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Efficiency of Recycled Plastic Bedding Material and Gender in Improvement of Productive Traits, Physiological, and Immunological Parameters of Hybrid Broiler Chickens

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ABSTRACT

Litter management is important for poultry housing husbandry and affects chicken performance. The present study evaluated the effect of bedding material and gender on the productive, physiological, and immunological performance of a new hybrid chicken (WINZY Line 105) under cold stress for 56 days of age. A total of 540 one-day-old broiler chicks were divided into two groups. The groups, including 270 males (M) and 270 females (F) were further divided into two sub-groups, including sawdust litter (SL) and plastic slatted floor (PSF), three replicates, and 45 chickens each. Broiler chickens were raised during the winter with an average temperature of 10^{o}C for 56 days. Productive, physiological, and immunological performance parameters were measured. The obtained results indicated that M reared on PSF (M x PSF) recorded the highest values in body weight (BW), body weight gain (BWG), carcass characteristics, and the best values in feed conversion compared with other interaction groups during all experimental periods. In addition, F reared on PSF had higher BW, carcass, and thigh percentages, low feed intake (FI), and best feed conversion compared to females reared on SL. The M reared on PSF had the highest hepatic enzymes except AST which was higher in F reared on PSF than other treatments. However, renal function biomarkers (Creatine, Uric acid, Urea) were higher in both M and F that were reared on SL than those reared on PSF. Moreover, there was a significant interaction detected for antibody titters against avian influenza (H5) and Newcastle disease at 21 days of age suggesting that the highest values observed for M reared on PSF (M x PSF) compared with other interaction groups during the experimental period, and it was higher in F that reared on PSF than F reared on SL at 21 days of age. It can be concluded that plastic slatted floors could be an alternative to substitute wood shavings to raise broiler chickens since it was efficient from the perspective of environmental conditions and production rates.

Keywords: Bedding material, Environmental adaptation, Hybrid chicken, Immunological parameter, Productive trait, Plastic slatted floor, Performance

INTRODUCTION

Bedding management is critical for animal welfare, especially in intensive production systems. Litter protects the chickens from the rigid ground, and facilitates the evaporation of urine, excreta, and spilled water. To improve the health and welfare of chickens, they should be kept on a dry floor. A variety of factors are used in broiler production to meet these goals. The main factors are the type of litter material used, housing system, litter control methods, and bird water balance (Collett, 2012).

The purpose of bedding material included excreta and moisture absorption, aerobic decomposition of excrement, and heat insulation (Shepherd and Fairchild, 2010). Additionally, it influences the body weight (BW) and immunity of broiler chicks, which reflects on growth rate and carcass quality like carcass body weight percent. Broilers reared on sand and paper roll floors perform similarly to those reared on wood shavings (Bilgili et al., 2009; Toghyani et al., 2010).

Broiler performance can be enhanced through practical litter management to ensure a healthy atmosphere

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in their houses by controlling ammonia concentrations, and increasing immunological responses against various diseases (Beker et al., 2004; Miles et al., 2004; De Jong et al., 2014; Wei et al., 2015). In addition, heat exhaustion puts broiler breeding in danger (Liverpool-Tasie et al., 2019).

The most common materials used as litter in commercial broiler production are wood shavings and sawdust; recently, plastic floors have been effective in providing a healthy environment and higher production rates. Wood shavings and plastic floors demonstrated better performance with males than females at 42 days of age including weight increase, feed intake, and feed conversion (Almeida et al. 2017).

Climate change negatively impacted both direct and indirect agricultural production systems and people's food security, especially in dry areas like Sub-Saharan Africa (Thompson et al., 2010). The Food and Agricultural Organization (FAO, 2011) advised increasing public awareness of how climate change affects food security and nutrition, the mechanisms affecting food security, and how to adapt to climate change.

This study aims to investigate the effect of two different bedding materials (sawdust litter and plastic slatted floors) on the growth performance and immunological parameters of both males and females of the new hybrid chickens WINZY Line 105.

