

RELATIONSHIP BETWEEN LITTER MOISTURE AND PARTICLE SIZE DISTRIBUTION ON USED AND FRESH BEDDING IN COMMERCIAL TURKEY HOUSES AT MARKET AGE

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Abstract

Bedding material is expensive; therefore, it is commonly reused after windrowing in the grow-out phase in commercial turkey houses in the United States. Bedding material is significant to keep the high moisture away from the birds, which can deteriorate their performance and welfare.

This study aimed to determine the relationship between litter moisture and particle size distribution in commercial turkey houses at the end of the grow-out phase (average 118 days of age).

Composite litter samples were collected from turkey barns (N=17), then subsamples in triplicate were dried and material separated by vibration on 10 various pore sizes of sieves ranging from 25.40 mm to 0.15 mm, plus the remainder. The material remaining on each sieve was weighed and expressed as a percentage of material retained. For used bedding, on sieve sizes 1-3, a total of 8 samples were collected (N=7 rice hulls, N=1 wood shavings), and from sieve size 4 onward, N=10 (N=7 rice hulls, and N=3 wood shavings). A total of 7 samples were collected from fresh bedding placed in the barn at the start of the grow-out phase (N=4 rice hulls, N=2 wood shavings, N=1 combination of rice hulls and wood shavings). For the used bedding, the litter moisture was positively correlated with large particles, i.e., sieve 1 correlated very strongly (>25.40 mm, $r=0.81$, $P=0.015$), and it tended to correlate with sieve 2 (19.05 mm, $r=0.64$, $P=0.086$).

A negative correlation was revealed between litter moisture and finer particles, i.e., sieve 6 (1.68 mm, $r=-0.78$, $P=0.008$), sieve 7 (1.19 mm, $r=-0.95$, $P=0.0000$), sieve 8 (0.84 mm, $r=-0.95$, $P=0.0000$), sieve 9 (0.60 mm, $r=-0.83$, $P=0.003$), sieve 10 (0.30 mm, $r=-0.73$, $P=0.016$), and remainder (<0.15 mm, $r=-0.81$, $P=0.005$). No relationship was found for fresh bedding between moisture content and particle size distribution.

The relationship between litter moisture and particle size distribution indicated that on used litter, coarse particles are associated with higher litter moisture, and fine particles are related to lower litter moisture. It is assumed that the accumulated mixture of feather, spilled feed, and excreta influenced the characteristics of litter, including water releasing capacity and water holding capacity, besides other information such as litter depth, number of times the litter is being used, length of growing period, and in the case of various bedding materials, further studies are needed.

Keywords: bedding, rice hulls, wood shavings, litter moisture, particle size distribution, turkey, poultry, used litter

1. INTRODUCTION

Bedding material is very important in poultry houses to keep the birds away from wetness and prevent wet litter which may deteriorate their health, performance, and welfare (Collett, 2012; Dunlop et al., 2016).

Bedding represents a significant cost in turkey production and is expensive; therefore, many farmers in the United States, Australia or Canada use new bedding only for the brooding phase when the poults are placed, and they reuse the same litter multiple times in the growing phase (Ritz et al., 2006; Staavereen et al., 2020; Flores et al., 2021). However, in many countries in Europe, the use of new bedding is recommended for each phase.

Important litter characteristics that may influence the litter moisture content include particle size distribution, water holding capacity, and water releasing capacity (Grimes et al., 2021).

Studies have indicated that coarse particles are associated with higher litter moisture and fine particles are related to lower litter moisture. For example, Hester et al. (1997) examined turkey flocks kept on bedding made of coarse and fine particle board residue and found lower moisture on fine particle bedding. In addition, another study examined turkey hens kept on wood shavings or *Miscanthus* grass bedding and also found lower moisture on wood shavings bedding that was associated with more of the finer particles compared to the *Miscanthus* grass bedding (Furo, 2019).

Water holding and releasing capacity are two important factors defining litter. Litter with a high water holding capacity is desirable, as this can hold more moisture, and a high releasing capacity is needed as the bedding has to release the water into the air to lower the moisture content (Shepherd, 2008).

Therefore, the objectives of the study were to 1) determine the relationship between litter moisture and particle size distribution in commercial turkey houses at the end of the grow-out phase (average age of 118 days) and 2) study the relationship between litter moisture and particle size distribution on used and fresh bedding at the beginning of the growing phase.

