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Research Article

Impacts of Corncobs as an Alternative Litter Material on Broiler Welfare Reared in Deep Litter System

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ABSTRACT

A total of 378 one days-old Arbor Acres chicks was reared up to 35 days old on three types of litters; wood shaving, crushed corncobs and mix of wood shaving and crushed corncobs to study the effect of crushed corncobs on growth performance, broiler welfare indicators, blood biochemical parameters and the litter quality. Obtained results revealed that; the litter type had no significant effect on the broiler performance (body weight, weight gain, feed consumption, feed conversion and mortality). Birds reared on wood shaving showed more activities than others, while dust bathing behaviour was prominent in crushed corn cobs group. Wood shaving group recorded the highest catalase and total antioxidant activity and lowest H/L ratio and MDA followed by mixed litter group, finally the lowest moisture and total colony count cfu/g was recorded in corncobs group as litter quality indicators. As conclusion the crushed corncobs may be suitable as litter material and could be used to replace wood shaving with a percentage to obtain the best performance and optimum broiler welfare.

Key words: Boiler, Deep litter, Corn cobs, Behaviour, Stress, Litter quality

INTRODUCTION

Litter quality and type are very important for the broiler welfare, where they spend their entire life. Many litter materials have been used as bedding; sawdust is currently the most popular bedding materials. (Shanawany, 1992 and Celen and Alkis, 2009). Litter material plays several important roles such as moisture absorption, thermal insulation, and affects general health status, productive parameters, carcass quality, and welfare of broilers. (Garces *et. al.*, 2013).

Wood shavings and sawdust are traditionally used as litter material in poultry houses. However, availability of wood by-products such as wood chips, sawdust and wood shavings will continue to decline as production of biofuel production expanded and these materials are diverted for use as biofuels. This increased demand will make the use of traditional wood-based litter economically unfeasible for poultry (Davis *et. al.*, 2010). So, the search for alternative materials, such as peanut hulls, rice husks, corncobs, coffee husks, and sugarcane bagasse have been investigated (Huang *et. al.*, 2009).

There are many aspects that may impair broiler welfare, poor litter quality is one of the main welfare problems in modern broiler production, (Ferrante *et. al.*, 2006). Broiler welfare had been measured using indicators such as performance parameters including daily weight gain, feed intake, and mortality rate, litter quality measures, and levels of dermatitis, (Manning *et. al.*, 2007). Therefore, the goal of this study was to evaluate the impact of crushed corncobs as alternative litter material on broiler performance, behavioural, physiological welfare indicators and litter quality indicators.

MATERIALS AND METHODS

This study was conducted at Poultry Research Unit, Department of Veterinary Hygiene and Management, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt.

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Animal and housing

Total of 378 unsexed one day old Arbor Acres chicks were housed, in 9 symmetrical pens 2. 25 x 2 m^2 each, Feed and water were provided ad libitum via trough feeders and bell drinker. The birds were vaccinated against Newcastle disease virus (Hitchner B1 at 6 days, eye drops and Lasota at 18 days eye drops), Avian influenza (H5N1, at 14 days 0.2 ml/ bird S/c) and IBD (at 14 days old, eye drops). The basal broiler starter, grower and finisher ration readymade was formulated to meet the Arbor Acres broilers nutrient requirements (Table 1).

Table 1: Composition and nutritive value of starter, grower and finisher diet according to Arbor Acres broilers requirement.

	Components	Starter kg/100 kg	Grower kg/100 kg	Finisher kg/100 kg
Ingredients use in the diet	Yellow Corn	60.28	64.3	58.7
	Soya bean meal (47%)	34.25	29.28	33.4
	Safflower oil	1.51	2.49	3.5
	Na bicarbonate	0.18	0.07	0.05
	Sodium chloride	0.33	0.33	0.33
	DL-Methionine	0.16	0.15	1.7
	Lysine	0.18	0.21	1
	Di calcium phosphate	1.49	1.52	1.8
	Lime stone	1.33	1.34	1.5
	Premix*	0.3	0.3	0.3
Chemical composition	Metabolizable Energy (Kcal/kg)	2988	3083	3200
	Crude Protein (%)	23	21	19
	Crude Fat (%)	4.83	5.79	6.5
	Fiber (%)	3.7	3.42	3.4
	Calcium (%)	0.9	0.9	0.9
	Phosphorus (total) (%)	0.73	0.7	0.7
	P. Available (%)	0.40	0.4	0.4