MATERIALS AND METHODS

Ethical approval

The animal study protocol was conducted with permission and approved by the Review Board of Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. All experiments were conducted according to the relevant guidelines and regulations of the Ethical Committee coded: 202110

Broiler chickens

A new hybrid breed broiler that originated from a crossing between the local native Egyptian breed (Fayomy) PP line and the French line breed (Sasso) GG line. The average body weight for males is 2.2 kg, while for females it was 1.750 kg at 52 days of age. This line was characterized by a sex phenotype difference where the color of females was reddish brown and can be easily differentiated from the yellowish-grey color of males at one day old.

Experimental design

The current study was conducted in collaboration with Misr Organic Food Industry Company, Animal Production Research Institute Animal Health Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. This study was conducted at the facility of poultry breeding station, Anshas, Sharkaia, Egypt. The chicks were hatched from the fifth generation of cross-type chickens (WINZY line 105) of both sexes. A total of 540 chicks were reared from one day old up to 56 days old. The chicks were divided into two groups of 270 males (M) and 270 females (F). Groups were further divided into two sub-groups based on the type of litter: sawdust litter (SL) and plastic slatted floor (PSF), with 3 replicates of 45 chickens each under the same management conditions including ventilation system, lighting program, temperature inside houses, feeding formulae, and vaccination programs. The composition and calculated analysis of the basic diet was done according to the NRC (1994) and presented in Table 1. The chickens, house facility, and plastic-slated floor were supplied by Misr Organic Food Industry Company.

Floor design

The floors were distributed in rooms at the same height in each room. Broiler chickens were reared on two types of bedding material (sawdust litter and plastic slatted floor). Sawdust litter was distributed with height (7 cm) and considered as control groups. The plastic slatted floor was designed with narrow holes measured 2-3 millimeters thick. Water and feed diet were provided *ad libitum*. Broiler chickens in this experiment were reared during the winter season (December 2021 and January 2022) under extreme cold conditions. The ambient temperature in the daytime reached 10°C and fell to 2°C at night. The chicks were reared in a semi-closed, controlled house with a nearly fixed temperature inside to maintain chickens during growth.

Effective operation

Live body weight (BW) and feed intake (FI) were recorded weekly, consequently body weight gain (BWG) and the feed conversion (FC) ratio were calculated too. Daily mortalities were counted, and a weekly mortality rate was computed.

Features of slaughter and carcass

After eight weeks, chickens were kept fasting for 5-6 hours to keep the corps of the chickens empty at slaughtering time, then three chickens from each treatment were slaughtered by slitting the jugular vein, de-feathered,

eviscerated, weighted, and the percentages of live body weights were calculated. The breast, thigh, and giblets were excised, weighed, and expressed as percentages to live body weights.

Table 1. Composition of basal diet of the hybrid broiler (WINZY Line 105) affected by gender and plastic-based bedding material from day one to eight weeks of age

Ingredients (%)	Starter (1-21 days)	Grower (22-42 days)	Finisher (43-56 days)
Yellow corn	56.00	61.65	65.25
Soya bean meal 44%	32.50	25.00	21.00
Corn gluten meal 62%	6.00	7.00	7.00
Cotton seed oil	2.00	2.50	3.25
Di-calcium phosphate	0.80	1.00	1.00
Limestone	1.85	2.00	1.75
Salt	0.25	0.25	0.25
Mineral and vitamin mix*	0.30	0.30	0.30
DL-Methionine	0.15	0.15	0.10
L-lysine	0.15	0.15	0.10
Total	100	100	100
Calculated analysis			
Crude protein (%)	23.08	20.88	19.29
ME (kcal/kg diet)	3004.95	3104.62	3201.57
Crude fiber (%)	3.61	3.24	3.08
Calcium (%)	1.00	1.00	0.97
Available phosphorus (%)	0.55	0.56	0.54
Methionine (%)	0.53	0.52	0.46
Lysine (%)	1.23	1.07	0.95
Methionine+Cysteine (%)	0.91	0.87	0.79