2. MATERIALS AND METHODS

2.1 Sampling

Commercial male and female turkey houses in Minnesota and Indiana were visited at the end of the growing period a few days before the birds were marketed (average 118 days of age for both sexes). The turkey flocks were placed either on used or fresh bedding at the beginning of the grow-out phase, and the birds spent 8-14 weeks on these litters until marketing. Used bedding (N=10) consisted of rice hulls (N=7) and wood shavings bedding (N=3) for sieve sizes 4 and onward, and only 7 observations were made for the coarse particles (sieve sizes of 1, 2 and 3). Used bedding was applied at least once prior to the birds being placed in the grower house, and then windrowed to heat up the litter and kill bacteria. On fresh bedding, a total of seven samples were collected either from rice hulls (N=4), wood shavings (N=2) or combination of these two beddings (N=1).

2.2 Litter sampling

At each visit, litter samples were collected from four points within the barn: close to the waterers and feeders (but at least 30 cm away from these equipment), and from two points from resting area, representing a diagonal line in the barn. The litter samples sampled in the same turkey house were then combined (composite sample, 3.6L each), then transported on ice to the freezers (-30°C) on campus until further processing. Each composite litter sample per farm was then triplicated (100 g each) and dried at 60°C for 24 hr, then analyzed for particle size distribution at the Bioproducts and Biosystems Engineering Laboratory, University of Minnesota.

2.3 Particle size distribution

For the particle size distribution, a set of 10 sieves with various openings, plus the remainder (pan) were used, including 25.40 mm, 19.05 mm, 4.76 mm, 3.36 mm, 2.38 mm, 1.68 mm, 1.19 mm, 0.84 mm, 0.60 mm, 0.30 mm, and 0.15 mm, as sieve size of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and remainder in the pan, as referred to as sieve size 1 to 10, plus remainder, respectively. The sieves were placed on a shaker machine (Soiltest CL-305), and after 5 minutes of shaking, the net weight was determined for each sieve by the total weight of the sample and expressed in a percentage format.

2.4 Statistical analysis

Data was not normally distributed by the Wilk-Shapiro test; therefore, Spearman correlation was run to discover the relationship between litter moisture and particle size distribution separately on used and fresh bedding (partial correlation). Significance was set at $P < 0.05$, and a trend was also noted ($P < 0.10$).

Since the data was not normally distributed or ANOVA assumptions were not met, the Kruskal-Wallis test explored the mean differences for the net weight of litter left in each sieve category of used and not used bedding and for potential litter moisture differences for each sieve size. The significance of $P < 0.05$ was set.

Data was arcsine square root transformed for statistical analyses, however on the figures (1-9) data shown without transformation for easier interpretation.

3. RESULTS

3.1 Net weight comparison of each sieve category by use

The net weight left in any of the sieve categories was not different between litter sampled either on used or fresh bedding at market age ($P > 0.05$, Figure 1).

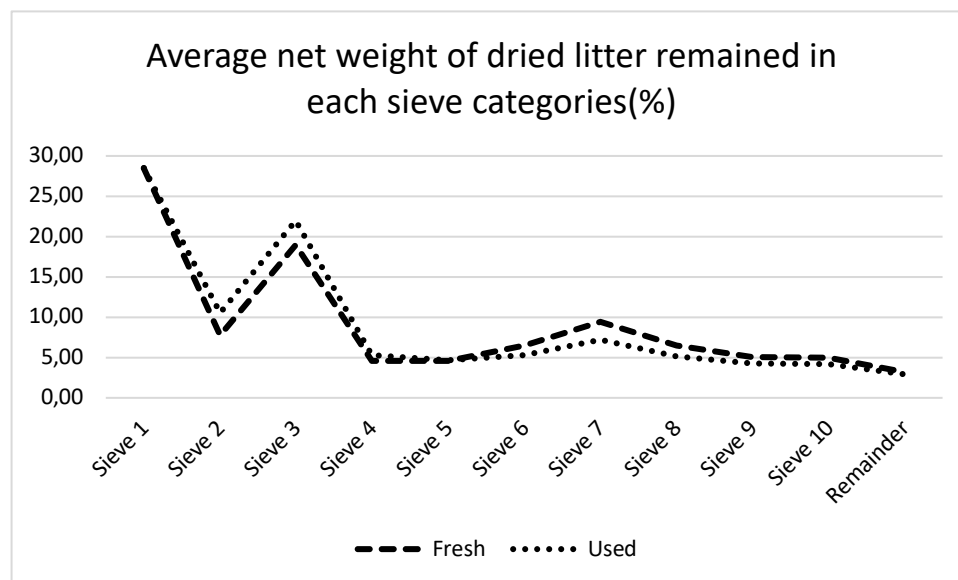


Fig. 1. Net weight of dried litter remaining in each sieve category as percent of total weight (%) by use

