Management Strategies for Utilizing Hardwood Sawdust as Poultry Bedding

Final Report

Submitted:

To
Northeastern Area State and Private Forestry
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Project Summary

Many concentrated poultry-producing areas of the USA including the Delmarva Peninsula have shortages of quality pine-base bedding materials. Yet, there are often ample supplies of cost-effective hardwood sawdust (HW) that could supplement this deficit. However, the poultry industry has been reluctant to use HW due to periodic mold-induced respiratory health concerns.

A demonstration was implemented to evaluate management strategies for utilizing HW as poultry bedding. On a commercial farm growing roaster chickens; loblolly pine (LP), yellow poplar (YP) and white oak sawdust (WO) were each placed in 2 houses. For each bedding type, 1 house received fresh-cut sawdust (SD) directly from sawmills or SD held in storage for 3 months. One half of each house also received a peracetic acid-base mold inhibitor prior to chick placement.

The average moisture content of SD for all species at placement in Flock 1 was 31%. Moisture content of SD obtained directly from sawmills was higher (39%) compared to that which had been in storage for 3 months (23%). While in storage the temperature of the SD averaged 137 F. Storage and the use of the mold inhibitor had little influence on bedding mold populations. However, there was a two-log reduction in mold populations in Flock 2 compared to Flock 1, and a one-log reduction in LP compared to the HW species. Two-week mortalities were less in Flock 2 for all bedding types. Based on the weight and content of the gizzards there were indications chick prefer consuming the WO. In Flock 1 the incidence of foot pad dermatitis was less with fresh compared to stored bedding and less with YP compared to the other bedding types for both flocks. Based on the physical, chemical and biological observations in this field demonstration, the data suggests that YP may be viable alternative to LP in regions facing a bedding shortage. Under conditions of this demonstration, using a mold inhibitor or placing bedding materials in storage had no influence on mold populations and chick health.

Another underutilized, low cost source of wood by-products in the many regions is grindings from land clearings. Although not suitable as bedding in its present form, when composted with other local by-products it may offer a treatment strategy to convert it into a potentially useful and cost-effective bedding material. A screened composted material derived from this source was evaluated in a small, floor pen study inside a commercial chicken house. Results from this preliminary evaluation suggest it had no detrimental effects on broiler performance. A larger evaluation has been implemented in a commercial house. Results to date suggest it may have potential if some of the physical and microbial properties of the compost-base bedding can be modified.

Introduction

Over the past few years pine-base sawmill closures in the Delmarva region has resulted in a 75% decrease in mill output causing a major shortages in conventional bedding materials for the poultry industry (i.e. pine sawdust and shavings). At the same time the remaining mills continue to implemented technologies to improve efficiencies (i.e. band saws) or use their by-products for on-site energy resulting in further reductions of bedding for the poultry industry. Other industries also compete for this resource and often able to pay a premium (i.e. horse and landscape industries). Similar situations are occurring in many poultry production regions on East Coast and the South. A recent survey of the nation's poultry industry suggests future bedding supplies will be short, at a higher cost and possibly poorer quality. Since there will be limited supplies of conventional pine-base bedding materials in the future, other re-processed pine-base or alternatives sources are desperately needed. Not only is there a deficit of bedding, the demand for more material may increase in the future. The poultry industry in many locations would like to increase the frequency of house cleanouts in an effort to improve health and production efficiency, and to address increasing water and air quality issues.

Underutilized, cost-effective hardwood sawdust is often available on Delmarva and most poultry producing areas in the Eastern United States. However, due to previous negative health (i.e. mold-induced respiratory disease) and production issues with hardwood sawdust, the poultry industry has used limited quantities of this material. Select, dry hardwood residues from furniture manufacturing plants has been used in limited quantities in a few broiler producing areas. Under poor storage (uncovered outside stockpiles) or some in-house conditions (warm, moist, low ventilation), "green" hardwood has had extensive mold growth. Although *Penicillium* and *Aspergillus* are predominant mold species isolated from wood-base bedding materials, *Aspergillus fumigatus* induced respiratory infections (referred to as aspergillosis) has caused severe mortality and morbidity in poultry. This condition is acerbated when the spores of this mold become airborne under dry, dusty, low humidity conditions. Minimizing mold growth, maintaining proper litter and relative humidity to reduce spore inhalation, and treating the bedding with fungistatic compounds have been some of the strategies used in the past to lessen potential respiratory infections.

