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BEHAVIOUR, WELFARE AND PERFORMANCE OF BROILER CHICKS REARED ON DIFFERENT LITTER MATERIALS

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ABSTRACT

Two hundred forty day-old Ross broiler chicks were used in this experiment. Chicks were weighed on arrival and randomly assigned to six litter treatments (20 birds per pen) with two replicates for each treatment. The litter treatment consists of six different litter types: Wood shavings (WS), whole rice straw (straw), sand, rice straw covered by a layer of wood shavings (WS + straw), sand covered with wood shavings (WS + sand) and sand covered by a layer of rice straw (straw + sand). Behavioral observation was carried out twice daily, two days a week for 6 consecutive weeks. Body weight (BW) and Feed intake per pen were measured weekly, from which body weight gain (BWG) and feed conversion ratio (FCR) were measured. At 42 days of age, welfare parameters were measured including fear, stress, fluctuating asymmetry, feather score and leg health and problems. Also, some carcass traits and moisture content of the litter were assessed. Dead birds were recorded for each treatment. Results revealed that birds reared on (WS + sand) exhibited significantly higher feeding behavior, BW and BWG than birds reared on straw and (straw + sand). Bedding types had no significant effect ($p>.05$) on feeding behavior and other productive performance when litters were used separately (WS, straw or sand). Standing and walking behaviors decreased on sand and wood shavings whereas sitting increased. Contrarily, birds reared on straw and (straw + sand) beddings exhibited significantly more standing and walking behaviors and less sitting behavior. FCR and welfare parameters were not affected by the type of litter materials either used separately or in combination. Percentage of gizzard to live weight was significantly higher in birds reared on wood shavings. Percentage of heart to live weight was significantly higher in birds reared on (WS + sand). Other carcass traits were not affected by litter types. Straw had significantly more moisture content compared to other litter types whereas sand had significantly lower moisture content compared to straw (WS + straw). It is concluded that, behaviors of broiler chicks affected by different bedding types. Rice straw and sand could be used as alternative bedding materials to wood shavings without adverse implications of birds performance and welfare.

***Key words**: Broilers; Welfare, Performance; Litter types; Sand; Rice straw.*

INTRODUCTION

In the last several years, drastic decline of farmland and the need for animal feed in Egypt have led to shortage of wheat straw conventionally used as poultry litter. Wood shavings and other wood by-products are the most common materials used in commercial production. Availability of wood products and by-products such as wood chips, sawdust and wood shavings will continue to decline as production of lignocellulosic-based biofuel production processes expand and these materials are diverted for use as biofuels feedstock. This increased demand will likely make use of traditional wood-based litter materials economically unfeasible for poultry (Davis *et al.*, 2010). Low supplies, high cost and unavailability of suitable material have encouraged the search for alternative litter materials.

Several attempts of replacing traditional litter material have been made by using many substrates such as, refined gypsum, cotton waste (Grimes *et al.*, 2006), recycled paper (Lien *et al.*, 1992; Santiago *et al.*, 2006; Villagra *et al.*, 2011), kenaf core (Brake *et al.*, 1993), sand (Bilgili *et al.*, 1999b; Arnould *et al.*, 2004; Shields *et al.*, 2005), feather (Gunnarsson *et al.*, 2000), coffee husk (Ortiz *et al.*, 2006), chopped corn cobs and Stover (Grimes *et al.*, 2002), hazelnut husks (Sarica and Cam 2000), rice hulls (Veltmann *et al.*, 1984), rice hull ashes (Chamblee and Yeatman 2003), rice and wheat straw (Benabdeljelil and Ayachi 1996) and chopped Switchedgrass (Davis *et al.*, 2010).

Broiler production is extremely intensive and there are many aspects that may impair animal welfare. Poor litter quality is one of the main welfare problems in modern broiler production (Ferrante *et al.*, 2006). Litter quality has a direct effect on bird's skin condition, wet litter being a major risk for contact dermatitis including foot pad dermatitis, hock burns and breast blisters. It have been reported that pathologies of broiler locomotion system are related to many factors including low litter quality (Shields *et al.*, 2004). Indeed, selection for bon and muscle strength has been a low priority compared to growth rate and productive performance; this led to an increasing incidence of skeletal problems (Loveridge 1999). Bedding substrate stimulates particular behaviors of broiler chickens. Sand appears to be one of the most simpler and more cost effective potential substrate (Shields *et al.*, 2005) that might be to encourage broiler to display normal behaviors that require energetic movement that includes exercise of the leg such as, walking, foraging and dust bathing behaviors and consequently reduced leg problems (Arnould *et al.*, 2004). Bedding type can significantly affect carcass quality, growth performance of broilers, litter quality and litter bacteria (Malone *et al.*, 1983; Lien *et al.*, 1992). Factors which affect the efficiency of a type of litter include particle size, moisture content and buildup, rate of caking, and other physical characteristics of the material used (Malone *et al.*, 1983; Toghyani *et al.*, 2010).