*Vitamin and mineral mix. mix: each 3kg contains: Vit. A, 12000000 IU; Vit. D3, 2000000 IU; Vit. E, 10 g; Vit. K, 2.0 g; Vit. B1, 1g; Vit. B2, 5g; Vit. B6, 1.5 g; Vit. B12, 10 mg; Folic acid, 1g; Biotin, 50mg; Pantothenic acid, 10 g; Nicotinic acid, 30 g; Choline chloride, 250 g; Mn, 60g; Fe 30, g; Zn, 50 g; Cu, 10g; I, 1 g; Co 100 mg; Se, 100 mg; Anti-oxidant, 10 g, and complete to 3.0 kg by Calcium Carbonate. The data in the table was calculated according to NRC (1994).

Blood parameters

Blood parameters were measured at the Reference Laboratory for Veterinary Quality Control on Poultry Production, Animal Health Research Institute, Giza, Egypt. Blood testing was carried out to evaluate physiological performance in the tested groups. Blood samples were taken from 18 chickens/treatment after slaughtering at 56 days of age from each group in collecting tubes containing heparin as an anticoagulant to obtain whole blood as 1 mL per individual bird. Then, it was centrifuged for 15 min at 3000 rpm and stored at -20°C. Blood testing parameters conducted in this study included: liver function testing the concentrations of two enzymes, aspartate transaminase (AST) and alanine transaminase (ALT), and measuring glucose level, alkaline phosphatase (ALP), and kidney function testing creatinine (CRE), uric acid and urea by calorimetric methods using commercial kits of Bio Diagnostic Co., Egypt, following the manufacturer's instructions.

Immunological parameters

On days 10 and 21, blood samples were collected to determine immunological parameters including antibody titters against avian influenza virus (H5) and Newcastle disease (ND). Blood samples were taken on days 10 and 21 from 18 chickens from each group using sterile plastic syringes to collect blood from the wing vein as 1 mL per individual bird then left for complete agglutination to separate serum. The collected sera were transferred to Eppendorf tubes and centrifuged at 3000 rpm to separate clear sera. Serum samples were tested to determine the immunological response after vaccination by measuring antibody titers against avian influenza virus (AIV-H5) and Newcastle disease virus (NDV) using Hemagglutination inhibition test (HI) according to standard protocol (WOAH, 2021).

Statistical analysis

The experiment data were statistically examined by analysis of variance according to Mead (2002) using ANOVA procedures of SAS (SAS, 2011). The statistical model was used as the following formula.

$Y_{ij} = \mu + Z_i + S_j + (ZS)\ ij + e_{ij}$

Where Y_{ij} is an observation, μ is the overall mean, Zi is the effect of the sex groups, (i is equal to 1 and 2), Sj is the effect of bedding materials (j is equal to 1 and 2), (ZS)ij is the interaction effect between sex and bedding materials (ij = 1, 2….+4), eij refer to random error.

The differences between means were tested by using Duncan's multiple-range test procedures (Duncan, 1955), and p-values less than 0.05 were considered significant. The percentage values were subjected to sine transformation before analyzing variance. Means were present after recalculating from the transformed value to percentages.

RESULTS

Body weight and body weight gain

The effects of sex and bedding material on BW and BWG are illustrated in Table 2. During all the experimental periods, males (M) had significantly higher BW and BWG values than females (F). However, the bedding material has a low impact on the BW. Chickens raised on plastic slatted floors (PSF) had higher BWGs at different ages (1-8 weeks) than chickens kept on sawdust litter (SL). The results indicated that a significantly higher interaction was found for BW and BWG, indicating that the highest values were observed for M reared on PSF compared with those of the other interaction groups during all experimental periods and this interaction was higher for F reared on PSF than for F reared on SL ($p < 0.05$).