As fecal deposition increases on the fresh bedding during the first flock on litter (litter is the combination of bedding and fecal matter), there is rapid shift in the fungal populations. The populations changes from predominantly molds to yeast species during a typical two-month poultry growout cycle. A rapid shift in litter pH (acid to alkaline state) and ammonia which acts as a mold inhibitor is responsible for the change in fungal populations. As the litter ages with increasing number of flocks (sometimes 2-5 years before complete bedding replacement), the fungal population tends to stabilize and the potential for mold-induced litter respiratory infection is all but eliminated.

In the past there were concerns with using the moist, acidic, "green" hardwood sawdust due to potential corrosion of the metal equipment (ie. feed pans) in contact with the fresh bedding. With the shift to plastic poultry house equipment this is no longer a major issue in the industry.

Another underutilized, low cost source of wood by-products in many regions are grindings from land clearings, often associated with resident and commercial developments.   In the present form this material is not uniform in composition, the particles are too large and often from mixed species. Composting this material with other local by-products may offer a treatment strategy to convert this mixed species product into a potentially useful and cost-effective bedding material.   Malone and Chaloupka (1983) found broilers reared on two types of composted municipal garbage had superior performance to those reared on pine shavings bedding.   A Delaware-base recycling operation charges tipping fees for land clearing grindings and other nitrogen-base poultry processing plant by-products and produces quality compost that may be an alternative bedding material.

In this study various management and treatment strategies were evaluated to alter “green” hardwood sawdust and other mixed wood residues into a potentially acceptable bedding alternative.

Project Objectives

The specific objectives were:

1. Compare two species of hardwood sawdust to pine sawdust as poultry bedding.
2. Determine if storage of the bedding material prior to use influences poultry production and health.
3. Evaluate the merits of treating hardwood sawdust with a mold inhibitor.
4. Assess composting as a treatment strategy for mixed-wood residues.
5. Provide outreach programs to the forest and poultry industries on the opportunities of utilizing hardwood sawdust as a poultry bedding material.

Methods and Materials

<u>*Objectives 1-3:*</u>

1. *Compare two species of hardwood sawdust to pine sawdust as poultry bedding.*
2. *Determine if storage of the bedding material prior to use influences poultry production and health.*
3. *Evaluate the merits of treating hardwood sawdust with a mold inhibitor.*

Starting in July 2005 a regional source of representative loblolly pine (LP), white oak (WO) and yellow poplar (YP) sawdust was identified, secured and transported to an Allen's Hatchery litter storage shed. After three months in storage and in conjunction with cleanout of an Allen's six-house poultry farm, these bedding materials and another batch of fresh, non-stored sawdust was transported to the farm. As shown in Figure 1, there were two houses used for each wood species with one house receiving the fresh and the other the stored bedding material. One half of every house was treated with a mold inhibitor (Hyperox^{R} by Antec International) and applied at a rate of at 7.5 gal./1000 ft^2 (diluted 1:100) prior to chick placement and the other house served as a control. Since this was roaster farm, the females were reared separately from the roasters (males) which permitted independent measurements within each half of the house. At ~6-7 weeks of age the females were processed and the males were given access to the entire house for an additional ~2 weeks. After all birds were processed following the first flock, the litter was reconditioned with a machine which removes the wet, caked areas and mixes the drier fecal matter into the subsurface bedding component. Following an additional 2-3 week layout period, these houses were retreated with a mold inhibitor and the procedure was repeated for a second flock. The study ended after the second flock since the type of bedding material used has little impact on poultry production as it ages.

The specific parameters and methodologies used for these three objectives were:

1. Moisture, pH and particle size distribution of each bedding type were determined at the beginning of each of the two flocks. Initial moisture of the bedding materials placed in storage was determined.
2. Total mold counts of the fresh, stored and treated bedding materials at Days 1, ~10 and ~20 was enumerated during each of the two flocks. These ages (1, 10 and 20 days) represent the time birds are first exposed to the litter in each section or chamber of the house during the growout cycle.
3. Approximately 5-7 days after the birds have been exposed the litters in each new section of the house (a total three growing chambers), a sample of one day's mortality was necropsied for signs of mold-induced respiratory disease.
4. A sample of 20 male and 20 female seven-day-old chicks from each house were submitted to the diagnostic lab to determine the consumption of the various species of sawdust. The weight and contents of the gizzards were evaluated.
5. At the end of each flock the amount of "caked" litter was subjectively scored (percentage of total floor area), and measured (number of loads removed).