In Egypt there is increasingly need to test and use untraditional alternative bedding materials especially sand and rice straw for many benefits. Sand is available and cheap as about 95% of Egypt's is desert area. In literature, sand is being considered as an alternative to pine wood shaving as bedding for broiler chickens (Girmes *et al.*, 2002) with similar Litter quality and bird performance, and sand is advantages in that is harbors fewer microorganisms like Escherichia coli (Bilgili *et al.*, 1999b). Moreover, sand could be categorized as a 3-3-2 grade fertilizer, similar to the average equivalent to a 3-3-2 grade fertilizer (percent nutrient content of Alabama broiler litter which is (N-P_2O5-K_2O). This is means that the content of the litter is no less than 3% nitrogen, 3% phosphate, and 2% potassium. Consequently, sand litter could be used as a supplemental fertilizer for croplands, hayfields, pastures, and home gardens (Bilgili *et al.*, 1999a).

Burning of rice straw considered as severe economic looses not only due to the lost cost of straw but also it causing severe environmental pollution and health hazard such as respiratory allergy diseases.

Fluctuating asymmetry (FA) is the recommended and most commonly used measure of developmental instability (Palmer and Strobeck 1986; Møller and Swaddle 1997). It describes random departures from perfect symmetrical development in traits that are genetically coded to be bilaterally symmetric (Palmer 1994). The magnitude of these departures is thought to be a reflection of the failure of the organism to maintain developmental homeostasis resulting from an inability to counter the effects of genetic and environmental stressors. The magnitude of these departures might be an objective, integrated, and animal-based measure of animal welfare (Møller *et al.*, 1995, 1999). FA of the tibias can provide a noninvasive snapshot of one facet of leg condition (Ventura *et al.*, 2010).

Fear is regarded as a powerful emotion that exerts a progressive inhibitory effect on behavior patterns generated by all other motivational systems. From a production and welfare standpoint of view fear is undesirable in broiler because it can resulted in reduction in adaptability to the environment, feed conversion and growth, and induce strong escape responses, which can lead to injury and death in the domestic fowl (Hogan 1965; Jones 1986, 1987, 1996). The reduction of fearfulness levels thought to improve not only the birds' economic performance but also the extent to which they are able to adapt to, or cope with environmental restrictions imposed by an intensive husbandry system (Faure and Mills 1998). Fear can be assessed by duration of the tonic immobility reaction (TI). A long duration of TI is thought to be indicative of high levels of fearfulness, and vice versa (Jones 1986). Stress reduced fitness of the individual and fitness reduction involves increased mortality, or failure to grow, or failure to reproduce (Fraser and Broom 1990). The hematological stress indicator heterophil/lymphocyte ratio (H/L) is expected to increase if hens experience mild to moderate long-term stress (Maxwell 1993).

The objective of the current study was to evaluate the effect of using alternative poultry litter materials used either separately or in combination on the behavior, welfare and performance of broiler chicks.

MATERIALS and METHODS

1. Experimental design and bird management:

A total of 240 one day old broiler chicks (Ross) were allocated to six completely randomized designs in floor pens of 20 chicks (10 birds/ m2) with two replicates for each treatment. The treatment consists of six different litter materials: WS, straw, sand (5 cm depth), (WS + straw), (straw + sand) and (WS + sand), 2.5 cm depth for each layer to provide 5 cm height layer with no premixing of its constituents. Chicks were raised from 1 to 42 days of age; no litter was added, removed or replaced during the course of trial. Food and water were offered ad-libitum. Feed was divided into two phases: Starter diet (1-15 days) and finisher diet (16-42 days). All diets were formulated to meet NRC (1994) recommendation. Lighting was provided for 24 h/day throughout the experimental period. Ambient temperature was 31°C on the day of arrival and was subsequently lowered

by 1°C every two days until a temperature of 21°C was reached. Temperature was measured continuously in each pen at chick height. A standard vaccination program was applied during the whole period for all groups.

2. Measurements:

2.1. Behavioral observation:

Behavioral observation was conducted two days per week, in 2 periods per day once in the morning (8:00-10:00) and the second one in the after noon (13:00-15:00) for 6 consecutive weeks. Each pen was observed for 15 minutes in each period of observation. Instantaneous scanning observations (Lee and Criag 1990) were applied in this study. The feeding, drinking, standing, walking, sitting, foraging, preening, dustbathing, wing stretching and/or wing flapping, ruffling and aggressive behaviors were scanned every 60 seconds. The percentage of birds engaged in each behavior was calculated during all scan samples in each pen.

2.2. Performance

Body weight and feed intake per pen were recorded weekly. Body weight gain and feed conversion ratio were calculated for each pen. At 42 days of age, three birds per pen were randomly chosen (six birds/ treatment), weighed slaughtered and their carcass, liver, gizzard, heart and lymphoid organs (spleen and bursa of Fabricius) were weighed and calculated as a percentage of live body weight.