*Each 3 Kg of premix contains: Vitamins: A: 12000000 IU; Vit. D3 2000000 IU; E: 10000 mg; K3: 2000 mg; B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Choline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

Experimental design

Chicks were randomly divided into three groups, three replicate, 42 chicks each. Birds were placed in concrete-floored naturally ventilated broiler house of 3 different bedding materials; wood shaving (WS), crushed corn cobs (CC) and mix of 50% wood shaving; 50% crushed corn cobs (Mix)

Measuring parameters

Growth performance parameters; the final performance was determined through average feed intake, average body weight, average weight gain, feed conversion rate (FCR), and mortality rate in addition to the carcass traits were recorded through dressing yield and visceral organs weight.

Behavioural welfare indicators

Birds in each replicate were observed through scan samples (Sandilands *et. al.,* 2006) for five weeks, 3 days /week. Behavioral observation time was 20 min / replicate/ day, in two observational periods; from 8.00 am - 15.00 pm. During the scan sampling the number of birds performing preening, dust bathing, leg and wing stretching, head scratching and resting behaviors were recorded within 5 minutes for each behavior. According to Helle *et. al.,* (2007), behaviours were represented as percentages of the birds showing the behaviour act from the of the total birds.

Physiological welfare indicators

Five blood samples from each replicate were collected two times. at the 15 days old and at 35 days old, to measure heterophil, lymphocyte ratio according to Feldman *et. al.,* (2000). and Oxidative stress parameters including Malondialdehyde according to Ohkawa *et. al.,* (1979), Catalase activity according to Aebi (1984), and Total antioxidant capacity according to Koracevic *et. al.,* (2001).

Litter quality and microbiological assessment

Litter and cloacal samples were biweekly collected at 15 and 35 days of age for litter quality assessment physically and microbiologically. Litter samples were collected from each pen. Samples were taken from 10-12 locations using disposable polyethylene latex gloves, taking a hand pinch in a zigzag pattern of a "W- manner" throughout the house. Samples were taken through the depth of the litter without disturbing the soil far away from feeders. These samples were combined and thoroughly mixed; approximately 500-gram sub-sample was placed and labelling into sterile plastic bag and submitted to the laboratory for analysis (Goan and Walker, 1914). Physical examination; including pH was determined by electrometric pH meter (HI 981504/5, Romania) as described by Peters *et. al.,* (2003), where a 10 grams of well mixed litter sample was soaked in 100 ml of dist. water, for moisture content determination; 10 grams of well mixed sample was transferred to pre-weighed empty clean petri dish and introduced to the hot air oven at 100 ^{o}C overnight, then cooling in desiccator and reweighed. The difference in weight before and after drying represents the moisture content (AOAC, 1996). Cloacal swabs were taken randomly from 5 chicks per pen into sterile saline solution. The collected samples were transported to the lab. in a cool bag (4^{o}C) and processed for microbiological analysis up to 2 hours after the collection (Jennifer *et. al.,* 2004)

Microbiological examination litter samples and cloacal samples was conducted within 2 hours after lab arrival; Total Colony Count (TCC), Total Fecal Enterococci (Streptococci group D) (TFS) and Total Fungal count (TFC) were determined according to methods described by Danon-Moshe *et. al.,* (1985); A.P.H.A. (1998) and Fries *et. al.,* (2005), respectively.

Statistical analysis

All data are presented as means±standard error (SE). Growth, performance, haematology, and blood chemistry were analysed using one-way ANOVA, followed by Duncan (1955) which was used to compare differences among individual means, with SAS program software (2004). A probability of 0.05 was utilized to account for the statistical difference between the means. Before the analysis, percentage data were normalized by arcsine-transformation.

RESULTS AND DISCUSSION

Good litter is a basic indicator for better environment and healthier birds. As the litter is most important for moisture absorption and insulation from the cold ground below and help in a well-heated floor surface that boost bird performance and uniformity.