3.2 Correlation between litter moisture and particle size distribution

Results indicated that on used bedding, the litter moisture correlated with large particle sizes (> 25.40 mm, $r = 0.81$, $P = 0.015$, sieve 1, Figure 2), and it tended to be associated with sieve 2 (19.05 mm, $r = 0.64$, $P = 0.086$, Figure 3). A negative correlation was found between litter moisture and finer particles, i.e., sieve 6 (1.68 mm, $r = -0.78$, $P = 0.008$, Figure 4), sieve 7 (1.19 mm, $r = -0.95$, $P = 0.0000$, Figure 5), sieve 8 (0.84 mm, $r = -0.95$, $P = 0.0000$, Figure 6), sieve 9 (0.60 mm, $r = -0.83$, $P = 0.003$, Figure 7), sieve 10 (0.30 mm, $r = -0.73$, $P = 0.016$, Figure 8), and remainder (< 0.15 mm, $r = -0.81$, $P = 0.005$, Figure 9).

On fresh bedding, no significant correlation or trend was found between litter moisture content and particle size ($P > 0.10$, Figures 2-9).

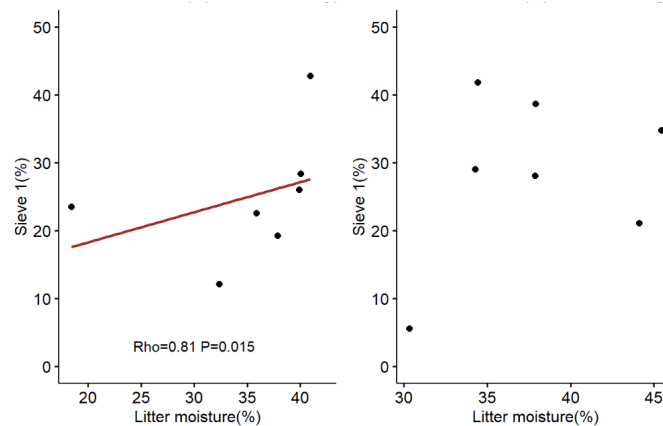


Fig. 2. The relationship between the amount of litter particles remaining on the sieve 1 (%) and litter moisture on used (left) and fresh bedding (right)

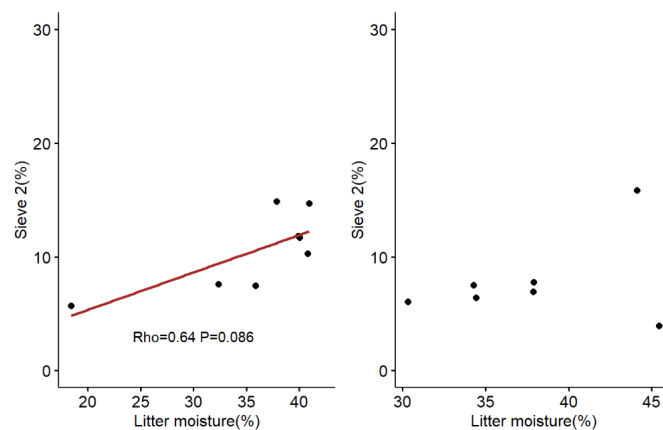


Fig. 3. The relationship between the amount of litter particles remaining on the sieve 2 (%) and litter moisture on used (left) and fresh bedding (right)

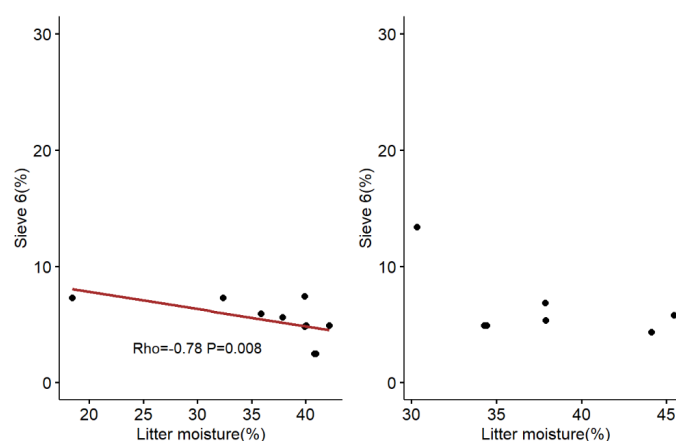


Fig. 4. The relationship between the amount of litter particles remaining on the sieve 6(%) and litter moisture on used (left) and fresh bedding (right)