2.3. Welfare indices:

A- Fearfulness:

Fear was assessed by the duration of tonic immobility (TI), a well validated fear test (Forkman *et al.*, 2007). Six birds from each pen were tested in the sixth week of life, by placing each bird on its back in a U shaped wooden device and restrained for 15 seconds. The number of attempt to induce immobility and the latency from induction till the birds righted itself were recorded. The maximum duration of test was 5 minutes.

B- Stress (Heterophil/ lympmocyt ratio, H/L):

At 42 days of age, direct blood smears were taken for differential leucocytic count (4 chicks from each pen- eight birds/treatment) by a wing vein. The smear were stained using May- Gunwald-Giemsa stain and one hundred leucocytes, including heterophils, esinophils, basophils, lymphocytes, and monocytes were counted using light microscope with an oil immersion lens x 40.

C- A latency- to-lie (LTL) test:

LTL test was used to study leg health. This test measures the amount of time a chicken can remain standing to avoid sitting down in shallow, luck warm water (5 minutes test period). This test is correlated walking ability of the chicken (Berg and Sanotra 2003). Five birds from each pen were tested at the end of the experiment without visual or physical contact with other birds.

D- Fluctuating asymmetry (FA):

Fluctuating asymmetry was defined as the absolute difference between the left and right legs (Villagra *et al.*, 2011). Measurements were taken on tibia diameter (width), which was recorded 1 cm above the spur point on the mid-diaphysis with a digital caliper to the nearest 0.01 mm. Width measurement was taken twice on both the right and left leg to reduce measurement error. Mean width for each leg was calculated and used in statistical analyses.

E- Footpad and Hock health:

Birds removed from their home pens for FA measurement were also examined to determine footpad and hock health. Footpad dermatitis was quantified using the scale of 4 points as follows: 0 = no lesions; 1 = mild lesion affecting a very small area of skin; 2 = severe lesion; and 3 = grossly affected region with lesion covering most of the footpad area. Right and left feet were scored separately. Scores were later averaged to attain one score per bird for statistical analysis (Pagazaurtundua and Warriss 2006).

Hock burns were scored on a 3-point scale of 3 points as follows: 0 = unaffected hocks; 1 = minor discoloration or lesions; 2 = severe scabbing and lesions. Right and left hocks were scored separately and later averaged for analysis (Kjaer *et al.*, 2006).

2.4. Feather score

At the end of the experiment 5 birds per pen were subjected to feather scoring of the back and flank. The score ranged from 1= good feathering to 3= no feathers (Benabdeljelil and Ayachi 1996).

2.5. Moisture content of the litter

At 42 days of age, litter samples were collected from five locations within each pen in a plastic container (four peripheral, equidistant from each pen corner, and one central). At least 200g of litter sample were taken from each location. Each sample was thoroughly mixed. Moisture determinations were performed on a 100 gm sample (five samples/pen) weighed and oven-dried for 72 hrs at 105°C (modified after Benabdeljelil and Ayachi 1996).

2.3. Statistical analysis:

The collected data were analyzed with ANOVA using generalized linear models (GLM- procedure, SAS Institute, 2001).

RESULTS

1. Behavioral patterns:

The effects of different bedding materials on broilers behaviors are summarized in Table 1. A significantly higher proportion of chicks grown on the (WS + Sand) were engaged in feeding behavior 18.30 ±.93 compared to chicks grown on straw and (straw + sand) 14.43±1.12, 13.28±.86, respectively, ($p<.01$). Birds reared on (straw + sand) exhibited significantly lower feeding behavior 13.28±.86 compared to birds

reared on (WS+ straw) and sand 16.80±.97, 16.32±.96, respectively, (p<.01), with birds reared on straw and WS being intermediary but not different from them (14.43±1.12, 15.63±1.10, respectively, p>.05). There was a non significant difference (p>.05) in feeding behaviour between birds reared on WS, sand and straw.

Birds reared on straw and (straw + sand) showed a significantly more standing behavior 4.57±.64, 4.34±.60 respectively, compared to birds reared on WS, sand and (WS + Sand). The data were 2.48±.35, 2.78±.37, 2.17±.35, respectively, (p<.01). Also, significantly higher percentage of birds reared on straw and (straw + sand) were engaged in walking behavior 4.79±.53, 4.69±.81 respectively, compared to birds reared on WS, sand, (WS+ straw) and (WS + Sand) 2.77±.31, 2.37±.27, 2.58±.29, 2.22±.28 respectively, (p<.01). Percentage of birds observed sitting was significantly lower in straw and (straw + sand) reared birds 48.37±1.71, 48.84±1.88 respectively, compared to birds reared on WS, sand and (WS+ straw) 56.18±1.96, 54.31±1.31, 53.98±1.55 respectively, (p<.01). Birds grown on (WS + Sand) litter has significantly more sitting behaviors compared to birds reared on straw 53.45±1.78, 48.37±1.71 respectively, (p<.01), but not differed from other groups.

Results of dust bathing behavior (Table 1) showed that percentage of birds engaged in dust bathing behavior was significantly higher in sand and (WS+ sand) reared birds 98±.23, .75±.19 respectively, compared to straw reared birds, .17±.09 (p<.01) with other groups being in between but not differed from them. Birds reared on sand engaged in none significantly more dust bathing than birds reared on WS (p>0.5).