Performance parameters

From results obtained (Table 2) it was clear that there was no significance differences P>0.05 in feed conversion ratio in different litter types although there was a significant differences in final body weight and feed intake, as in case of wood shaving litter group and mixed litter group achieved final body weight 1843.3±4.9 gm and 1813.3±46.6 gm respectively, and feed intake 2716.6±40.4 gm and 2783.5±85.43 gm respectively, while in case of crushed corncobs group final weight and feed intake was 1727±24.2 gm and 2589.4±91.9 gm respectively; and this come in accordance with results obtained by Davis *et. al.,* (2010), and Mendes *et. al.,* (2011), who reported that broiler feed convertion didn't affected by the litter type. Also agreed with AL-Homidan and Robertson (2002) and Demirulus (2006) whose recorded the heavier body weight and higher daily feed intake was associated with wood shaving litter.

Table 2: Final productive performance in broiler chickens in different litter materials.

Parameters \ Gp.	WS	CC	Mix
Initial weight (g)	42.3±0.0^a	42.3±0.0^a	42.3±0.0^a
Feed Intake (g)	2716.6±40.4^a	2589.4±91.9^b	2783.5±85.4^a
BW (g)	1843.3±4.9^a	1727.0±24.2^b	1813.3±46.6^a
BW gain (g)	1801.1±4.9^a	1684.8±4.9^c	1771.1±4.66^b
FCR	1.5±0.01^a	1.5±0.03^a	1.6±0.012^a
Mortality percentage	10.7±1.7^a	6.2±1.85^b	6.2±0.63^b

WS means wood shaving litter, CC means corncobs litter, and Mix means 50 % wood shaving and 50 % corncobs; Result expressed as Mean ±Standerd error; a, b, c: Different letter means significantly differ at p≤ 0.05 between the groups.

Table 3: Final dressing yield of broiler in different litter materials.

Parameters \ Gp.	WS	CC	Mix
BW (g)	1843.5±0.04^a	1727±0.024^a	1813.3±0.04^a
Dressing wt (g)	1475±0.014^a	347.5±0.0014^b	1446.6±0.04^a
Dressing %	80.02±5 0.9^a	78.05±1.17^a	79.7±0.23^a
Liver wt (g)	54.5±0.28^a	38.8±0.46^c	46±0.57^b
Gizzard wt (g)	36±0.57^b	31.9±0.05^c	40.4±0.34^a
Spleen wt (g)	1.7±0.17^b	1.8±0.11^b	2.9±0.05^a
Heart wt (g)	7.8±0.11^a	7.75±0.14^a	7.4±0.3^a
Bursa wt (g)	1.8±0.11^a	1.1±0.05^a	1.3±0.15^a

WS means wood shaving litter, CC means corncobs litter, and Mix means 50% wood shaving and 50% corncobs; Result expressed as Mean ±Standerd error; a, b, c: Different Letter within the column means significantly differ at p≤0.05 between the groups.

The carcass characteristics and internal organs weight illustrated in Table (3), showed no significant differences in dressing percentage between different litter types, P>0.05. it was 80 % in wood shaving, 79.7 % in mixed litter and 78 % in corncobs this result agreed with Swain and Sundaram (2000) who referred that bedding materials didn't affect carcass weight and the dressing percentage of broilers. In the same time the best liver and heart weight was obtained in wood shaving group 54.5±0.28 gm and 7.8 gm respectively; this come in accordance with Demirulus (2006). Bursa weight was not significant differed as P>0.05, the same results obtained by Toghyani *et. al.,* (2010) litter types didn't affect lymphoid organ (bursa of fabricius) percentage from live weight.

Welfare Behavioural indicators

From the observation and result illustrated in Table (4), there was a great impact to litter types on welfare parameters, as crushed corncobs showed higher percentage of resting behaviour and dust bathing; 68.54 %, 3.25 % respectively followed by other types either wood shaving or mixed litter, this may be related to the fact that corncobs used in crushed form and more fine than wood shaving and mix group, so it gives the bird more comfortable substrate for resting and dust bathing, these results agreed with Shields *et. al*., (2004), the finer material such as sand was probably preferable to the birds, also finer materials easily penetrating the feathers and stimulating preening, these interpretation to confirm the increased preening percentage in crushed corncobs litter 10.812±0.36 %, followed by mixed litter 9.425±0.19 and lowest preening behaviour was reported in wood shaving group 8.410±0.24 %.

