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An Evaluation of Chopped Giant Miscanthus Grass as Poultry Bedding

Abstract

Giant miscanthus grass (GMG) was evaluated as a poultry bedding material on a brand new eight-house commercial broiler farm. Chopped GMG was placed in four broiler houses (houses 1, 2, 3 and 4) while pine shavings (PS), which are the typical bedding materials for most broiler production, were placed in the second set of 4 houses (houses 5, 6, 7 and 8). The study compared the effects of the GMG on house environmental conditions and production variables to that of the pine shavings. Ammonia concentration, litter moisture content, and paw scores for each flock were compared. Results showed that there were no significant differences ($p < 0.05$) between treatments in ammonia concentration, with the GMG mean of 20.06 ppm compared to PS with a mean of 19.73 ppm of the 6 flocks over the course of the experiment. Paw scores were taken in the week of processing in flocks 3 and 4. No significant differences ($p<0.05$) were observed in paw scores between the two treatments. There were no significant differences ($p<0.05$) in litter moisture between GMG (19.45% moisture) and PS (21.20% moisture); however, there was a flock effect where flock 4 had significantly higher litter moisture when compared to the other flocks ($p<0.05$). The results indicate that GMG can be utilized as an alternative bedding material in commercial broilers houses.

Introduction

For many years, chickens raised for meat production have been housed in open sheds with litter-covered floors. Bedding materials on the barn floors in poultry houses provides an insulating barrier between the birds and the ground (Dunlop et al., 2015). According to Shepherd and Fairchild (2010), bedding material should be absorptive, non-toxic, easy to dry, and allow the birds to perform natural behaviors such as dustbathing and scratching. Litter material should also be inexpensive, readily available, and free from dust and contaminants (Shepherd and Fairchild, 2010).

Litter quality does not remain consistent during use. Dunlop et al. (2015) concluded that litter properties are constantly changing in the poultry houses. There are additions of manure from the flock and spillage of water and feed. The amount of water stored in the litter increases throughout the grow-out period, even though the moisture content remains the same. Tunnel ventilation in poultry houses helps reduce litter moisture content.

Poor litter quality can have a negative impact on flock performance (Benabdeljelil and Ayachi, 1996; Malone et al, 1983), bird health, and the quality of the carcasses and egg quality (Torok et al., 2009). Quality of the birds' paws, a measure of bird health, can be affected by environmental conditions, nutrition, and bedding material (Shepherd and Fairchild, 2010). Paw quality refers to the overall health of the foot, including toes and footpad. If the moisture content in the litter is high, it can result in a number of paw problems such as foot pad dermatitis, podo-dermatitis, foot pad ulcers and osteomyelitis (Martland,1985). This can have a negative impact on bird welfare/health as birds suffer from pain and discomfort, resulting in unsteady gait, which may contribute to reduced feed intake and slower weight gain.

Poor litter quality not only increases the risk of asthma in farm workers (Ngajilo et al., 2018), but can also have a negative impact on bird health. Overly dry materials tend to be dusty, and dust may cause respiratory problems for birds (Malone et al., 1990; Torok et al., 2009). Lien et al. (1992) concluded that the litter type may also affect broiler chicken when litter is consumed, with litter and its associated bacteria affecting the body weight and carcass quality.

According to the University of Georgia Center for Agribusiness and Economic Development (UGCAED, 2022), broiler production is the number one commodity in Georgia. Pine shavings are one of the most commonly used bedding materials. While Georgia is consistently ranked as one of the top forestry states in the nation (UGCAED, 2022), the demand for pine shavings can outstrip their availability to the thousands of poultry houses throughout the state. Over the years, researchers have tested a number of alternative materials for use as poultry bedding:

- Veltman et al. (1984) compared rice hull products as litter material in turkey poult performance.
- Malone et al. (1990) evaluated kenaf core for broiler litter.
- Lien et al. (1992) used recycled paper chips as litter for broiler chickens.
- Brake et al. (1992) evaluated the chemical and physical properties of hardwood bark used as broiler litter material.
- Lien et al. (1998) evaluated peanut hulls as a litter source for broiler breeder replacement pullets.
- Bilgili et al. (1999) tested sand as litter for rearing broiler chickens.
- Chamblee and Yeatman (2003) evaluated rice hull ash as broiler litter.
- Shields et al. (2005) evaluated the effects of sand and wood shavings bedding on the behavior of broiler chickens.
- Grimes et al. (2006) used litter material made from cotton waste, gypsum, and old newspaper for rearing broiler chickens.

The objective of this study was to evaluate giant miscanthus grass as a viable alternative to pine shavings for poultry production.

Methods

A study was conducted on a newly constructed, eight-house commercial broiler farm. Data were collected over six flocks, and each flock remained in the houses for a six-week period. The eight houses were identical solid walled 50ft. X 500ft. structures with automated environmental control systems. The eight houses were divided into two treatments. Standard practices for commercial broiler production were followed for both treatments. Houses with treatment 1 contained giant miscanthus grass (GMG) and houses with treatment 2 contained pine shavings (PS). Dried GMG, chopped at about 2 inches, was placed in houses 1, 2, 3 and 4 (GMG treatment) and pine shavings were placed in houses 5, 6, 7 and 8 (PS treatment). Bedding materials were placed in each house at a depth of approximately 4 inches. Approximately 27,500 day-old chicks were placed in each of the eight houses on the farm and the birds were grown for six weeks. The bedding remained in each of the houses for six flocks; however, after each flock was caught (six weeks old) and processed, the litter cakes were removed and the remaining litter was tilled and windrowed. The windrows remained for five days after which it was spread out in the house and top-dressed with fresh bedding material (GMG in houses 1 through 4 and PS in houses 5 through 8) for the incoming flock. Data were collected from the middle houses (3 and 4 with GMG and 5 and 6 with PS).

Litter moisture

Litter samples were randomly collected from five different regions in each of the houses immediately after the birds were removed. Samples from each house were combined, weighed and placed in drying ovens at 131°F for 72 hours. After 72 hrs. drying, the samples were weighed again, and litter moisture content calculated for each house.

Ammonia concentration

Ammonia concentrations (ppm) were evaluated using ammonia passive Dosi-Tubes (GASTEC). Samples were collected by randomly placing the tubes in three regions in each of the houses. The tubes were placed at bird level every Wednesday in each of the six weeks the birds remained in the house. The tubes remained in the houses for seven hours each day before they were recovered. The tubes were placed in the morning and were collected in the evening at which time the ammonia concentrations were recorded.

Paw quality

Paw quality was assessed by scoring the footpads of birds in each of the treatment houses. Each house was divided into four quadrants and ten birds were randomly selected from each quadrant and scored. Samples were taken in flocks three and four when the birds were five weeks old. A 3-point scale paw score of 0, 1, or 2 (Bilgili et al., 2006) was used to determine the degree of damage to the birds' paws (Figure 1).