Results summarized in Table 1. Showed non significant differences of litter materials on the percentage of birds engaged in drinking, foraging, preening, wing stretching and/or wing flapping, ruffling and aggressive behaviors. Also, the results in the current study found non significant difference in all behavioral patterns observed between birds grown on WS and sand (p>0.5).

2. Productive performance:

In the current study, significant difference was observed in body weight (BW) between birds reared on the different types of litter at the end of second week of age (Table 2). Birds grown on (WS+ sand) had significantly higher (BW) 423.94±9.02 compared to birds grown on straw, sand and (straw + sand) 335.88±14.14, 369.21± 12.53, 331.76±11.45 respectively, (p<.01). At 4th week of age broiler chicks reared on (WS + sand) and (WS+ straw) had significantly heavier (BW) (p<.01) than birds reared on other litter types. Results of body_weight at 5th week and body weight gain (BWG) (g/bird) indicated that birds reared on (WS + sand) had significantly higher (BW) and (BWG) 1681.84±39.54, 1634.01± 39.63 respectively, compared to birds reared on straw 1495.58±39.62, 1447.74± 39.93 respectively, and (straw + sand) 1520.88±45.08, 1473.04± 44.83 respectively, (p<.05), (Table 2). Birds reared on WS, straw or sand showed non significant (p>.05) differences in BW (except in the 2ed week) and BWG. FCR and percentage of bird's mortality were not affected (p>.05) by the types of litter either used separately or in combination.

3. Carcass traits.

Carcass traits (percentage of live boy weight) of broiler chicks reared on different litter materials at 42 days of age are presented in Table 3. percentage of heart to live weight was significantly higher in birds reared on (WS + sand) .88±.06 compared to birds reared on WS, straw, sand, (WS+ straw) and (straw + sand), .51±.03, .56±.034, .62± .07, .54±.08, .60±.079 respectively, (p<.05). Percentage of gizzard was significantly higher in birds reared on (WS) 4.02±.07 compared to birds reared on straw, sand, (WS + straw), (WS + sand) and (straw + sand) 2.22±.15, 2.75±.12, 3.24±.23, 2.74±.12, 2.66±.22 respectively, (p<.01). It was observed that carcass weight, liver, spleen and bursa were not significantly affected by the types of litter materials used (Table 3).

4. Welfare indices:

The effect of different litter types on some welfare indices are summarized in Table 4. Litter types had no effect on all welfare indices measured in the current study. Also types of litter had no effect on breast blisters (since the birds were not affected, the data of breast blisters are not presented).

5. Moisture content:

The effect of litter types on moisture content at 42 days of age are presented in Figure 1. Whole rice straw had significantly more moisture content 37.20±1.78 compared to other litter types 22.96±4.51, 11.85±1.80, 25.21±2.19, 15.73±4.38, 22.34±5.41, (p<.01), respectively for WS, sand, (WS + straw), (WS + sand) and (straw + sand). Sand had significantly (p<.01) lower moisture content compared to straw and (WS + straw) litters. There was no difference in moisture content between (WS), (WS + straw), (WS + sand) and (straw + sand), 22.96±4.5, 25.21±2.19, 15.73± 4.38, 22.34±5.41, respectively (p>.05) (Figure 1).

Table 1: The effect of different litter materials on the total number of chicks observed performing various behaviors (% Mean ± SE).

	(WS) Wood-shavings	Straw	Sand	WS+ straw	WS + Sand	Straw + Sand	Sig.
Feeding	15.63^{abc}±1.10	14.43^{bc}±1.12	16.32^{ab}±.96	16.80^{ab}±.97	18.30^{a}±.93	13.28^{c}±.86	**
Drinking	3.55±.47	2.79±.50	2.59±.49	2.30±.37	3.55±.53	3.29±.46	ns
Standing	2.48c±.35	4.57^{a}±.64	2.78^{c}±.37	3.07^{bc}±.35	2.17c±.35	4.34^{ab}±.60	**
Walking	2.77^{b}±.31	4.79^{a}±.53	2.37^{b}±.27	2.58^{b}±.29	2.22b±.28	4.69^{a}±.81	**
Sitting	56.18^{a}±1.96	48.37^{c}±1.71	54.31^{a}±1.31	53.98^{a}±1.55	53.45ab±1.78	48.84^{bc}±1.88	**
Foraging	7.27±.51	8.61±.85	8.60±.58	9.48±.77	7.76±.74	9.67±1.21	ns
Preening	7.53±.59	9.10±.82	7.04±.58	7.43±.63	7.17±.58	8.23±076	ns
Dust Bathing	.53^{ab}±.15	.17^{b}±.09	98^{a}±.23	.50^{ab}±.16	.75a±.19	.46^{ab}±.16	*
Wing st. and/or wing flapping	2.68±.32	3.78±.40	3.81±.36	2.78±.30	3.73±.38	3.72±.38	ns
Ruffling	.47±.16	..43±.16	.58±.16	.54±.15	.37±.12	.73±.20	ns
Aggression	.85±.26	.92±.36	.56±.23	.48±.22	.49±.18	.69±.24	ns

^{a,b}Means with the same letters and row are not significantly different. Sig.: significance. ns: non significant.* p<0.05. ** p<0.01.