Table 4: Welfare behaviour indicators in different litter materials represented as percentage.

Parameters \ Gp.	WS	CC	Mix
Preening	8.410 ±0.24^b	10.812±0.36^a	9.425±0.19^b
Dust Bathing	1.033±0.59^b	3.258 ±1.42^a	1.133±0.07^b
Leg and wing stretch	6.543±0.11^b	7.148±0.54^{ab}	7.610±0.45^a
head scratching	2.409±0.24^a	2.320±0.18^a	1.532±0.05^b
Rest	55.437±1.9^b	68.541±0.79^a	68.667±0.4^a

WS means wood shaving litter, CC means corncobs litter, and Mix means 50 % wood shaving and 50 % corncobs; Result expressed as Mean ±Standerd error, mean represent the percentage of behaviour act; a, b, c: Different letter means significantly differ at p≤ 0.05 between the groups.

Physiological welfare indicators

Results in Table (5) showed that, heterophils lymphocytes ratio was normal according to Astuti et. al., (2015) although the corncobs group reported the highest H/L ratio 0.57±0.03 followed by mix group 0.51±0.03 and the lowest ratio was in wood shaving 0.41±0.015, the same sequence obtained at 30 days old the highest H/L ratio 0.72±0.045 in corncobs group followed by mixed litter 0.61±0.04 and the lowest ratio was reported in wood shaving 0.47±0.015. In the same time the lowest MDA 5.89±0.12 u/ml, 6.67±0.11u/m at 15 and 30 days respectively was recorded in wood shaving group. Also, the highest catalase and total antioxidant activity were recorded in wood shaving group followed by mixed litter, these results agreed with Yildirim *et. al.,* (2017) who referred that lowest serum MDA level was in the group reared on wood shaving litter. Although there were a significance differences in antioxidant status of broiler in between litter types but it didn't affect the broiler performance.

Table 5: Oxidative stress parameter in different litter materials.

	Parameters \ Gp.	WS	CC	Mix
15 Days old	Heterophil/lymphocyte	0.41±0.015[a]	0.57±0.03[c]	0.51±0.03[b]
	Malondialdehyde(U/ml)	5.89 ±0.12[c]	7.11 ±0.19[a]	6.13±0.07[b]
	Catalase (U/ml)	313.66±4.64[a]	288.74±3.4[b]	302.09 ±5.51[a]
	Total antioxidant (U/ml)	0.755±0.05[a]	0.66±0.025[a]	0.71±0.15[a]
35 Days old	Heterophil/lymphocyte	0.47±0.015[a]	0.72 ±0.045[c]	0.61±0.04[b]
	Malondialdehyde(U/ml)	6.67±0.11[c]	7.11±0.22[a]	6.85±0.15[b]
	Catalase (U/ml)	270.6±3.53[a]	259.13 ±7.28[b]	267.36 ±6.76[ab]
	Total antioxidant (U/ml)	0.69±0.025[a]	0.57±0.02[b]	0.65±0.015[a]

WS means wood shaving litter, CC means corncobs litter, and Mix means 50 % wood shaving and 50 % corncobs; Result expressed as Mean ±Standerd error, a, b, c: Different letter means significantly differ at $p \leq 0.05$ between the groups.

Table 6: Litter physical quality in different litter materials.

	Parameters \ Gp.	WS	CC	Mix
15 Days old	pH	8±0.25[a]	7.9 ±0.3[a]	7.9 ±0.55[a]
	Moisture %	34.5±0.35[a]	24.6±0.2[b]	25±0.75[b]
30 Days old	pH	8±0.34 [a]	7.85±0.6[b]	7.9±1.2[b]
	Moisture %	33.7±1.2[a]	21.3±1.0[c]	24.8±0.5[b]

WS means wood shaving litter, CC means corncobs litter, and Mix means 50 % wood shaving and 50% corncobs; Result expressed as Mean ±Standerd error, a, b, c: Different letter means significantly differ at P≤0.05 between the groups.

Table 7: Litter microbial quality; total aerobic plate count, total fungal count and total fecal enterococci in different litter materials.