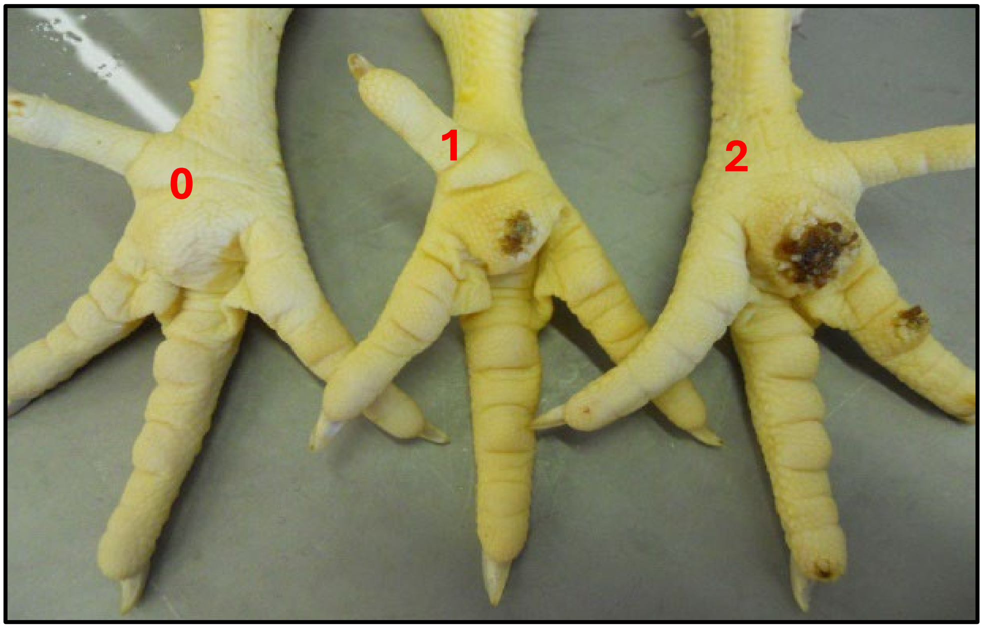

Figure 1: Paw scores for damage assessment of bird feet.
0 = no abnormalities.
1 = irritation and discoloration.
2 = discoloration and broken skin.

Other analyses

At the end of each production cycle, birds were caught, transported to the processing plant, and slaughtered and weighed. The production data including feed conversion ratio and bird weight were collected. Mortality was recorded daily and the mortality rate from each house was calculated at the end of each production cycle. Litter samples from flocks one and four were submitted to a lab to be evaluated for nutrient content.

Statistical analyses

All data collected were analyzed with the GLM procedure of SAS (version 9.2, SAS Institute, Inc., Cary, NC) using a one-way analysis of variance (ANOVA) to determine the mean differences between treatments. Once the means were determined to be significantly different, they were separated using the Tukey-HSD multiple comparisons procedure. Difference in means were regarded as significant at $p < 0.05$.

Results and Discussion

Performance data were collected over six flocks: each flock was kept in houses for six weeks before they were caught and processed. The performance data collected included bird weight, feed conversion ratio (FCR), and flock mortality rate. The average bird weights for the GMG treatment (TRT 1) and the PS treatment (TRT 2) were recorded for flocks one through six (Table 1). We evaluated the difference in the average flock weight in each treatment within each flock. There were no significant differences ($p = 0.05$) between treatments 1 and 2 in flocks 2, 3, 4, or 6. However, we observed a significant flock-to-treatment effect in flock 5, where the birds in treatment 1 weighed significantly more than the birds in treatment 2 ($p < 0.05$). Likewise, Evans et al. (2019) found that growing turkey toms on miscanthus grass bedding resulted in similar growth performance when compared to traditional pine shavings.

Table 1. Average bird weight over six flocks of birds in the giant miscanthus grass treatment and the pine shavings treatment groups.

Bird Weight		
Treatment	Flock	Weight (lbs.)
1	2	6.82^{ab}
2	2	6.93^{a}
1	3	6.4^{dc}
2	3	6.65^{bc}
1	4	6.87^{ba}
2	4	6.96^{a}
1	5	6.87^{ba}
2	5	6.33^{d}
1	6	6.81^{ba}
2	6	6.81^{ba}

$^{(a, b, c, d)}$ Values in the columns with the same superscripts show no significant differences ($p=0.05$).

A similar observation was made when we evaluated the FCR in each treatment in flock (Table 2). There were no significant differences ($p = 0.05$) between treatments 1 and 2 in flocks 2, 3, 4, and 6. However, we observed a significant difference ($p < 0.05$) in the FCR in flock 5 where treatment 1 had a higher FCR than treatment 2.

