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Effect of Pine Wood Shavings, Rice Hulls and River Bed Sand on Broiler Productivity When Used as a Litter Sources

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Abstract: As the poultry industry has grown and expanded and as alternative uses of wood by-products have expanded, the availability of wood shavings and sawdust for litter materials has been challenged. Litter type utilized is largely dependent upon local availability of the material and location of the farm. Unfortunately, the availability of pine shavings has steadily decreased due to competition for its use from other industries and use as an energy source. The objective of this research was to evaluate conventional litter sources to sand as a substitute litter. For the experiment Pine Wood Shavings (PWS), Rice Hulls (RH), River Bed Sand (S) and river bed sand top dressed with pine wood shavings (SP) were the four litter source treatments implemented. Chicks were identified and randomly allocated in a randomized complete block design. Litter temperatures were recorded prior to bird placement. Body weight, cumulative feed consumption, feed conversion (feed: body weight) and litter moisture were determined on a weekly basis through 42 days of age. Mortality was recorded daily. At processing carcass weight, percentage carcass yield without giblets and gizzard yield were determined on a prechilled basis. Litter surface temperatures were significantly ($p<0.001$) higher for PWS, RH and SP compared to just S alone. Broilers raised on S had significantly ($p<0.001$) higher body weights and consumed more feed than those raised on PWS or RH throughout the 42 days. No significant differences were found for feed conversion, mortality or carcass yield. Carcass weight and gizzard yield were significantly ($p<0.001$) higher for birds raised on S. Sand maintained approximately 15% lower moisture level in comparison to PWS and RH and a 5% difference to SP ($p<0.001$). In conclusion, sand can potentially be used as an alternative litter material for growing broilers.

Key words: Broiler, litter, sand, moisture, pine shavings

INTRODUCTION

As the poultry industry in the USA has grown and expanded and as alternative uses of wood by/products have expanded, the availability of wood shavings and sawdust for litter materials has been challenged. The availability of pine shavings has steadily decreased due to the competition for the composite board industry, horticulture and its use as an energy source (Carpenter, 1992). There are many factors which must be taken into account for successful litter management. These include the type of litter used, the time of the year, depth of the litter, floor space per bird, feeding and watering devices used, kind of flooring and ventilation system that can affect litter (Snyder *et al*., 1958). Also the type of litter utilized is largely dependent upon local availability of the material and location of the farm.

Sand as a litter material is not new to poultry production (Snyder *et al*., 1958) yet it is receiving renewed interests Hess *et al*. (1996). Bilgili *et al*. (1999a) reported successfully rearing several broiler flocks on sand in comparison with pine shavings in a research setting. Further studies were conducted in the field under commercial conditions (Bilgili *et al*., 2000; Hess *et al*., 2001). In multiple tests, broilers reared on sand performed as well as those on pine shavings. Footpad quality and male broiler body weights were improved when reared on sand in some cases. Moisture and ammonium levels were similar to pine shavings with significantly lower levels of bacteria in the sand litter when compared with shavings. Darkling beetle populations are reduced with sand litter. However, sand does not heat up as well when compared to shavings litter. This requires more attention from the producer to make sure the floor temperature is correct before chicks are placed. Sand has been considered for use in other regions and has been found to have mixed results (Malone *et al*., 2001a; Malone *et al*., 2001b, Watkins, 2001). While broiler performance was similar or better, in some cases, than for broilers reared on litter, some issues raised included poorer chick starts on sand as compared to shavings. Sand used as a litter is not always cost effective for all operations and sand is not compatible with composting, combustion or pelleting (Grimes *et al*., 2002). The objective of this study was to evaluate the potential of using river bed sand as a litter for broiler production.

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MATERIALS AND METHODS

One-day-old male Hubbard® x Hi-Y®[1] chicks were received from a commercial hatchery (CADECA, Tegucigalpa) and placed in an open-sided naturally ventilated broiler house using a daily photoperiod of 23D:1L.

Each of the 56 experimental pens 1.25 x 3.75 m used contained 56 chicks that were weighed and housed at a density of 12 birds per square meter. Four treatments, Pine Wood Shavings (PWS), Rice Hulls (RH), Sand (S), and sand top dressed with pine wood shavings (SP) were randomly assigned in blocks. Fourteen replicates containing each treatment were allocated to the 56 pens in a randomized complete block design. The house was heated by LP gas space heaters and provided with nipple waterers and tube feeders. Commercial mash diets (Table 1) and water were provided *ad libitum*.

Body weight, cumulative feed consumption, feed conversion (feed: body weight) and litter moisture (AOAC, 1990) were determined on a weekly basis through 42 days of age. Mortality was recorded daily. At processing carcass weight, percentage carcass yield without giblets and gizzard yield were determined on a prechilled basis. Litter temperatures for all pens were recorded three hours prior to bird placement.

Statistical analysis: Data were evaluated by ANOVA using the General Linear Models (GLM) procedure of SAS software (SAS Institute, 2007). Percentage data were subjected to arc sine square root of the percentage transformation and treatment means were separated by least significant difference. A probability of $p<0.05$ was required for statements of significance.