6. At ~6 weeks of age the incidence of foot pad lesions was subjectively scored on 25 birds of each sex.
7. In collaboration and support by the cooperating poultry company, the following production data was requested for males and females grown on each species of sawdust for the two flocks; body weight, feed conversion, livability, carcass quality, incidence of condemned carcasses at the processing plant, and overall production cost.

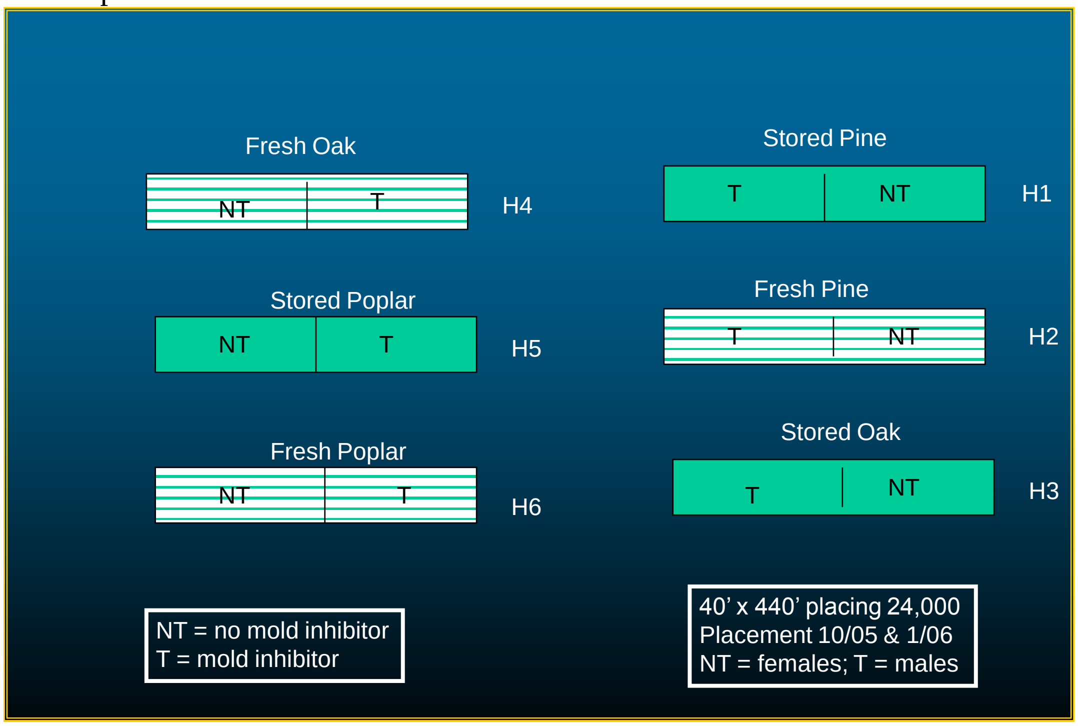

Figure 1: Diagram of the poultry farm with treatment identification.

<u>*Objective 4:*</u>

4. *Assess composting as a treatment strategy for mixed-wood residues.*

A compost bedding material was obtained from a local, commercial compost operation. This material was derived from wood grindings, anaerobic lagoon crust from a poultry processing plant, shredded corn stalks, hay and straw; and horse stable bedding. These products were mixed, composted for several weeks at 160 F, and allowed to cure up to 9 months. The aged composted was then screened (< ½ inch) and placed in two 5 x 20 ft pens inside a commercial broiler house. Two additional pine sawdust pens were used as a control. Initial litter depth was ~3 inches. Chick density simulated commercial practices, .33 ft2/bird from 0-7 days, 0.5 ft2/bird 8-14 days and 1.0 ft2/bird from 15 days to 42 days.

Samples of each bedding type were collected for initial and final microbiological (mold), chemical and physical profile characteristics. Broiler performance parameters (body weight, livability and foot pad lesions) were assessed at 7, 14 and 42 days. Fertilizer value of each litter type was determined at 42 days of age.

Objective 5:

5. *Provide outreach programs to the forest and poultry industries on the opportunities of utilizing hardwood sawdust as a poultry bedding material.*

As the results from Objectives 1-4 become available, rapid dissemination of the findings were incorporated in presentations and publications at the local, regional and national level. The target audience was primarily the poultry industry and additional discussions were held with poultry bedding suppliers and the forest industry.