Feed intake and feed conversion

The effect of sex and bedding type on FI and FC are shown in Table 3. Significant increases in FI and FC among males and females were found during all the experimental periods ($p < 0.05$). Compared with females, males presented a higher FI during all experimental periods and improved FC by 0.2% during the whole 8 weeks and 0.25% during (4-8 weeks). No significant differences were found in FI during all experimental periods for chickens reared on either floor type (SL or PSF), while chickens reared on PSF had higher FCs by 0.08% and 0.06%, respectively, than chickens housed on SL at 4–8 and 1–8 weeks of age ($p < 0.05$). The interaction effects demonstrated that the FI of males raised on both types of floors did not differ significantly. However, compared to females raised on SL, those raised on PSF had lower FI and higher FC. For all the experimental periods, the FC values for males raised on PSF were higher than those for the other interaction groups ($p < 0.05$).

Carcass traits of several internal organs

As shown in Table 4, males had significantly higher live body weight (LBW) than females including carcass 2.3%, breast 0.97%, and thigh 0.8%, while giblet percentages were not significantly different ($p < 0.05$). Compared with those raised on sawdust litter, the chickens raised on plastic slatted floors had a substantially higher percentage of carcass by 1.55%, breast by 0.83%, and thigh by 0.98% ($p < 0.05$). The interaction effects indicated no significant differences in LBW between males reared on both floor types (SL and PSF; $p < 0.05$). However, females reared on PSF had higher LBW (carcass by 1.2% and thigh by 1.18%) than females reared on SL. Among the males reared on SL, those reared on PSF had the highest LBW (carcass by 1.9%, breast by 0.84% and thigh by 0.79%; $p < 0.05$). Furthermore, there was no significant difference in giblet percentages among the groups ($p > 0.05$).

Blood parameters

The hepatic and renal function biomarkers affected by the sex and rearing system are presented in Table 5. Alanine transaminase (ALT) and glucose levels were significantly higher in males than in females. However, renal function biomarkers (CRE, uric acid, and urea) were significantly higher in F than in M ($p < 0.05$). Chickens that were reared on PSF had the highest hepatic function biomarkers AST and ALT and the lowest renal function biomarkers ($p < 0.05$). The interaction effects indicated also that M reared on PSFs had the highest hepatic function biomarkers, except for AST, which was higher in F reared on PSFs than in those of other groups ($p < 0.05$). However, renal function biomarkers were higher in both M and F chicks reared on SL.

Immunological performance

According to the data in Figure 1, M had significantly higher antibody titers against avian influenza AI (H5) and ND at the 10^{th} and 21^{st} days of age than females ($p < 0.05$). Moreover, chickens reared on PSF had higher antibody titters against AI (H5) and ND on the 21^{st} day of age than those reared on SL. The data revealed that there was a higher interaction effect on the antibody titters against AI (H5) and ND at 10^{th} and 21^{st} days of age, suggesting that the highest values were observed for M reared on PSF compared with those of the other interaction groups during the whole experimental period ($p < 0.05$).

Table 2. Body weight and body weight gain of the hybrid broiler (WINZY Line 105) affected by gender and plastic-based bedding material from day one to eight weeks of age

Items		Body weight			Weight gain		
		1d	4 W	8 W	1d-4 W	4-8 W	1d-8 W
Gender	M	33.64±0.68	594.48±15.52^{a}	1813.78±22.04^{a}	553.36±10.30^{a}	1234.61±22.70^{a}	1787.97±23.88^{a}
	F	33.67±0.26	510.30±10.01^{b}	1508.50±21.81^{b}	476.63±9.89^{b}	998.20±16.30^{b}	1474.83±22.12^{b}
	P Value	0.956	0.006	0.001	0.001	0.001	0.001
Bedding materials	SL	33.66±0.48	544.00±45.27	1646.33±166.40	510.34±45.23	1102.33±122.16^{b}	1612.67±166.40^{b}
	PSF	33.65±0.55	560.78±46.03	1683.78±171.31	519.65±38.38	1130.48±130.75^{a}	1650.13±171.31^{a}
	P Value	0.983	0.609	0.055	0.590	0.028	0.041
Interaction between gender and bedding materials							
Gender	**Bedding materials**						
M	SL	33.64±0.76	585.44±10.52^{a}	1800.67±7.40^{b}	551.80±3.54^{a}	1215.22±11.08^{b}	1767.02±8.70^{b}
	PSF	33.64±0.76	603.51±1.33^{a}	1842.56±6.38^{a}	554.91±9.41^{a}	1254.00±10.22^{a}	1808.91±6.43^{a}
F	SL	33.68±0.07	502.56±6.57^{c}	1492.00±10.00^{d}	468.87±11.12^{b}	989.44±6.59^{c}	1458.32±10.93^{d}
	PSF	33.66±0.41	518.04±5.12^{bc}	1525.00±9.95^{c}	484.38±10.93^{b}	1006.9±5.06^{c}	1491.34±11.68^{c}
P Value.		0.973	0.022	0.007	0.002	0.003	0.002