Table 2. Average feed conversion ratio over six flocks of birds in the giant miscanthus grass treatment groups and the pine shavings treatment groups.

Bird Feed Conversion Ratio		
Treatment	Flock	Ratio
1	2	1.85^{ba}
2	2	1.85^{ba}
1	3	1.81^{bc}
2	3	1.76^{c}
1	4	1.85^{ba}
2	4	1.82^{bc}
1	5	1.91^{a}
2	5	1.79^{bc}
1	6	1.80^{bb}
2	6	1.75^{c}

$^{(a, b, c, d)}$ Values in the columns with the same superscripts show no significant differences ($p=0.05$).

We evaluated the moisture content of the litter after four flocks of birds were reared in each house (Figure 2). The amount of moisture in the litter can influence the ammonia emissions (Elliot and Collins, 1982; Miles et al., 2011), levels of dust (Roumeliotis et al., 2010) and health issues in birds (Shepherd and Fairchild, 2010). High litter moisture can also result in odor and risk bird health and food safety (Eriksson de Rezende et al., 2001).

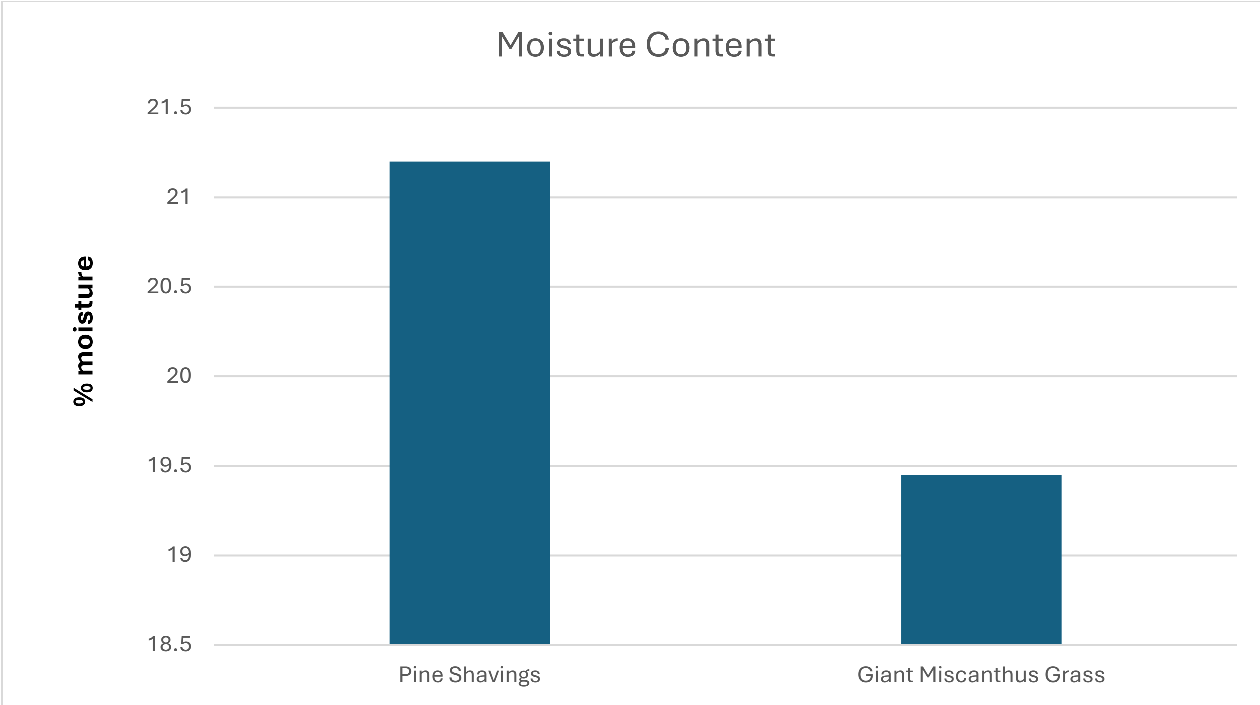

Figure 2. Comparative moisture content after six flocks in litter of pine shavings and chopped giant miscanthus grass.