Results and Discussion

<u>*Objectives 1-3:*</u>

1. *Compare two species of hardwood sawdust to pine sawdust as poultry bedding.*
2. *Determine if storage of the bedding material prior to use influences poultry production and health.*
3. *Evaluate the merits of treating hardwood sawdust with a mold inhibitor.*

As shown in Figure 2 the particle size of the different "sawdust" treatments varied between and within species and storage type. In particular, the fresh YP had smaller particles since this was derived from a mill using a band saw while the others were secured from a mill using a circular saw. The stored pine had a splintery texture since this was predominantly a re-ground wood chip which is often used a substitute for sawdust.

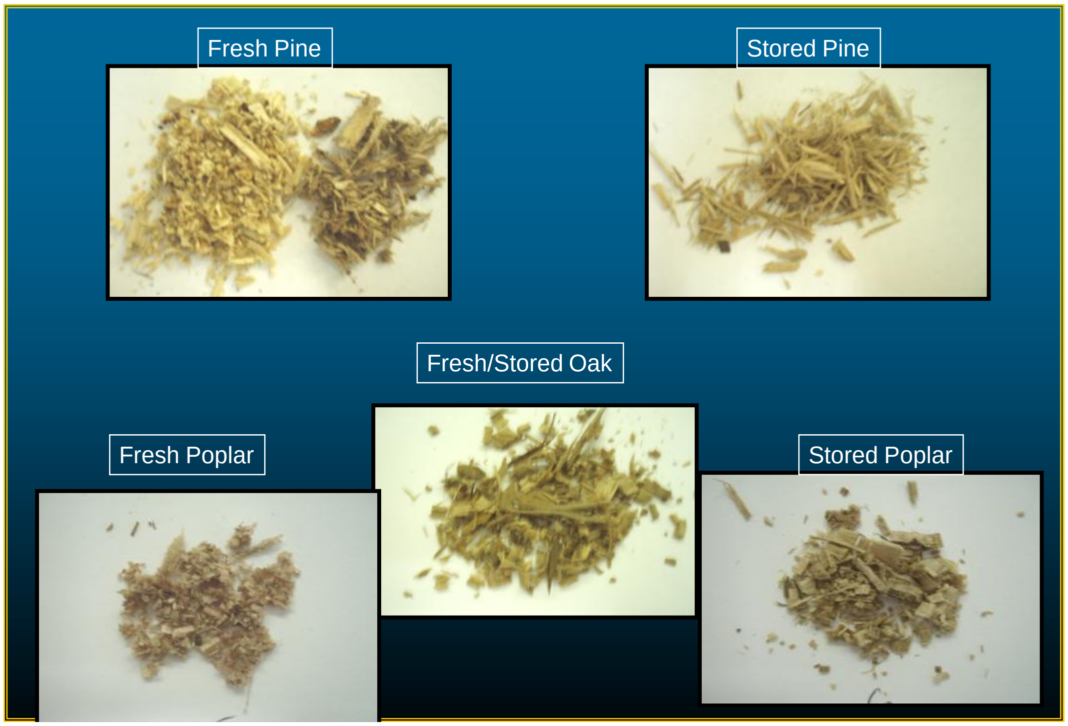

Figure 2. Particle size and texture of poultry bedding materials.

The moisture content of each species for pre-storage and initial levels for Flocks 1 and 2 are presented in Figure 3. Moisture values for all SD types obtained directly from sawmill was the highest (40%). For the material placed in storage for 3 months there was 14% moisture loss (37% vs. 23%). Although the fresh and stored beddings moisture contents differed at placement in Flock 1, by Flock 2 they were all similar (average = 29%). The self-heating (composting action) of the bedding materials during the 3-month storage period helped drive-off a portion of the moisture. Temperatures of the bedding materials dropped ~ 5 to 10 F during storage with YP showing the greatest reduction

(Figure 4). Average temperature of the WO and YP during storage was 137 F. The temperature probe for the LP was damaged during storage and this data was lost.