$^{a, b, c, d}$ Means bearing different superscript letters within the same column were significantly different ($p < 0.05$). d: Day, W: week, M: Males, F: Females, SL: Sawdust litter, PSF: Plastic slatted floor.

Table 3. Feed intake and feed conversion of the hybrid broiler chickens affected by gender and plastic-based bedding material from day one to eight weeks of age

Items		Body weight			Weight gain		
		1 d – 4 wk.	4 wk.- 8 wk.	1d- 8wk.	1d-4 W	4-8 W	1d -8 W
Gender	M	1253.85±11.37^{a}	2799.30±43.03^{a}	4053.15±51.94^{a}	2.27±0.05^{b}	2.27±0.04^{b}	2.27±0.04^{b}
	F	1137.58±20.33^{b}	2511.04±50.61^{b}	3648.62±54.25^{b}	2.39±0.06^{a}	2.52±0.08^{a}	2.47±0.07^{a}
	P Value	0.023	0.007	0.005	0.032	0.008	0.006
Bedding materials	SL	1189.67±66.67	2666.94±130.0	3856.62±199.52	2.34±0.08	2.43±0.10^{a}	2.40±0.12^{a}
	PSF	1201.76±60.33	2643.40±183.22	3845.16±222.11	2.32±0.09	2.35±0.12^{b}	2.34±09^{b}
	P Value	0.678	0.057	0.122	0.321	0.046	0.033
Interaction between gender and bedding materials							
Gender	**Bedding materials**						
M	SL	1253.09±5.12^{a}	2784.69±30.3^{a}	4037.79±28.66^{a}	2.27±0.04^{c}	2.29±0.02^{c}	2.29±0.03^{c}
	PSF	1254.61±11.18^{a}	2813.91±45.39^{a}	4068.52±62.22^{a}	2.26±0.05^{c}	2.24±0.04^{d}	2.25±0.05^{d}
F	SL	1126.25±6.51^{b}	2549.19±14.55^{b}	3675.44±17.17^{b}	2.40±0.05^{a}	2.58±0.03^{a}	2.52±0.02^{a}
	PSF	1148.91±14.61^{b}	2472.89±25.62^{c}	3621.80±66.54^{c}	2.37±0.06^{b}	2.46±0.05^{b}	2.43±0.05^{b}
P Value.		0.037	0.008	0.009	0.042	0.009	0.008

$^{a, b, c, d}$ Means bearing different superscript letters within the same column were significantly different ($p < 0.05$). d: Day, W: Week, M: Males, F: Females, SL: Sawdust litter, PSF: Plastic slatted floor

Table 4. Carcass traits of the hybrid broiler (WINZY Line 105) affected by gender and plastic-based bedding materials from day one to eight weeks of age