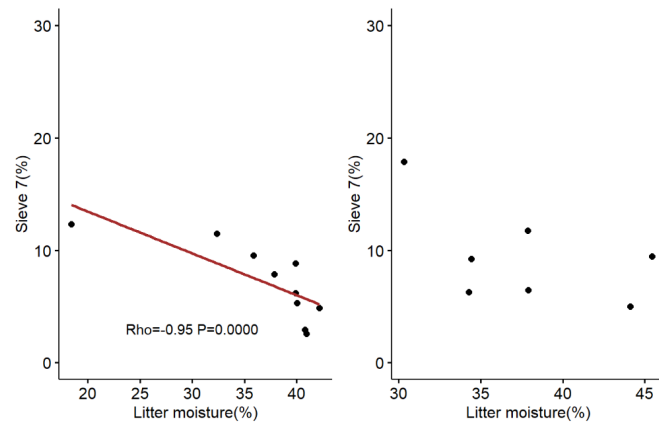


Fig. 5. The relationship between the amount of litter particles remaining on the sieve 7(%) and litter moisture on used (left) and fresh bedding (right)

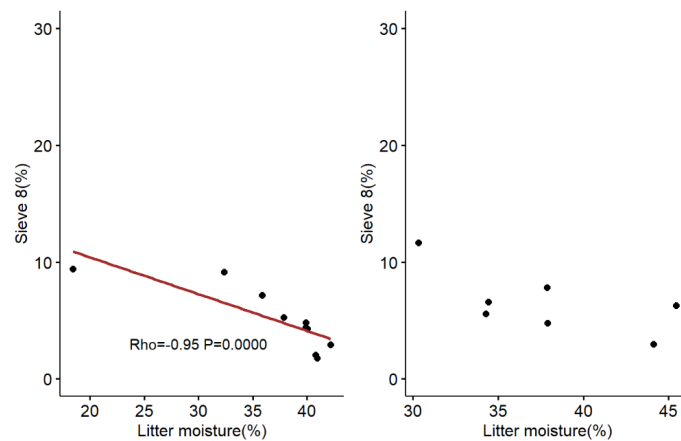


Fig. 6. The relationship between the amount of litter particles remaining on the sieve 8(%) and litter moisture on used (left) and fresh bedding (right)

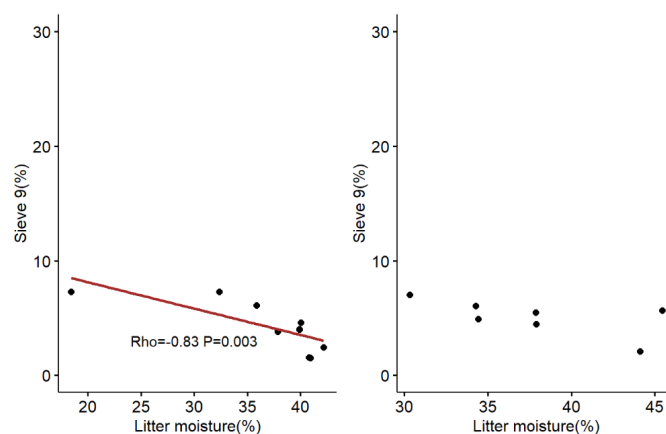


Fig. 7. The relationship between the amount of litter particles remaining on the sieve 9(%) and litter moisture on used (left) and fresh bedding (right)

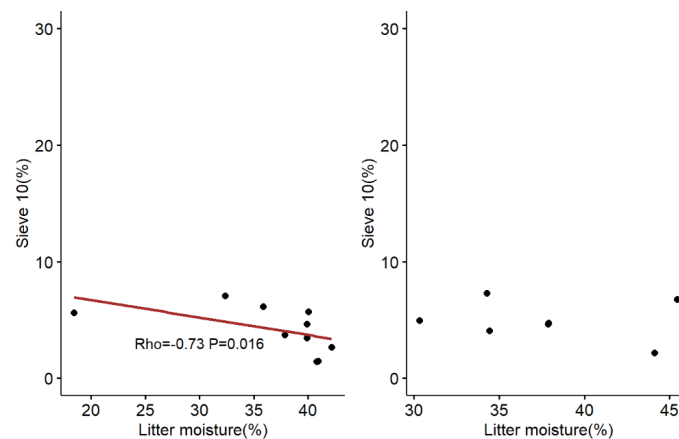


Fig. 8. The relationship between the amount of litter particles remaining on the sieve 10(%) and litter moisture on used (left) and fresh bedding (right)

