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Short Communication

Evaluation of the Physical and Chemical Properties of Some Agricultural Wastes as Poultry Litter Material

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ABSTRACT

The physical and chemical properties of some agricultural wastes included wheat straw, sugarcane bagasse, sugarcane peat; rice hulls as well as wood sheaving and sawdust as the control were examined for determine their potential as poultry bedding materials. Sugarcane bagasse and peat compared to other materials had greater initial moisture content ($P<0.05$) and there were no significant difference between other materials. The highest and lowest water holding capacity (WHC) was related to sugarcane peat (548.14%) and rice hulls (116.70%), respectively ($P<0.05$). Water releasing capacity (WRC) was significantly affected only in two hours after socking the materials in water so that the highest and lowest WRC were related to rice hulls (6.03%) and peat (1.75%), respectively ($P<0.05$). The highest and lowest pH values were related to peat (7.26%) and sawdust (4.60%), respectively ($P<0.05$). The highest and lowest bulk density were related to sawdust (182.51 kg/m^3) and bagasse (46.28 kg/m^3), respectively ($P<0.05$). The highest and lowest nitrogen (N) percentage values were also related to wheat straw (0.39%) and sawdust (0.01%), respectively ($P<0.05$). In conclusion, rice hulls due to its favorable properties could be successfully used as alternative poultry litter material. Peat was not a satisfactory material for applying as poultry bedding. In contrast to peat, bagasse due to similar properties to straw seems to have good potential for using as poultry litter material.

Keywords: Agricultural waste, physical and chemical properties, litter, poultry.

INTRODUCTION

Although rearing the meat poultry in cage systems has recently attracted a lot of attention, however, some of the meat poultry stocks particularly broiler chicken still grow up on the floor of the poultry houses with a substrate known as litter material as poultry bedding. The recent trend in poultry industry has increased the demand for litter materials. Litter serves a number of important functions, such as absorbing moisture of excreta, reducing contact between birds and manure, insulates chicks from the cooling effects of the ground and provide a warm and sponge like bedding for instinctual and well-being needs such as soil scratching, dust bathing and search for food and normal behaviors (Grimes *et al*., 2002; Lacy, 2002). Litter management is one of the important management practices would be consider by poultry growers to overcome some problems associated with litter such as wet litter, ammonia and odors emissions, incidence of carcass lesions, etc. In this regard, the selection of litter material type, quantity and qualityand availability of that have an important role in controlling environment within poultry house and bird performance (Lacy, 2002; Garcês *et al*., 2013).

Research in identifying potential sources of materials for application in poultry litter is necessary because of their direct impacts on poultry welfare, health and performance. In addition, it's easy availability and costs of the material finally is the main determinant of choice and their application as poultry litter (Grimes *et al*., 2002). Effects of different litter materials on poultry are related to its chemical and physical properties. For efficient use of the material as bedding, materials must be dry, dust and pathogen free, fragile, appropriate particle size, high capacity to absorbing and releasing moisture, non-toxic, etc. (Brake *et al*., 1992; Grimes *et al*., 2002).

In general, each material with properties listed above can be satisfactorily used as litter material, but approximately we can't find a material that meets all of the above characteristics.

Furthermore, it must be compatible as a fertilizer or animal feed after it has served its purpose in the poultry house (Lacy, 2002). Therefore, litter quality, bird performance and carcass quality is considerably influenced by these materials (Malone *et al*., 1982). Wood shaving is the most common and effective litter material used by the poultry industry for many decades in the entire the world (Brake *et al*., 1992; Grimes *et al*., 2002). Appropriate properties such as particle size, absence of dust, bulk density, thermal conductivity, quick drying rate, and compressibility make wood shavings an ideal litter material for poultry.

Nevertheless, both softwood and hardwood shavings have become increasingly expensive and difficult to obtain and they are unavailable in most poultry production areas in the entire world, encouraging researchers to evaluate other litter sources such as agricultural wastes (Grimes *et al*., 2002; Garcês *et al*., 2013). Several alternative materials have been studiedas bedding material (Grimes *et al*., 2002; Khosravinia, 2006; Garcês *et al*., 2013).The fairly inexpensive agricultural wastes such as rice hulls (Hester *et al*., 1985), grains straw (Malone, 1992), leaves (Khosravinia, 2006),sugarcane bagasse (Davasgaium and Boodoo, 1997; Watkins, 2001), citrus pulps (Harms *et al*., 1968) and tea refused (Ataputta and Wickramasinghe, 2007) were found to have substantial potential as local and seasonal alternative poultry litter material. For example, corn cobs may be suggested as a litter material source in areas with large quantity of corn cultivation (Smith, 1956; Khosravinia, 2006). The easy availability and relatively low cost of these materials are the important criteria which determine their suitability for applicationin the poultry litter in addition to having the properties listed above.Therefore, in the current laboratory study an attempt was made to compare the physical and chemical properties of some agricultural wastesfor examine their potential as poultry bedding material.