	Parameters \ Gp.	WS	CC	Mix
15 Days old	Total colony count Cfu*/g	1.1 x10^{14}	7 x 10^{13}	5.3 x 10^{14}
	Total fecal enterococci cfu/g	1.2 x 10^{12}	1.2 x 10^{12}	3.6 x 10^{12}
	Total fungal count cfu/g	4.6 x 10^{11}	1.3 x 10^{12}	4.6 x 10^{11}
30 Days old	Total colony count cfu/g	1.4 x 10^{14}	8 x 10^{13}	1.9 x 10^{14}
	Total fecal enterococci cfu/g	1.2 x 10^{12}	1.2 x 10^{12}	3.6 x 10^{12}
	Total fungal count cfu/g	6.4 x 10^{12}	1.2 x 10^{13}	1 x 10^{13}

WS means wood shaving litter, CC means corncobs litter, and Mix means 50% wood shaving and 50% corncobs; *Means colony forming units /g.

Table 8: Microbiological character of fecal swab; total aerobic plate count, total fungal count and total fecal enterococci in different litter materials.

	Parameters \ Gp.	WS	CC	Mix
15 Days old	Total colony count Cfu*/g	1 x 10^{13}	1.6 x 10^{13}	2.5 x 10^{13}
	Total fecal enterococci cfu/gm	1.2 x 10^{10}	1.1 x 10^{11}	2.8 x 10^{11}
	Total fungal Count cfu/g	9 x10^{9}	8 x10^{10}	5 x 10^{8}
30 Days old	Total colony count cfu/g	1.3 x10^{12}	1.5 x10^{12}	6.5 x10^{11}
	Total fecal enterococci cfu/g	3.2 x10^{11}	8.2 x10^{11}	2.6 x10^{11}
	Total fungal Count cfu/g	1 x10^{9}	1 x10^{8}	3 x10^{9}

WS means wood shaving litter, CC means corn cobs litter, and Mix means 50% wood shaving and 50% corn cobs; *Means colony forming units /g.

Litter Physical and microbiological indicators

Litter quality is an important hygienic aspect during broiler production; it was significantly influenced the performance, carcass quality, and the welfare of broilers Brake *et. al*, (1992). The physical characters of litter including pH and moisture content was illustrated in Table 6, within two samples of litter at 15 days and 35 days there was a significant difference P<0.05, the moisture percentage on wood shaving at 15 days and 35 days was 34.5±0.35 and 33.7±1.2 %, followed by mixed litter 25±0.75 at 15 days and 24.8±0.5 % at 35 days. The lowest moisture content was recorded in corncobs litter 24.6±0.2 and 21.3±1.0, at 15 and 35 days respectively. These results may be due to the high level of cellulose and hemicelluloses (86 to 93%) in corncobs that reflected on absorption and release of water very quickly, this come in accordance with Heba El-lethey (2005) who referred that the highest moisture content was recorded in wood shaving. The litter pH of WS and other litter materials was approximately the same, this agrees with Garcês *et. al.,* (2013) corncobs had similar physico-chemical characteristics to wood shaving and it could be used as litter materials for broiler production.

Corncobs litter recorded the lowest total colony count 7 x1013 cfu/g and 8 x1013 cfu/g at 15 days and 35 days old respectively, compared to wood shaving and mixed litter groups, these results due to the fact that corncobs is rich in hemicelluloses more than 60% that considered as a substrate for production of citric acid which has biological activities as a preservative for its antibacterial effect according to Ashour, *et. al.,* (2013). The results were agreed with Heba El-lethey (2005) who confirmed that the highest bacterial count, and fungal count were reported in wood shaving litter and disagreed with Karousa *et. al.,* (2012). Regarding to the effect of liter types on fecal microbiological characters Table (8) it was observed that there were no differences in between litter materials in Total Colony Count, total fecal enterococci (TFS) and total fungal count (TFC) count, this result confirmed by O'Reilly *et. al.,* (2013) who found litter materials not determine the bacterial counts in the cecum.

Conclusions

From the results obtained, the wood shaving is the standard litter material in poultry and crushed corncobs was considered as the effective alternative litter material to achieve maximum performance, optimum broiler welfare and typical litter quality, so it can be recommended to use litter mixture from wood shaving and crushed corncobs.

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