Table 2: The influence of different litter materials on productive performance of broiler chicks (Mean ± SE).

Group	BW W1	BW W2	BW W3	BW W4	BW W5	Gain (g/bird)	FCR	Mortality %
(WS) Wood-shavings	174.70 ± 3.84	404.66^{ab} ± 16.28	677.05 ± 19.72	1057.05^{b} ± 18.54	1548.52^{ab}± 45.09	1500.68^{ab}± 44.79	2.19 ± .09	2.50
Straw	157.64 ± 5.45	335.88^{cd} ± 14.14	664.47 ± 22.46	1020.00^{b} ± 31.66	1495.58^{b} ± 39.62	1447.74^{b}± 39.93	2.27 ± .06	2.50
Sand	161.05 ± 3.89	369.21^{bc} ± 12.53	671.57 ± 19.92	1042.10^{b} ± 32.55	1556.57^{ab}± 54.82	1508.53^{ab}± 54.90	2.22 ± .10	0.00
WS + straw	167.77 ± 4.95	404.66^{ab} ± 16.28	691.38 ± 25.37	1214.44^{a} ± 33.88	1631.11^{ab} ± 51.9734	1583.28^{ab}± 51.94	2.10 ± .09	2.50
WS + sand	164.73 ± 4.48	423.94^{a}± 9.02	708.15 ± 15.03	1246.31^{a} ± 29.45	1681.84^{a} ± 39.54	1634.01^{a} ± 39.63	2.00 ± .04	0.00
Straw+ sand	158.82 ± 4.91	331.76^{d}± 11.45	620.00 ± 19.29	1042.94^{b} ± 27.83	1520.88^{b} ± 45.08	1473.04^{b}± 44.83	2.24 ± .07	0.00
Sig.	Ns	**	Ns	**	*	*	ns	ns

^{a,b}Means with the same letters and column are not significantly different. Sig.: significance. ns: non significant.* p<0.05. ** p<0.01.

Table 3: Effect of different litter materials on carcass traits of broiler chicks at day 42 (Mean ± SE).

	(WS) Wood-havings	Straw	Sand	WS+ straw	WS + Sand	Straw + Sand	Sig.
Carcass%	73.33±.27	71.22±.32	73.12±.67	74.19±.30	77.20±4.92	70.74±.66	ns
Gizzard%	4.02^{a}±.07	2.22^{c}±.15	2.75b^{c}±.12	3.24^{b}±.23	2.74^{bc}±.12	2.66^{bc}±.22	**
Heart%	.51^{b}±.03	.56^{b}±.034	.62^{b}±.07	.54^{b}±.08	.88^{a}±.06	.60^{b}±.079	*
Liver%	2.46±.13	2.19±.08	2.36±.10	2.24±.19	2.42±.26	2.40±.18	ns
Lymphoid organs							
Spleen %	.14±.01	.12±.01	.12±.01	.13±.01	.11±.01	.14±.01	ns
Bursa %	.11±.01	.10±.01	.09±.01	.08±.01	.09±.01	.14±.01	ns

^{a,b}Means with the same letters and row are not significantly different. Sig.: significance. ns: non significant.* p<0.05. ** p<0.01.

Table 4: Effect of litter materials on welfare of broiler chicks at day 42 (Mean ± SE).

Group	TI (sec) duration	TI (no)	FA	Back score	Rump score	Total score	Footpad dermatitis	Hock burns	LTL (sec)	H/L Ratio
(WS) Wood-shavings	91.00± 23.27	1.60± .24	.47± .13	1.25± .25	1.00± .00	2.25± .25	1.50 ± .28	2.00± .40	83.20± 20.35	.04±.01
Straw	86.40± 42.36	2.00± .44	.42± .17	1.00± .00	1.00± .00	2.00± .00	.75± .47	3.00± .00	163.60± 56.74	.06±.01
Sand	117.20± 33.43	1.60± .24	.52± .11	1.00± .00	1.00± .00	2.00± .00	1.25 ± .47	1.75± .25	124.80± 52.81	.10±.01
WS + straw	243.40± 34.72	2.20± .20	0.55 ±.11	1.50± .28	1.25± .25	2.75± .25	2.00± .40	2.25± .25	81.80± 35.14	.07±.01
WS+ Sand	138.20± 43.07	2.00± .44	.30± .17	1.25± .25	1.00± .00	2.25± .25	.75 ± .47	1.25± .25	114.60± 50.16	.08±.01
Straw+ sand	100.00± 48.70	1.60± .40	.27± .16	1.25± .25	1.25± .25	2.50± .50	.75± .47	2.00± .81	161.80± 52.01	.05±.01
Sig.	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

^{a,b}Means with the same letters and column are not significantly different. Sig.: significance. ns: non significant. TI: tonnic immobility. TI (no): number of tonnic immobility induction. FA: fluctuating asymmetry. LTL: latency to lie test. H/L: heterophil to lymphocytic ratio.