Items		Body weight (gm)	Carcass (%)	Breast (%)	Thigh (%)	Giblets (%)
Gender	M	1901.67±12.69[a]	78.25±1.95[a]	25.45±1.08[a]	28.02±0.54[a]	4.86±0.09
	F	1771.67±11.19[b]	76.28±1.88[b]	24.48±0.64[b]	27.22±1.12[b]	4.78±0.15
	P Value	0.006	0.033	0.022	0.036	0.151
Bedding materials	SL	1820±14.62	76.49±2.23[b]	24.55±0.78[b]	27.13±1.09[b]	4.80±0.16
	PSF	1853.33±54.04	78.04±1.51[a]	25.38±0.64[a]	28.11±0.48[a]	4.84±0.09
	P Value	0.336	0.047	0.041	0.040	0.611
Effect of interaction between gender and bedding materials						
Gender	**Bedding materials**					
M	SL	1898.33±30.12[a]	77.31±1.43[bc]	25.03±1.02[bc]	27.62±0.12[b]	4.83±0.10
	PSL	1905.00±32.23[a]	79.19±0.99[a]	25.87±0.88[a]	28.41±0.46[a]	4.88±0.09
F	SL	1741.67±12.52[c]	75.67±2.85[d]	24.07±0.56[d]	26.63±1.23[c]	4.76±0.22
	PSL	1801.67±14.46[b]	76.89±0.88[cd]	24.90±1.12[c]	27.81±0.45[b]	4.79±0.08
P Value.		0.024	0.031	0.042	0.032	0.345

[a, b, c, d] Means bearing different superscript letters within the same column were significantly different ($p < 0.05$). d: Day, W:week, M: Males, F: Females, SL: Sawdust litter, PSF: Plastic slatted floor

Table 5. Blood parameters of the hybrid broiler (WINZY Line 105) as affected by gender and plastic-based bedding material from day one to eight weeks of age

Items		AST (U/L)	ALT (U/L)	Glucose (mg/100ml)	ALK (U/L)	CRE (mg/dl)	Uric acid (mg/dl)	Urea (mg/dl)
Gender	M	67.10±4.19	59.55±2.02[a]	81.05±3.54 [a]	110.44±4.94	0.81±0.08[b]	3.80 ±.62[b]	4.81±1.16[b]
	F	65.70±4.33	56.38±2.17[b]	78.14 ±1.40[b]	109.37±4.2	0.89±0.11[a]	4.23 ±.49[a]	5.11±0.86[a]
	P Value	0.422	0.007	0.004	0.654	0.002	0.009	0.005
Bedding materials	SL	64.07±3.76[b]	56.92±2.16[b]	78.07±2.86[b]	105.78±0.88[b]	0.93±0.06[a]	4.31±.60[a]	5.29±0.71[a]
	PSF	68.73±3.72[a]	59.02±2.51[a]	81.11±2.61[a]	114.03±1.26[a]	0.77±018[b]	3.72±.42[b]	4.63±1.11[b]
	P Value	0.003	0.023	0.033	0.005	0.004	0.003	0.003
Effect of interaction between gender and bedding materials								
Gender	**Bedding materials**							
M	SL	66.47±3.31[b]	58.77±1.00[b]	78.76±2.83[bc]	105.98±0.65[b]	0.88±0.03[b]	4.48±.68[a]	5.23±0.68[a]
	PSF	67.73±3.5[b]	60.33±1.71[a]	83.33±1.38[a]	114.90±0.66[a]	0.73±0.06[d]	3.98±0.39[b]	4.39±.54[c]
F	SL	61.67±1.70[c]	55.07±1.28[c]	77.38±1.19[c]	105.57±1.04[b]	0.98±0.03[a]	4.14±0.41[ab]	5.34±.88[a]
	PSF	69.73±3.31[a]	57.70±2.28[bc]	78.89±1.14[b]	113.16±1.05[a]	0.80±0.02[c]	3.46±0.28[c]	4.88±.74[b]
P Value.		0.023	0.016	0.008	0.007	0.006	0.005	0.006

[a, b, c, d] Means bearing different superscript letters within the same column were significantly different ($p < 0.05$). d: Day, W: Week, M: Males, F: Females, SL: Sawdust litter, PSF: Plastic slatted floor