MATERIALS AND METHODS

Sampling

In the current study, four samples from different agricultural waste types included wheat straw, sugarcane bagasse, sugarcane peat, rice hulls as well as wood sheaving and sawdust (Figure 1) were collected from different regions of Khuzestan province, Iran. Wood sheaving was imported from outside the Khuzestan province. Sawdust was obtained from local woodworkoperations. Sugarcane bagasse and peat were received by Karoon Agro-industry Company at Khuzestan province. Wheat straw and rice hulls were obtained from a one of the main areas (Baghmalek city, Khuzestan province) of wheat and rice cultivation.

Figure 1. Materials used in the experiment.

To ensuring the collected material being fresh, an attempt was made to collect materials from the latest cultivation of the crops as far as possible.

Laboratory procedure

A total of 3 subsamples of each collected samples of different materials were examined to evaluate physical and chemical properties included initial moisture content, water holding capacity (WHC),water releasing capacity (WRC), pH, bulk density and N. Because of high moisture content of sugarcane bagasse and peat as received, after determining initial moisture content, were dried for 24 h at room temperature and all of the examinations were performed on dried samples.

Moisture content of the materials was measured using 10 g of sample at 105ºC for 24 h (AOAC, 1994). For determine water holding capacity (WHC), first each sample material was dried and 20 g of sample placed in plastic pans at a depth of approximately 4 cm. Then, the pans filled with water and left them to stand at room temperature (22–24°C) for 60 min. After draining excess water for 3 min, the samples were weighed to determine the percentage of water absorbed on a dry matter basis. To determine water releasing capacity (WRC), in 2 and

24 h intervals after draining the excess water, the samples weighed again and amount of moisture losses in each time period was calculated based on the percentage of moisture released on a dry matter basis.

For pH measurement, 1:10 sample per distillated water was prepared. After 30 min, pH values of each sample were recorded by pH meter (Model 691 Metrohm, USA)until constant values were obtained. The bulk density was determined by the method described by Brake *et al*., (1992). Briefly,a large amount of each material was placed into a measured plastic container and then was shaken until the container was full and packed firmly. Container plus material were weighed and bulk density was calculated for each sample as kg/m^3. N percentage of each material type was determined by Kjeldal procedure according to AOAC (1994).

Statistical Analysis

Data were analyzed according to the ANOVA procedure of SAS software, version 6.12as a completely randomized design. Significant differences among treatments were determined at a 5% probability by Duncan's multiple range tests.

RESULTS AND DISCUSSION

The results of comparing the physical and chemical properties of examined materials are presented in Table 1. Sugarcane bagasse and peat in comparison with other tested materials had greater initial moisture content (P<0.05) and there were no significant difference between other tested materials. One of the important properties of suitable material for litter is that having a least amount of moisture, because high moisture increases the risk of pathogen growth and ammonia production in the litter (Carlile, 1984). According to Al-Homidan *et al*. (2003) litter moisture have a substantial impact on ammonia volatilization compared to other factors such as the type of litter material. Because of high moisture content (>50%) in the sugarcane bagasse and peat, their moisture content should be reduced before using as litter material.

Table 1. Comparison of physical and chemical properties of different materials as poultry litter material

Item	Wheat straw	Sugarcane bagasse	Sugarcane peat	Rice hulls	Wood sheaving	Sawdust	SEM	P-value
Initial moisture (%)	5.02^{c}	41.07^{b}	57.67^{a}	4.98^{c}	7.03^{c}	7.44^{c}	5.20	0.0215
WHC1 (%)	290.24^{b}	348.15^{b}	548.14^{a}	116.70^{c}	141.30^{c}	283.35^{c}	35.66	0.0001
WRC2, after 2 h (%)	3.96^{c}	3.34^{c}	1.75^{d}	6.03^{a}	4.97^{b}	2.30^{d}	0.37	<0.0001
WRC2, after 24 h (%)	48.42	42.38	23.22	47.28	54.46	55.20	2.46	0.093
pH value	6.17^{ab}	6.93^{ab}	7.26^{a}	6.20^{ab}	5.63^{bc}	4.60^{c}	0.25	0.0125
Bulk density (kg/m3)	55.19^{ed}	46.28^{e}	63.48^{b}	108.39^{c}	94.58^{c}	182.51^{a}	11.23	<0.0001
Nitrogen (%)	0.39^{a}	0.27^{c}	0.34^{b}	0.18^{d}	0.07^{e}	0.01^{f}	0.033	<0.0001

WHC: Water Holding Capacity
WRC: Water Releasing Capacity
[a,f] Columns with different letters are significantly different (P < 0.05).