There were no significant differences (p = 0.05) in moisture content between the houses with GMG and those with PS (Figure 2) even though the pine shavings had a numerically higher moisture content (21.2%), which was higher than the miscanthus grass (19.45%). Upon observation of the cakes in the houses, we did observe the miscanthus grass cakes appeared to be drier than the pine shavings cakes (Figures 3 and 4).

Figure 3. Miscanthus grass cake

Figure 4. Pine shavings cake

The results switched when we evaluated the ammonia concentrations in the houses. We tested the ammonia emissions from the miscanthus grass bedding material (houses 1, 2, 3, 4) and compared the emissions to houses that had pine shavings (5, 6, 7, 8) as their bedding material (Figure 5). The NH_3 concentrations we observed in the houses that had chopped giant miscanthus grass, was higher (20.05ppm) than that which we observed in the houses that had pine shavings (19.72ppm) as their bedding material (Figure 3). However, the difference between the emissions from the two treatments were not considered significant ($p = 0.05$). Miles et al. (2011) compared several materials for poultry bedding including vermiculite, sand, rice hulls, commercial litter, and wood shavings. They evaluated the water holding capacity of each substrate material and then examined the ammonia volatilization that occurred from each bedding type. They concluded that bedding absorption capacity was not a good indicator of the potential to release ammonia. Others, like Elliot and Collins (1982) and Liu et al. (2007) found that litter moisture content influenced ammonia emissions.