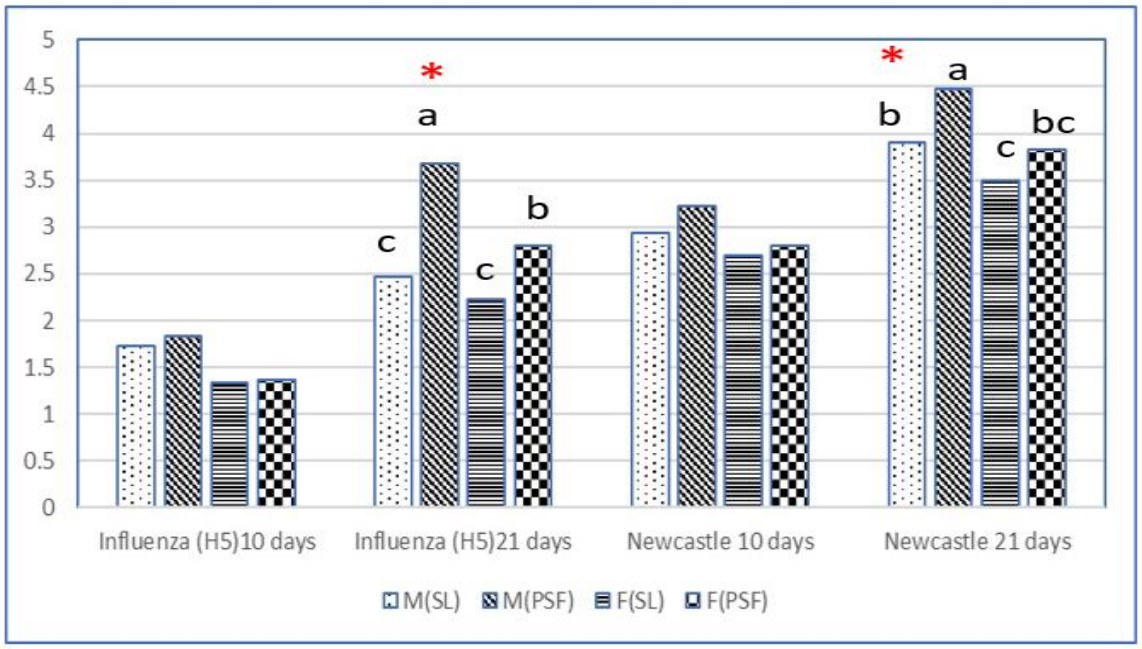

Figure 1. Antibody titers against avian influenza and Newcastle disease at days 10th and 21st of the age in hybrid broiler chickens (WINZY Line 105) as affected by gender and plastic-based bedding materials from day one to eight weeks of age. M (SL): Male (Sawdust Litter). M (PSF): Male (Plastic Slatted Floor). F (SL): Female Sawdust Litter. F (PSF): Female (Plastic Slatted Floor). *: $p < 0.05$.

DISCUSSION

Litter or bedding material is an important constituent of the poultry industry and growth performance, it primarily affects growth parameters such as BW and BWG (Almeida et al. 2017). In this study, the chickens reared on the plastic-slated floor had better growth performance than those in the wood shavings. The perforated plastic floors were considered to be a good alternative to wood shavings when rearing broiler chickens both sex male and female (Almeida et al. 2018). They were effective at promoting a better-quality environment and superior production rates.

Females and males grown on plastic floor had a BWG significantly higher than that reported in wood shavings. Similar results were obtained in a previous study; when comparing groups reared on different floor materials, the growth of chickens reared on a plastic-slatted floor was higher in terms of final BW, BWG, and growth rate than other flooring systems (Almeida et al., 2018; Çavuşoğlu et al. 2018).

Feed intake in females of Winzy line 105 was recorded as 3621.8g and 3675.4g at 8 weeks of age for rearing on PSF and SL respectively, while for males was 4068.5g and 4037.8g respectively. In a previous study, males grown on plastic floors were heavier than males raised on wood shavings, and females raised on plastic floors were also heavier than those reared on the wood shavings floor.

Manning et al. (2007) indicated the level of water usage may be influenced by the litter quality and the degree of absorbency of the litter material.

The higher final BW and total FI of broilers in the groups raised in fully or partially slatted flooring designs were significantly higher than those of broiler chickens in the deep litter flooring system (Topal and Petek, 2021).