Water releasing capacity (WRC) was significantly affected only in two hours after socking the sample materials in water so that the highest and lowest WRC were related to rice hulls (6.03%) and peat (1.75%), respectively (P<0.05). Davasgaium and Boodoo (1997) reported that different litter materials have a varying capacity in absorbing and holding the moisture.In the present study, the highest and lowest water holding capacity (WHC) was observed in sugarcane peat (548.14%) and rice hulls (116.70%), respectively ($P<0.05$). Sugarcane bagasse and peat have absorbed 3 and 5 times to their initial weights, respectively, while, absorbed moisture for rice hulls was 1 times to its initial weight.

Malone *et al*. (1982) found that moisture absorbing capacity of materials was an important factor in evaluating litter materials, whereas, Ruszler and Carson (1974) reported that moisture releasing capacity is a more important factor than moisture absorbing capacity. Particle size of litter material affects moisture releasing capacity of litter. Litter materials with smaller particle size have a little tendency to absorb and maintain the moisture (Ruszler and Carson, 1974). Adhesion of the particles of litter material to each other influenced by physical form and amount of absorbed moisture of different materials which finally affects amount of releasing moisture capacity (Brake *et al*., 1992).

WHC and WRC values of wheat straw and bagasse were relatively satisfying. Although wood sheaving is a good material with appropriate water absorbing capacity, in comparison to other tested materials except rice hulls, had lower WHC, but like rice hulls was better than other materials in WRC. Garcês *et al*. (2013) with evaluating some agricultural and ground materials found that the WHC of both sand and coconut hulls was lower and that of grass was higher than wood sheaving. Sawdust in spite of appropriate WHC properties was not suitable inWRC which was in contrast to results of Ruszler and Carson (1974). However, it is necessary to note that not only particle size, but also other factors might have an influence on WHC (Ataputta and Wickramasinghe, 2007). Differences in WRC between sawdust and peat which had similar particle size, probably was due to other physical properties of these materials.

The highest and lowest pH values were related to peat (7.26%) and sawdust (4.60%), respectively ($P<0.05$). It is reported that the low pH level of litter material has an advantage because in acidic pH of litter, the conversion of uric acid to ammonia will be reduced (Moore *et al*., 1996). Typical wood sheaving and sawdust have a pH ranged from 5 to 5.6 whereas, the pH of rice hulls is around 7.03 (Coufal *et al*., 2006).The highest and lowest bulk density values were related to sawdust (182.51 kg/m^3) and bagasse (46.28 kg/m^3), respectively ($P<0.05$).

Amount of needed litter material for poultry rearing is usually calculated based on depth and height (for example 5 or 10 cm) of litter. Hence, based on difference in bulk density of litter materials, there is need to use a various amounts of litter materials. Obviously, whatever the bulk density of a material is greater; much more of that material will is needed. The lower bulk density of a material shows high porosity in these materials and moisture absorbing capacity, air circulating and moisture releasing capacity will be better (Ataputta and Wickramasinghe, 2007). The highest and lowest N percentage values were related to wheat straw (0.39%) and sawdust (0.01%), respectively ($P<0.05$). Zifei *et al*., (2007) reported a relationship between N content of litter material and higher ammonia production from litter. While in another study reported that, having higher N content in litter material, the value of poultry litter as an organic fertilizer and ruminant feed may be higher. Although it does not appear that the nitrogen content of the bedding material has a major effect on the ammonia production, whereas, physical form and differences in the absorption and releasing of moisture had a substantial effect on the ammonia emissions (Ataputta and Wickramasinghe, 2007).

CONCLUSION

According to the results obtained from the current study, it is concluded that among the examined materials, rice hulls due to its favorable properties could be successfully used as poultry bedding. Peat was not a satisfactory material for bedding and it seems that other usages such as ruminant feeding would be considered. In contrast to peat, bagasse due to similar properties to straw seems to have good potential for using as a litter material. Watkins (2001) reported that growth performance of broiler chickens reread on bagasse litter were similar to those reread on wood sheaving litter. However, because of low cost and availability of this material in the countries with extensive cultivation of sugarcane as well as study of its direct impacts on birds and environment within poultry houses more research is needed.

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