RESULTS AND DISCUSSION

Litter surface temperatures were significantly ($p<0.001$) higher for PWS, RH and SP compared to just S alone. As temperatures were measured deeper in the litter differences among the treatments changed (Fig. 1). There were no differences in body weight among birds grown on PWS or RH (Table 1). Reed and McCartney (1970) ranked rice hulls immediately behind pine shavings as desirable bedding material. Morgan (1984) reported that broilers reared on rice hulls performed as well as broilers reared on pine shavings. Higher weight gains and improved feed conversion were observed for birds reared on rice hull when compared to those reared on sawdust, paddy straw and sand, Anisuzzaman and Chowdhury (1996). Birds that were grown on S and SP litters had significantly ($p<0.001$) higher body weights as compared to PWS and RH throughout the entire growing period. Bilgili *et al.* (1999a) reported similar results when rearing several broiler flocks on sand in comparison with pine shavings finding males to be heavier with no differences in female weights. One of the reasons for the improved weights could be due to the

Table 1: Effect of litter source on broiler body weight (g)

Age (d)	PWS	RH	S	SP	SEM
7	148.4^{ab}	145.9^{a}	153.0^{b}	150.3^{ab}	1.64
14	388.1^{ab}	382.9^{a}	401.1^{c}	396.5^{bc}	3.58
21	779.0^{a}	778.9^{a}	809.6^{b}	799.1^{ab}	6.39
28	1268.0^{a}	1284.4^{a}	1337.6^{c}	1312.8^{b}	8.34
35	1857.8^{a}	1868.2^{a}	1944.2^{b}	1924.2^{b}	14.19
42	2337.8^{ab}	2307.4^{b}	2419.8^{c}	2389.1^{bc}	20.87

^{abc}Means within rows without a common superscript are different ($p<0.001$). PWS = Pine Wood Shavings; RH = Rice Hulls; S = River Bed Sand; SP = River Bed Sand Top Dressed with Pine Wood Shavings

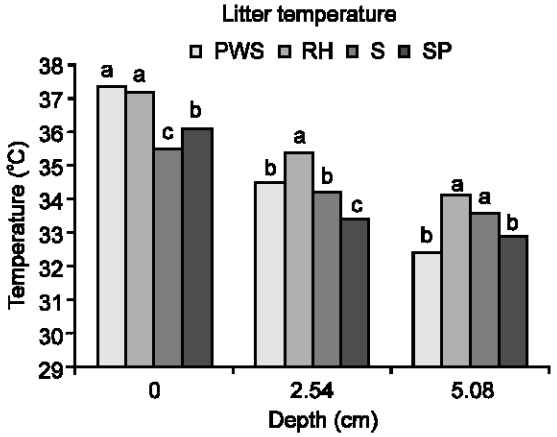

Fig. 1: Litter temperatures at different depths 3 h prior to bird placement. Statistical differences among the different litters are denoted by $^{abc}p\leq0.001$

variation in the river bed sand particle size. The sand used was of a large coarse particle size similar to grit. The consumption of these grit sized sand particles by the bird could have stimulated gizzard activity thus enhancing digestion and improving body weight of the birds. It was shown that coarse particles may slow the passage rate of digesta through the gizzard (Nir *et al.*, 1994), increasing the exposure time of nutrients to digestive enzymes, which in turn, may improve energy utilization and nutrient digestibility (Carre, 2000; Svihus *et al.*, 2004), thus, improving bird performance. Bacterial wise, sand is equivalent or slightly superior to pine shavings when used as a poultry litter (Macklin *et al.*, 2005). Aerobic bacterial counts on sand are lower than pine shavings (Bilgili *et al.*, 1999a) or are the same (Bilgili *et al.*, 1999b). Macklin *et al.* (2005), also found that enteric and anaerobic bacteria counts were also generally lower on sand than pine shavings. Sand, being inorganic, contains few nutrients that could be utilized by bacteria and thus, would tend to lead to lower bacterial numbers. In addition, sand may lack binding sites for bacteria. Pine shavings are organic containing nutrients that could be utilized by some bacterial species. In addition, litter moisture was lower for S and SP, maintaining a drier litter throughout the entire growing period (Table 5). Lower moisture content would

Table 2: Effect of litter source on broiler feed consumption (g)

Age (d)	PWS	RH	S	SP	SEM
7	149.3	142.7	158.5	148.0	5.22
14	535.6	519.8	551.2	522.9	8.90
21	1184.6^{a}	1153.9^{a}	1228.2^{b}	1188.3^{a}	11.61
28	2087.2^{a}	2027.4^{a}	2170.2^{b}	2076.9^{a}	21.45
35	3194.8^{a}	3097.6^{ab}	3305.1^{b}	3233.7^{b}	36.55
42	4225.8^{ab}	4136.7^{b}	4388.5^{c}	4302.9^{bc}	37.74

^{abc}Means within rows without a common superscript are different ($p<0.001$). PWS = pine wood shavings; RH = rice hulls; S = river bed sand; SP = river bed sand top dressed with pine wood shavings