Carcass body weight for females reared on PSF was higher than SL in both sexes. That was agreed with Kralik et al. (2015), who indicated that sex had a higher significant impact on the live weight, carcass weight, and weight of the main body parts. it is also preferable for individuals of younger ages, to be reared on a plastic-slated flooring system (Passini et al., 2012). Almeida et al. (2017) verified that females raised on plastic flooring had a heavier carcass weight than those raised on wood shavings, but male broiler chickens had a heavier carcass weight than females. Slat flooring systems showed preference in younger ages at slaughter (Çavuşoğlu et al., 2018). Poultry reared on plastic floor had higher live weights and carcass weights for males than females (Almeida et al., 2018).

Abo Ghanima et al. (2020) investigated the effects of three litter-rearing systems including wood-shaving litter,

perforated plastic slate-rearing systems, and cage-rearing systems, they reported that chickens raised on wood-shaving litter had lower dressing percentages than chickens raised on plastic-slatted floors. They reported that the style of flooring had no significant impact on the relative weights of the liver and heart. Broilers raised on different types of floors indicated nonsignificant differences in LBW and giblets, according to Farghly et al. (2021a; 2021b).

Compared to chickens reared on sawdust, chickens reared on perforated plastic floors had significantly heavier carcasses. According to Al-Nasseri et al. (2021), an increase in the live body weight of chickens reared on plastic floors due to general improvement in environmental conditions, including improved air quality and heat relief due to decreased dust content and decreased moisture in the floor, leading to increased performance and growth parameters. The plastic-slated floor system allows the chickens' feet to be in direct contact with the ground, this allows high heat conductivity in the environment and facilitates airflow around the chickens. Blood parameters like AST and ALT were higher in both sexes reared on PSF than SL. These results support those of Wang et al. (2015), who reported that chickens reared in litter-based systems had lower apparent ileal_digestible energy intake than those reared on the Net rearing system during the first 3 weeks of age.

The results also indicated that monitoring blood parameters was important for assessing stress and immune response to stressors in poultry (Saeed et al., 2019; Nwaigwe et al., 2020).

The increased significant interaction effect on the antibody titters against AI (H5) and ND on days 10 and 21 of age was observed in this study**.** Results suggested that the highest values were observed for M reared on PSF compared with those of the other interaction groups during the whole experimental period. There were higher antibody titers in female individuals reared on PSF than in female individuals reared on SL on the 21st day of age which indicated the desirable effect of PSF on immunity than the SL.

The level of AIV-H5 and NDV antibodies in chickens reared on PSF compared with those reared on sawdust litter SL revealed that antibody titers against NDV and AI were elevated in the PSF groups. These results indicated a significant increase in the level of antibodies against both viruses and increased their vaccination response and ability for stress control. Previous results suggested that rearing chickens in cages and on plastic-slated floors could enhance immunity (Sogunle et al., 2008).

CONCLUSION

The plastic slatted floors were effective in terms of environmental conditions and production rates, and they are suitable replacements for wood sawdust during the growing period of broilers chickens. This flooring system would enhance production rates and immunity under adverse climatic conditions in chickens. The production efficiency of the hybrid breed used in this study was enhanced using a plastic slated floor compared to the traditional sawdust floor, especially for body weight gain and antibody titers against ND and AI.

DECLARATIONS

Ethical considerations

The article was written originally by authors from the obtained original data and it was not submitted or published totally or even partially in other publications. The text article is checked by a well-known plagiarism checker software before submission to the journal.

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Authors' contributions

Mohamed EL-masry (ME) and Magdy Hassan (MH) designed, performed, and followed up the experiment. Ahmed Bealish (AB), Magdy Ouda (MO), and Ibrahim Fathey (IF) ran the experiment and conceived the study. Tarek El-Afifi (TE) and Abdelsatar Arafa (AA) did the laboratory work. Hanaa Abd El-Atty (HA) wrote the original draft. Hanaa Abd El-Atty (HA), Abdelsatar Arafa (AA), and Hanan Fahmy (HF) participated in the manuscript draft review, coordination, and editing. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no conflict of interest.

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Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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