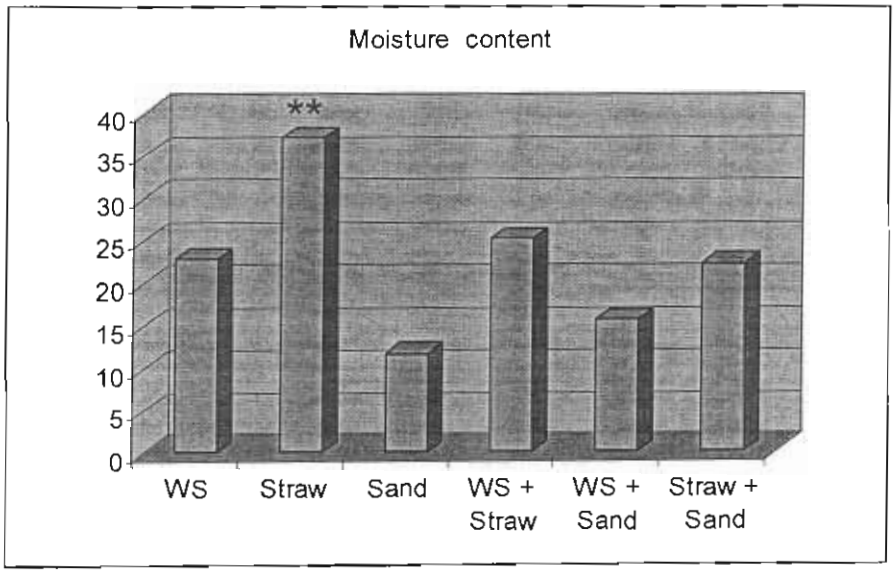

Figure 1: Effect of litter materials on moisture content (% Mean ± SE).

**Mean p < 0.01.

DISCUSSION

1. Behavioral patterns:

Results of feeding behavior indicated that using wood shavings in combination with sand (WS + Sand) and straw (WS + straw) improved feeding behavior. On the Contrary, sand covered by a layer of straw (straw + sand) resulted in lower feeding behavior, which in turn was reflected on the body weight. Unfortunately there are no literatures dialed with using rice straw and sand in combination as bedding materials. Benabdeljelil and Ayachi (1996) reported that feed consumption were not affected in broiler chicks grown on litters composed of soft wheat straw, sawdust covered by wood shavings and rice hulls covered by wood shavings.

Results from behavioral observations indicated that, bedding types had no effect on feeding behavior when litters were used separately (WS, straw or sand). This result was in close agreement with Benabdeljelil and Ayachi (1996) who found that feed consumption not significantly differed between birds reared on whole wheat straw, ground wheat straw, ground rice straw, wood shavings, sawdust and rice hulls. In the same trend, Shields *et al.* (2005) and Toghyani *et al.* (2010) found no difference in feeding behavior between broiler chicks reased on sand and wood shavings litter materials.

Birds reared on straw and (straw + sand) showed more standing and walking behaviors. Increased walking behavior may be related to low feeding behavior that demonstrated in these groups. Hocking *et al.* (1997) reported that pacing was negatively related to rate of consumption. Moreover, Hocking (1993) observed that the proportion of time spent standing and walking was associated with a decrease in the proportion of time involved in eating, scratching and pecking activities.

Our results indicated that when rice straw were used as a bedding material either separately or as a top layer in combination with sand (straw + sand) birds stand, walk more and sat less. Birds preferred sand and wood shavings for sitting behavior either used separately or in combination with other litter when top layer covered by wood shavings (WS + straw). These results were in agreement with Toghyani *et al.* (2010) who reported that locomotion behavior on sand and wood shavings decreased whereas sitting increased. There might be a perceptual difference in the way sand and wood shavings appear to broilers, in the way it feels on their feet and in their plumage. Cleanliness, temperature at lower depth in the bedding, odor or some other characteristics of the bedding may be important for resting (Shields *et al.*, 2005). Bilgili *et al.* (1999a) found that sand bedding in commercial houses is cleaner than other litters.

Results of dust bathing indicated that, birds prefered sand to wood shavings for dust bathing, however not reached to significant value. Rice straw is inferior bedding substrates for dust bathing, but using rice straw in combination with sand or wood shavings was associated with increased dust bathing behavior. This result was in agreement with Sanotra *et al.* (1995) who stated that birds prefer to dustbathe in sand rather than in wood shavings or straw. Similarly, Arnould *et al.* (2004) mentioned that, broiler chicks were attracted to trays of sand placed in their pens and use the sand preferentially for dustbathing and foraging. Also, shields *et al.* (2004) and Toghyani *et al.* (2010) found that broilers prefer sand to wood shavings, paper bedding, or rice hulls for dustbathing.