Table 3: Effect of litter source on broiler feed conversion (g:g)

Age (d)	PWS	RH	S	SP	SEM
7	1.03	0.99	1.06	1.01	0.035
14	1.38	1.36	1.38	1.32	0.023
21	1.52	1.48	1.52	1.49	0.014
28	1.65	1.58	1.62	1.58	0.016
35	1.72	1.66	1.70	1.68	0.019
42	1.81	1.79	1.82	1.80	0.028

PWS = Pine Wood Shavings; RH = Rice Hulls; S = River Bed Sand; SP = River Bed Sand Top Dressed with Pine Wood Shavings

Table 4: Effect of litter source on broiler mortality (%)

Age (d)	PWS	RH	S	SP	SEM
7	0.30	0.10	0.30	0.00	0.014
14	1.40	1.40	0.60	1.20	0.021
21	2.00	2.60	2.10	2.30	0.024
28	2.00	2.60	2.10	2.30	0.022
35	2.80	3.70	3.30	3.00	0.019
42	4.00	4.70	4.40	4.00	0.016

PWS = Pine Wood Shavings; RH = Rice Hulls; S = River Bed Sand; SP = River Bed Sand Top Dressed with Pine Wood Shavings

Table 5: Effect of litter source on carcass weight (g), carcass yield (%), and gizzard yield (%) at 42 d of age

	PWS	RH	S	SP	SEM
Carcass wt. (g)	1662.5^{a}	1697.5^{ab}	1761.4^{c}	1726.6^{bc}	18.34
Carcass yield (%)	74.78	74.91	74.60	74.52	0.006
Gizzard yield (%)	1.82^{a}	1.87^{ab}	1.97^{bc}	2.01^{c}	0.001

^{abc}Means within rows without a common superscript are different ($p<0.001$). PWS = Pine Wood Shavings; RH = Rice Hulls; S = River Bed Sand; SP = River Bed Sand Top Dressed with Pine Wood Shavings

help inhibit the proliferation of bacteria that could affect bird performance (Macklin *et al*., 2005).

Birds grown on S litter consumed more feed than birds on PWS, RH or SP (Table 2). The higher amount of feed consumed by birds grown on S litter could be related to these same birds having heavier body weights, which in turn, will consume more feed. There were no significant differences among the treatments for feed conversion or mortality (Table 3 and 4). Results coincide with studies conducted by (Bilgili *et al*., 1999a, b).

Significantly higher carcass weight and gizzard yields were observed for birds on S and SP litter when compared to birds on PWS and RH litter (Table 5). Birds that had higher live body weights (Table 1) subsequently had higher carcass weights. Higher percent gizzard yield

Table 6: Effect of litter source on litter moisture (%)

Age (d)	PWS	RH	S	SP	SEM
7	10.12^{a}	9.00^{a}	0.12^{c}	1.63^{b}	0.021
14	16.25^{a}	17.00^{a}	1.00^{c}	7.25^{b}	0.015
21	21.90^{a}	20.00^{a}	4.37^{c}	8.62^{b}	0.009
28	23.37^{a}	21.00^{a}	5.87^{c}	11.50^{b}	0.014
35	23.12^{a}	22.00^{a}	8.12^{c}	10.75^{b}	0.008
42	24.62^{a}	24.50^{a}	9.37^{c}	12.62^{b}	0.007

^{abc}Means within rows without a common superscript are different ($p<0.001$). PWS = Pine Wood Shavings; RH = Rice Hulls; S = River Bed Sand; SP = River Bed Sand Top Dressed with Pine Wood Shavings

were observed for birds that were raised on S and SP litter. As previously mentioned the consumption of these grit sized sand particles stimulated gizzard activity (Nir *et al*., 1994; Carre, 2000; Svihus *et al*., 2004). These results contradict those found by Bilgili *et al*. (1999b) who observed that gizzard yields were significantly lower for birds reared on sand (1.5%) than for birds reared on pine shavings (1.7%). Broilers reared on wood shavings or sawdust has been shown to have larger gizzards and contain more litter in the gizzard than those reared on other litter material (Malone *et al*., 1983). 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). This would require increased gizzard activity for the pine shavings, whereas sand, if consumed, may not cause the same degree of activity. Bilgili *et al*. (1999b), also suggest that it is possible that the rate of feed passage of sand through the gut and gizzard may be faster than that of the pine shavings. Contrary to Bilgili *et al*. (1999b) results, birds reared on S and SP had higher ($p<0.001$) gizzard yields, 1.97 and 2.01% compared to birds reared on PWS and RH with yields of 1.82 and 1.87%. The differentiation between these results is due to the fact that the sand used by Bilgili *et al*. (1999a, b) was beach sand (Personal communication, 2008) which would have had a salt like consistency and size as compared the sand used in this study which was a river bed sand having a larger coarser grit like consistency which might have increased gizzard activity more than PWS. No significant differences were found for carcass yield.

Sand maintained approximately 15% lower moisture level in comparison to PWS and RH and a 5% difference to SP (Table 6) during the entire 6 weeks. In conclusion, sand can potentially be used as an alternative litter material for growing broilers.

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