequently, the breast muscle and drumstick were separated by experienced personnel and also weighed for evaluation of their relative percentages to the total carcass. They were then deboned and stored for proximate composition analyses. Assessments were then done for the breast and drumstick dry matter, crude protein, crude fat, and ash as well as the pH using standard procedures [34].

Statistical analyses

Collected data were analyzed for statistical significance at $p < 0.05$ using the one-way ANOVA technique. The pen and the sacrificed birds were used as the experimental units for the evaluation of the growth performance indices and the carcass characteristics that were measured, respectively. When statistical significance was noted for the effect of the different bedding materials on the measured parameters, the means were separated using Tukey's multiple range test.

RESULTS

Growth performance

With routine management, the birds exhibited normal behavior and remained healthy throughout the entire 42-day period. Overall, the condition of ducks reared, regardless of the bedding provided was good with no disease incidences or mortalities being reported. The effects of the different commercially available bedding materials on the growth performance parameters of White Pekin ducks are recorded in Table 1. Higher body weights ($p < 0.05$) were noticed with rice husks on day 42 only with no significant effects nor trends ($0.05 < p < 0.10$) being noted for all the previous days (days 7, 14, 21,28, and 35). Improved daily gains ($p < 0.05$) were also noticed for birds raised with rice husks over the entire period (days 1–42) only with no major effects being noted in previous days and phases.

Concerning the feed intake, improved ADFI values ($p < 0.05$) were similarly noted with rice husks for the grower phase (days 22–42), and the entire experimental period (days 1–42). Marginally improved feed intake values were noted with the use of rice husks as the bedding materials on day 42 ($p = 0.092$). For the FCR, lower values ($p < 0.05$) that improved feed efficiency were noted with birds raised using the rice husks as the bedding material on day 35, the grower period, and the entire 42-day period. A marginal effect for improved feed efficiency with rice husks was also noticed on day 42 ($p = 0.077$).

Carcass characteristics

Effects of the different bedding materials on the carcass, breast, and drumstick percentages as well as the breast and drumstick proximate values are recorded in Table 2. The relative percentages for the total carcass, breast, and drumstick muscles for birds raised under rice husks were numerically higher than those raised under cocopeat and sawdust. However, neither significance nor trends ($0.05 < p < 0.10$) were noted. Similarly for the proximate analyses, neither significant effects nor trends ($0.05 < p < 0.10$) were noted for all the parameters that were measured in both the drumstick and breast muscle. Nevertheless, reduced ($p < 0.05$) pH values for the breast were noticed with the use of rice husks as the bedding.

DISCUSSION

Farghly et al. [35] have exhaustively enumerated that bedding materials should preferably be cheap, easily available, suitable for use as fertilizer, and comfortable enough to allow the birds to walk

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Table 1. Effects of different bedding materials on the growth performance of White Pekin ducks[1)]

Variable	Cocopeat	Rice husks	Sawdust	SEM[2)]	*p*-value[3)]
Body weight (g)					
Day 1	60.48	60.44	60.39	0.163	0.973
Day 7	277.89	302.13	298.31	5.938	0.206
Day 14	803.91	849.12	827.72	9.751	0.169
Day 21	1,409.23	1,439.91	1,404.44	11.902	0.437
Day 28	2,175.28	2,250.71	2,168.58	26.013	0.375
Day 35	3,189.68	3,263.10	3,181.57	22.435	0.273
Day 42	3,781.75[a]	3,964.15[b]	3,828.14[ab]	32.327	0.049
Average daily gain (g/d)					
Day 7	31.06	34.52	33.98	0.848	0.206
Day 14	75.14	78.14	75.63	1.000	0.441
Day 21	86.47	84.40	82.39	1.463	0.543
Day 28	109.44	115.83	109.16	2.881	0.586
Day 35	169.07	168.73	168.83	3.296	0.999
Day 42	84.58	100.15	92.37	3.800	0.256
Day 1–21	64.23	65.69	64.00	0.567	0.437
Day 22–42	112.98	120.20	115.41	1.470	0.123
Day 1–42	88.60[a]	92.94[b]	89.71[ab]	0.770	0.049
Average daily feed intake (g/d)					
Day 7	36.00	37.31	36.11	0.994	0.667
Day 14	106.36	107.05	106.57	0.123	0.738
Day 21	155.28	156.77	153.06	0.868	0.221
Day 28	237.98	231.80	233.17	2.928	0.683
Day 35	383.23	388.73	370.06	2.039	0.431
Day 42	246.32	262.69	253.92	4.109	0.092
Day 1–21	95.88	100.37	97.25	0.699	0.109
Day 22–42	269.18[a]	289.07[b]	270.72[a]	5.879	0.007
Day 1–42	180.53[a]	195.72[b]	188.48[ab]	3.936	0.037
Feed conversion ratio (g/g)					
Day 7	0.98	0.93	0.94	0.014	0.341
Day 14	1.34	1.37	1.36	0.013	0.560
Day 21	1.80	1.88	1.86	0.026	0.449
Day 28	2.19	2.03	2.16	0.044	0.301
Day 35	2.66[b]	2.31[a]	2.56[ab]	0.060	0.036
Day 42	3.46	2.59	2.84	0.165	0.077
Day 1–21	1.49	1.53	1.52	0.012	0.422
Day 22–42	2.67[b]	2.26[a]	2.48[ab]	0.058	0.008
Day 1–42	2.24[b]	2.00[a]	2.14[ab]	0.034	0.009

[1)]Values are the mean of eight replicate pens per bedding material.