Our results showed non significant difference in behavioral patterns observed between birds grown on WS and sand. In agreement with our results, Shields *et al.* (2005) indicated that when given a choice, broilers increasingly performed many of their behaviors on sand, but if only one bedding type was provided they performed those behaviors with similar frequency on sand or wood shavings.

2. Productive performance:

Birds reared on (WS + sand) had significantly higher BW and BWG compared to birds reared on straw and (straw + sand) at market age. This result could attribute to a significantly lower feeding behavior in these birds compared to birds reared on (WS + sand) which was in turn reflected on BW and BWG.

Types of litter when used separately (WS, straw or sand) had no effect on BW and BWG of broiler chicks. FCR and percentage of died birds were not affected by the types of litter materials either used separately or in combination. Our results were in close agreement with Lien *et al.* (1992); Brak *et al.* (1993); Benabdeljelil and Ayachi (1996); Chamblee and Yeatman (2003); Grimes *et al.* (2006); Davis *et al.* (2010) and Villagra *et al.* (2011), who reported that, litter materials had no influence on broilers performance and mortality rates.

This study indicated that straw and sand could be used as alternative for wood shavings as bedding materials with out implication on bird's performance. Using wood shaving in combination with sand and straw resulted in improved broilers body weight.

3. Carcass traits:

Percentage of gizzard to live weight was higher in birds reared on (WS) compared to birds reared on other litters. This finding was in agreement with Malone *et al.* (1993) and Biligili *et al.* (1999a) who found that broilers reared on pine shaving, wood shavings or sawdust had larger gizzards than those reared on other litter materials. If the size of the gizzard is determined by the amount of work required by the muscular walls of the organ to crush the feed particles as suggested by Branion (1963), then wood shavings probably require increased gizzard activity, whereas sand, if consumed, may not cause the same

degree of action. It is also possible that the rate of feed passage of sand through the gut and gizzard may be faster than that of wood shavings. Whole straw is very difficult to be consumed. Contrary to our results many authors indicated that carcass traits not affected by litter type.

In the current study, carcass weight, liver, spleen and bursa were not affected by the types of litter used. Similarly, Davis *et al.* (2010) reported that, carcass weight was not affected by using chopped Switchgrass or pine shavings as a litter material for broilers. Toghyani *et al.* (2010) found no significance effect of litter types on carcass, abdominal fat, gizzard, intestine and ceca of broiler chicks. The same authors added that, only the percentage of proventriculus to live weight was significantly lowered in the birds reared on rice hulls compared to birds reared on wood shaving, paper roll and sand.

4. Welfare indices:

In the present study, litter materials had no effect on the measured welfare indices including fear (tonnic immobility duration and number of tonic immobility induction), developmental instability (fluctuating asymmetry), feather score (back and rump score), footpad dermatitis, hock burns, leg health (latency to-lie-test) and stress (heterophil to lymphocytic ratio). Our results were in agreement with Benabdeljelil and Ayachi (1996) who reported that type of litters had no effect on feather scoring, breast blisters, leg abnormalities and footpad lesions of broiler chicks grown on litters composed of whole wheat straw, ground wheat straw, ground rice straw, wood shavings, sawdust and rice hull. The same authors found the same results when birds reared on combination of litters (straw on wood shavings), straw on sawdust, wood shavings on sawdust or wood shavings on rice hulls. Also, Villagra *et al.* (2011) indicated that, welfare parameters (TI, footpad dermatitis, breast lesion, tibial dyschondroplasia, gait score and broken bones) were not significantly differed between birds reared on wood shavings and sludge from paper recycling. The same authors added that, only the incidence of hock burns was significantly higher in birds reared on sludge from paper recycling compared to those reared on wood shavings. In the same trend, Bilgili *et al.* (1999a, b) found no differences in footpad lesion between broiler chicks reared on pine shavings and sand. Contrary to our results Shanawany (1992) and Ferrante *et al.* (2006) reported that feather scoring and footpad lesions were bad for straw litter compared to wood shavings.

Results in the current study indicated that rice straw and sand are possible alternative to wood shavings without negative implication on bird's welfare.

5. Moisture content:

Our results indicated that, rice straw had significantly more moisture content compared to other litter types. Using straw in combination with sand (straw + sand) or wood shavings (WS + straw) resulted in reduction of moisture content of straw. Results in the current study were in agreement with Ferrante *et al.* (2006) who suggested that, wood shavings had high water-holding capacity and had better litter quality than litter materials with poorer absorption capacity such as straw. If straw is used it should be chopped very short in order to improve its water-holding capacity (Sørensen *et al.*, 2002). Results of the current study were disagree with Bilgili *et al.* (1999a, b) who mentioned that, no significant differences were found for litter moisture between pine shavings and sand. Benabdeljelil and Ayachi (1996) found no differences in the percent of moisture content at 43 and 57 days of age between litter materials composed of whole wheat straw, ground wheat straw, ground rice straw, wood shavings, sawdust and rice hulls either used separately or in combinations.