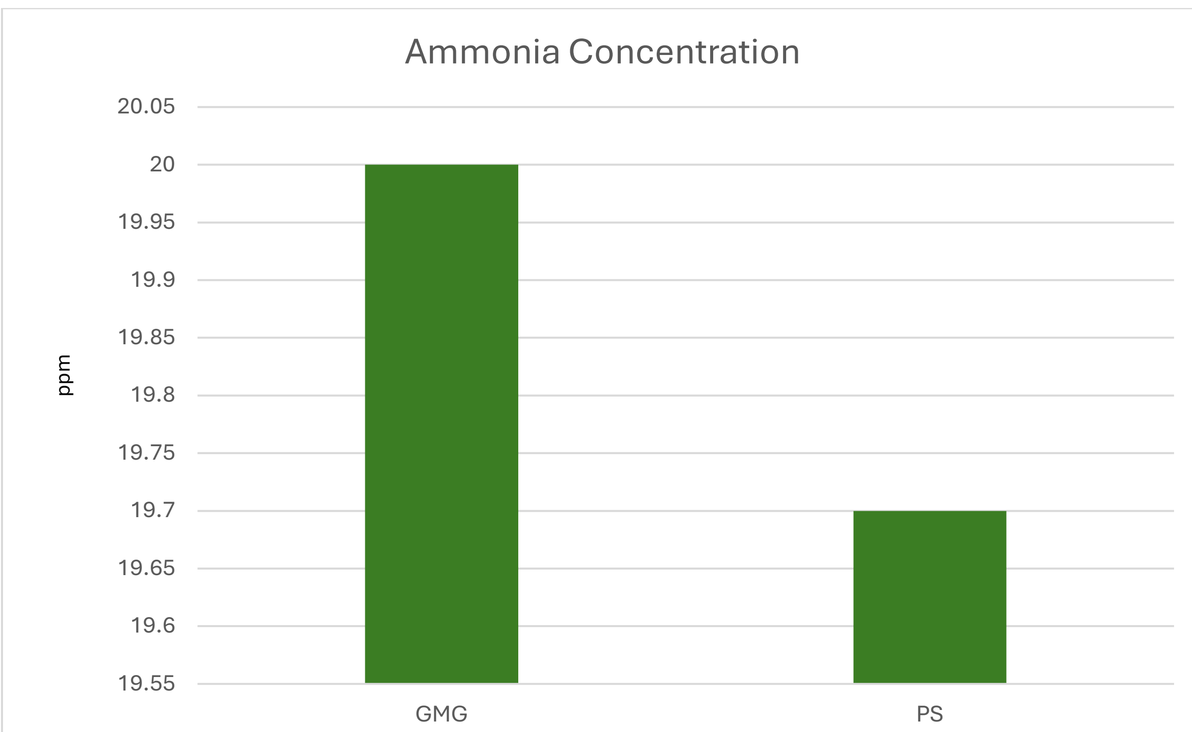

Figure 5: Comparing the ammonia concentration in houses with pine shavings and chopped giant miscanthus grass houses after growing six flocks.

We compared the impact that the two bedding materials (chopped GMG and PS) had on the birds' paws and observed no significant ($p=0.05$) differences in the paw scores. However, we observed some numerical differences in paw quality in the houses that had pine shavings as bedding. Here we identified a larger number of birds scoring 2 in the paw scores, though this difference was not significant ($p=0.05$).

Poultry litter is a nutrient rich by-product of poultry production (Gaskin et al., 2013). The litter is mostly used by crop producers to add nutrients and organic matter to the soil. As such, poultry litter is viewed as a valuable by-product used to enhance crop production at a lower cost than if the more expensive inorganic fertilizer was used. (Gaskin et al., 2013). To determine the nutrient value of the poultry litter generated from the GMG compared to that generated from PS, samples of the litter generated from flocks 1 and 4 were collected and submitted for nutrient testing. The results of the nutrient contents are shown in Table 3.

Table 3. Litter nutrient analysis: nitrogen (N), phosphorus (P), and potassium (L) content were analyzed from the two treatments groups in flock 1 and flock 4 to compare the nutritional value of litter from PS bedding compared to litter from the GMG bedding.

Litter Nutrient Analysis (lbs./ton)						
Treatment	**Flock 1**			**Flock 4**		
	N	P	K	N	P	K
1. GMG	**56.5***	29.8	29.6	**58.9***	61.6	55.1
2. PS	**42.1***	26.5	24.7	**64.2***	60.9	53.1

Numbers in the same column with (*) indicate significant differences. $p<0.05$

The nutrient analysis of the poultry litter in flock 1 showed significant differences ($p<0.05$) between the GMG treatment and the PS treatment in the amount of nitrogen that was in the litter after the first flock of birds were grown on the bedding. After one flock the GMG treatment had 56.5 pounds of nitrogen per ton in the GMG treatment compared to 42.1 pounds per ton in the PS treatment ($p < 0.05$). At the end of the fourth flock, a reversal of this result was observed where the PS litter had significantly more (64.2 lbs./ton) nitrogen than the GMG (58.9 lbs./ton) litter ($p < 0.05$). The phosphorous and potassium content in the litter of both flocks 1 and 4 were not significantly different when comparing the GMG litter to the PS litter (p =0.05).

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Conclusions

Pine shavings are typically the bedding of choice in the commercial poultry industry. Other materials such as peanut hulls and rice hulls are also common materials used as bedding. Due to the shortage of bedding materials, producers are reusing bedding for five or more flocks before cleaning out the used litter and replacing it with fresh bedding material. Reusing old bedding materials can have a negative impact on the incoming flock of birds. From this research we observed that flock performance on the GMG is comparable to that of birds grown on PS. Based on the bird performance and the quality and condition of the litter during this research, the giant miscanthus grass is a viable alternative to pine shavings as a bedding material in poultry houses. Poultry litter is also an organic fertilizer widely used by crop producers. Based on the results from this study, the nutrients in the litter generated from the GMG bedding compare favorably with the PS litter, showing that the litter generated from GMG can also be used as crop fertilizer that is high in nutrients. Currently, GMG is being grown around the US and can be accessible to poultry producers for use as poultry bedding.

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