[2)]Pooled standard error of the mean.

[3)]Statistical significance was determined at $p < 0.05$.

[a,b]Means with different superscripts within the same column differ significantly.

Table 2. Effects of different bedding materials on carcass characteristics of White Pekin ducks[1)]

Item	Cocopeat	Rice husks	Saw dust	SEM[2)]	*p*-value[3)]
Carcass relative percentages (%)					
Carcass	87.74	88.07	87.93	0.463	0.962
Breast	18.43	18.68	18.51	0.373	0.966
Drumstick	5.63	5.90	5.73	0.097	0.520
Drumstick proximate analyses (%)					
Dry matter	64.61	66.91	68.79	1.0913	0.319
Crude protein	19.16	18.15	19.45	0.311	0.212
Crude fat	11.16	12.44	10.15	0.683	0.430
Ash	1.36	1.13	1.25	0.046	0.116
pH	5.55	5.54	5.57	0.009	0.534
Breast proximate analyses (%)					
Dry matter	70.50	72.39	70.05	0.640	0.309
Crude protein	21.80	21.20	21.01	0.213	0.318
Crude fat	1.47	1.77	1.49	0.117	0.544
Ash	1.63	1.62	1.59	0.047	0.949
pH	5.97[b]	5.92[a]	5.96[b]	0.008	0.001

[1)]Values are the mean of eight replicate pens per bedding material.

[2)]Pooled standard error of the mean.

[3)]Statistical significance was determined at $p < 0.05$.

[a,b]Means with different superscripts within the same column differ significantly.

on them. An ideal bedding material should also have low MC, high water adsorption capacity, reduced ammonia emissions and thermal conductivity, short drying time for quick release of absorbed water to prevent caked and wet bedding incidences, low pH to prevent the proliferation of pathogens in the litter, and a lightweight property for ease of handling [35,36]. Considering the demonstrated impact of the living environment on productive indices [5,17] and the fact that ducks spend their entire growth period in contact with the bedding materials, we were specifically interested in determining whether different bedding materials could have varied effects on the growth performance and carcass characteristics of White Pekin ducks. Three different commercially available beddings made of coco peat, rice husks, and sawdust were evaluated in this study.

Determining the impact of bedding on productive indices such as growth performance could provide grounds for recommending suitable materials with possible advantageous impact on production, if all other factors such as availability and cost-effectiveness are kept constant. In conformance with Anisuzzaman and Chowdhury [37], the use of rice husk bedding materials for ducks in the current study exerted a desired incremental impact on the growth performance of ducks. The increased effect could be attributed to increased feed intake and efficiency of conversion of the consumed feed into lean muscle. A higher daily weight gain and elevated body weight were noted when rice husk was provided as the bedding material for the ducks. This inference could be important and relevant to paddy-producing countries such as South Korea, where the use of rice husks as bedding material for broiler chickens and ducks is predominant at approximately 85% [38].

Similar to chicks, hatched ducklings also deal with a transition to aerial breathing, the onset of independent thermal regulation, and a shift from a yolk-based lipid nutrient supply to an exogenous diet that is predominantly carbohydrate-based [39]. The first seven days of growth has a huge impact on the survivability and performance of the flock [40]. In this study, the growth performance of the birds in the first week and the subsequent four weeks showed that dissimilar

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bedding materials had no significant influences on the ducks. This could be attributed to the ability of all three bedding materials to support the survival of and be compatible with ducklings with no significant effects on the performance of ducks within the first five weeks.

In addition, suitable bedding materials should be devoid of harmful contaminants such as toxins, molds, or pathogens, as birds are known to occasionally feed on the material provided [35,41]. A similar observation has been reported by Musa et al. [42], who noted that birds could eat up to 4% of the provided litter. Considering that rice husk bedding had an incremental impact on duck growth performance at the later stages (week 6), the relative consumption of rice husks in their dry form from the bedding material could have a possibly unintended or previously unforeseen beneficial effect as ducks occasionally feed on them. Moreover, ducks can cope well with the consumption of highly fibrous material in their diet as has been reported [43]; nevertheless, further investigations are imperative. The consumption of high-fibre constituents such as rice husks could have gut-health-promoting effects [44], but have a limiting effect on nutrient digestibility, which could be accompanied by higher faecal weight and frequency due to a reduced nutrient transit time in the gut [43]. Faster feed passage in the gut could translate to a resulting increase in feed intake as a compensative strategy [44] as was noted in the increased daily feed intake of the ducks raised using rice husks.

The carcass characteristics were analyzed, and we found that the use of dissimilar bedding materials did not exert a profound impact on most of the parameters measured. The pH of leg and breast muscle samples was evaluated as it is one of the core determinants of muscle quality. No variations were noted in the leg muscle. However, an unexpected and significant impact of the rice bedding material, which has a lower pH value, was noted on breast muscle. pH is a function of the amount of glycogen before slaughter and the conversion rate of glycogen to lactic acid [45]. Lower pH could therefore point to a variation in glycolytic metabolism due to dissimilar bedding material; hence, further studies on pH and other carcass traits that could be subject to pH, such as muscle color, water-holding capacity, and cooking loss percentages, are necessary.

In conclusion, the type of bedding material provided could have a significant impact on the growth performance of ducks. The use of rice husks as an alternative bedding material had a positive impact on indices of growth performance for White Pekin ducks for 42 days and is therefore recommended. Further research on the effects of different commercially available bedding materials on performance, ammonia emissions, stress indicators, faecal microbiota and other meat quality parameters is recommended.

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