In this study, however rice straw had higher moisture content; birds reared on straw don't showed adverse welfare problems such as bad feather scoring, footpad lesions, hock burns and breast blisters. This could attributed to behavior of birds, as birds reared on straw based litter showed significantly lower sitting behavior and higher standing and walking behaviors (Table 1).

Further research should therefore be carried out to clarify other aspects that were not studied in this work, such as ammonia, odor, bacterial count of the litter, as well as using chopped rice straw either separately or covered by sand.

CONCLUSIONS

In conclusion, behaviors of broiler chicks affected by different bedding types. Rice straw and sand could be used as alternative bedding materials to wood shavings without adverse implications of birds performance and welfare. Using wood shaving in combination with sand or straw resulted in improved broilers body weight. Using sand or wood shavings in combination with rice straw resulted in reduced moisture content of rice straw bedding.

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تأثير استخدام أنواع مختلفة من الفرشة علي السلوكيات والأراحة والأداء في بداري التسمين

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أجريت هذة الدراسة على عدد ٢٤٠ فرخ من بدارى التسمين عمريوم حيث تم توزيعهم عشوائيا على ستة معاملات حسب نوع الفرشة (ستة مجموعات - ٢٠ طائر\ مجموعة) حيث تم تكرار كل معاملة مرتين. بدات المعاملات من عمر يوم حتى اليوم ٤٢ من العمر وكانت كالتالى: المجموعة الأولى تم استخدام نشارة الخشب كفرشة للطيور(WS). المجموعة الثانية تم استخدام قش الارز الغير مقطع (Straw). المجموعة الثالثة تم استخدام الرمل (Sand). المجموعة الرابعة تم استخدام طبقة من قش الارز مغطاة بطبقة من النشارة (WS + Straw). المجموعة الخامسة تم استخدام طبقة من الرمل مغطاة بطبقة من النشارة (WS + Sand). المجموعة السادسة تم استخدام طبقة من الرمل مغطاة بطبقة من القش (Straw + Sand). تمت ملاحظة سلوكيات الطيوربمعدل مرتين يوميا- مرتان فى الأسبوع ولمدة ستة أسابيع. تم وزن الجسم وحساب استهلاك العليقة لكل مجموعة أسبوعيا ومنة تم قيا س الوزن المكتسب ومعدل التحويل الغذائى. فى نهاية التجربة تم عمل بعض الاختبارات لقياس الاراحة في الطيور مثل (اختبار الخوف وتمييز لكرات الدم البيضاء والتذبذب وعدم التماثل وصحة القدم والساق ومشاكلهما وكذلك تصنيف حالة الريش على جسم الطائر) وذلك لكل المجموعات. وكذلك تم وزن بعض الاعضاء الداخلية. كما تم تسجيل عدد الطيور النافقة فى كل معاملة. وتم حساب نسبة الرطوبة فى الفرشة لكل معاملة فى اليوم ٤٢ من عمر الطيور. اظهرت الطيور المرباة على الفرشة المكونة من (WS + Sand) معدل أعلى معنويا في سلوك تناول الغذاء وكذلك كانت اعلى معنويا فى وزن الجسم والوزن المكتسب مقارنة بالطيور المرباة على (Straw) و (Straw + Sand). اظهرت النتائج انه لا يوجد تاثير معنوى للفرشة المستخدمة على سلوك تناول الغذاء والأداء الإنتاجي للطيور عند استخدام نوع واحد من الفرشة مثل (WS او Straw او Sand). اظهرت الطيور المرباة على (Sand) و (WS) معدل منخفض معنويا فى سلوكيات الوقوف والمشي ومعدل اعلى معنويا فى سلوك الرقاد. على النقيض من ذلك كان معدل سلوك الرقاد منخفضا وسلوكيات الوقوف والمشي مرتفعة في الطيور المرباة على (Straw) و (Straw + Sand). اظهرت النتائج عدم وجود فروق معنوية فى معدل التحويل الغذائى وفى جميع اختبارات قياس الاراحة بين المعاملات المختلفة سواء تم استخدام الفرشة بشكل احادى او استخدام نوعين من الفرشة معا. تميزت الطيور المرباة على (WS) بأعلى نسبة وزن للقونصة مقارنة بالمعاملات الاخرى. بينما تميزت الطيور المرباة على (WS + Sand) باعلى نسبة لوزن القلب. كانت نسبة الرطوبة مرتفعة معنويا فى قش الارز (Straw) مقارنة بالمعاملات الاخرى. بينما تميز الرمل (Sand) بأقل نسبة رطوبة مقارنة بكل من (Straw) و (WS + Straw). نستخلص من الدراسة أن نوع الفرشة المستخدمة كان له تأثير كبير على سلوكيات الدجاج. يمكن استخدام قش الارز والرمل كفرشة لبدارى التسمين بدلا من نشارة الخشب وذلك بدون اى اثار سلبية على كلا من الاداء الانتاجى واراحة ورفاهية الطيور.