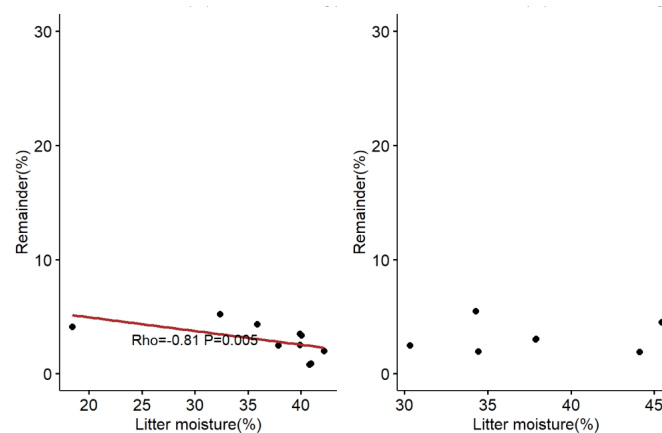


Fig. 9. The amount of litter particles remaining in pan (%) on used (left) and fresh bedding (right)

4. DISCUSSION

The goal of our study was to explore the particle size distribution of commercial turkey litter and its relationship with litter moisture, which is an important indicator of turkey management as it can affect the performance, health, and welfare of the birds.

The results indicated that on bedding that was used several times, the litter moisture increased when the coarse particles were represented in the litter samples (sieve sizes 1 and 2). When the finer particles were represented in the litter, the litter moisture decreased (sieve 6, 7, 8, 9, 10, and remainder). Shepherd et al. (2017) stated that the ratio of surface area compared to mass is greater in the case of finer particles than for large particles, which influences the water releasing capacity positively, i.e., releases moisture more easily and dries out faster.

A broiler study (Cengiz et al., 2011) investigated the relationship between fresh or used bedding particles, litter moisture, and the incidence and severity of footpad dermatitis, a condition highly associated with wet litter. The authors found similar litter moisture content at 48 days of age in a broiler trial, however, more broilers with healthy footpads were reported on litter with finer particle size (<0.5 cm) either on fresh or used bedding than on larger particle fresh bedding (>0.5 cm). Consequently, more broilers with severe footpad scores were reported on larger particle size bedding (<0.5 cm) than on fine particle bedding (>0.5 cm) made of either used or fresh bedding. It appears that regardless of the use of the litter, the particle size of bedding influenced the prevalence of footpad dermatitis, but not the moisture content. For this report, on fresh bedding, no relationship was found between litter moisture

and particle size distribution, similarly to Cengiz et al. (2011). This might indicate that the litter was able to keep some of the original features even after several weeks of use.

A broiler study investigated the footpad dermatitis, litter moisture and particle relationship on fresh straw bedding chopped into 2 cm length and unchopped straw, and found higher average FPD scores (1.94 vs 1.71 on a 4 point scale, where 0 for no lesion, and 3 for lesions covering over 50% of pads) on unchopped straw compared to chopped straw bedding at 6 wk of age, however, the litter moisture was not different on the beddings (Stojčić et al., 2016), keeping in mind that both bedding sources would have contained large coarse particles as the chopped straw would be equivalent to retention by sieve size 2 of 19 mm.

We assume that the used bedding, which accumulated more excreta, spilled feed, and feathers compared to the fresh bedding, might influence some of the litter characteristics, such as water releasing or holding capacity, or consequently even litter depth or the number of times the litter has been used. Shepherd et al. (2017) reported that higher litter depth absorbed more water compared to thinner litter depth. Thus, further studies are needed to observe these characteristics.

The limitation of our study was the uneven sampling being dependent of field sampling; it could have been better to study only one bedding type. Litter bacterial load could have been studied, as could their potential effect on bird performance. Performing particle size analysis of the bedding prior to use in the barn could have been performed for comparison with the samples collected at the end of the growing period. It could have been beneficial to analyze the particle size distribution of fresh and used litter at the beginning of the grow-out phase.

The significance of our study is to report the particle size distribution of the commercial turkey litter, and indicate that litter containing finer particle sizes could be more beneficial to use in turkey houses, which might improve litter moisture, turkey health and welfare. Our ultimate goal is to advise farmers and other stakeholders who work directly with turkeys to be able to select more appropriate bedding materials, i.e., they can influence birds directly and may increase their profit.

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