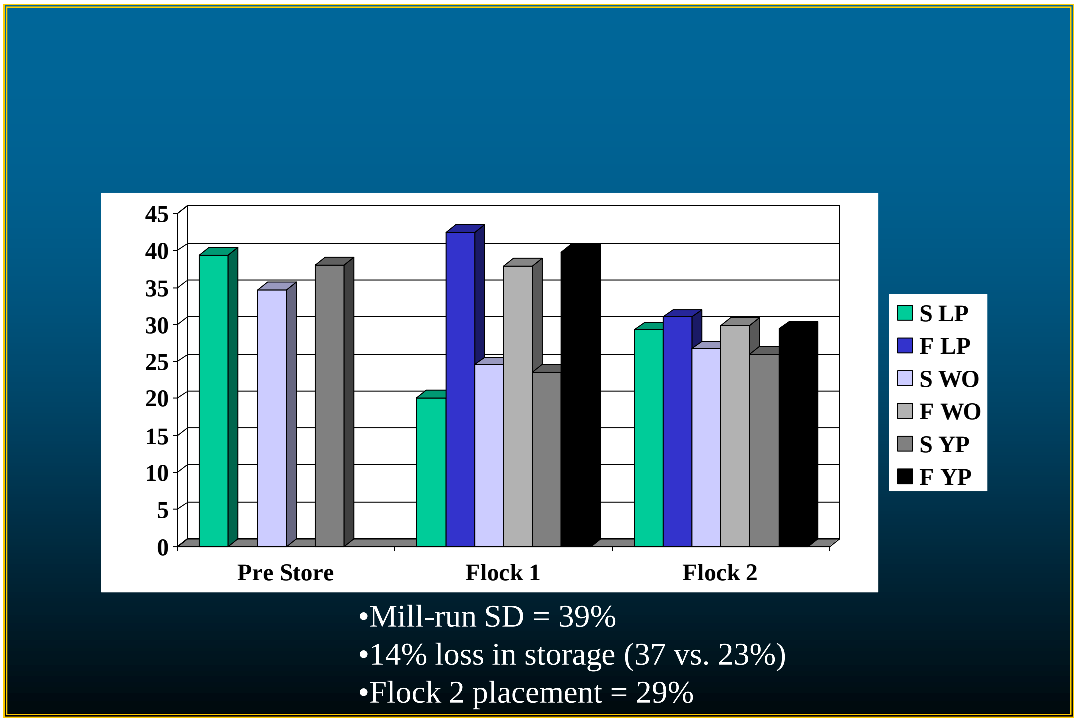

Figure 3. Moisture content of fresh (F), stored (S) and used bedding materials.

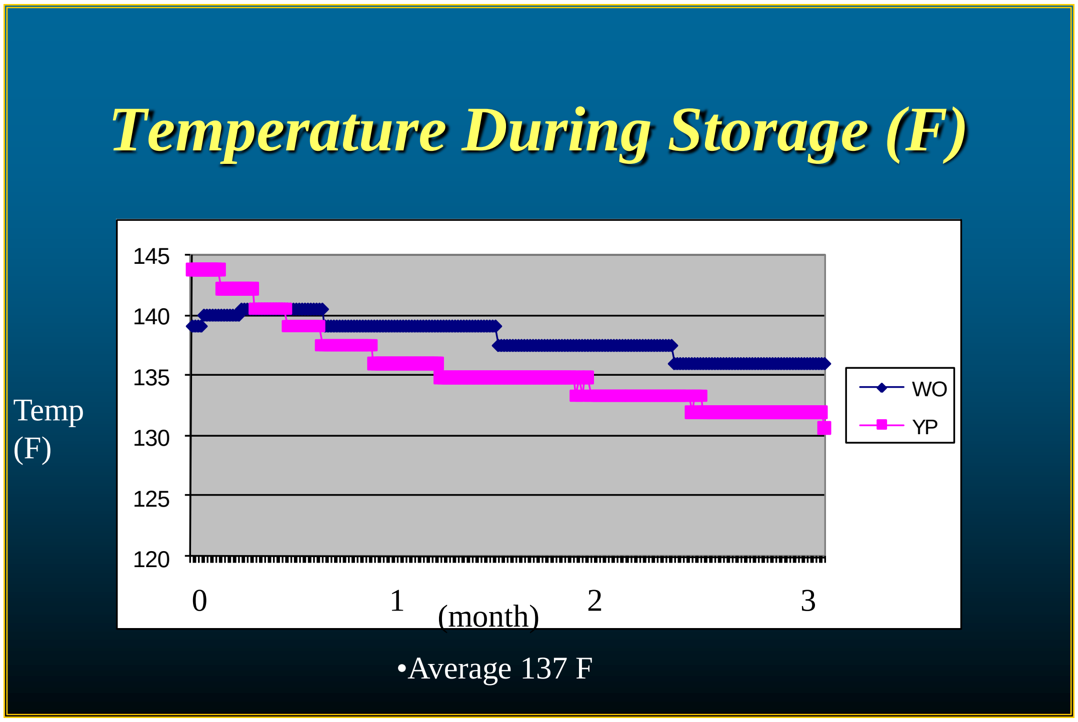

Figure 4. Temperature of the bedding materials during the 3-month storage period.

As shown in Figure 5 mold counts tend to be greatest in the first flock with WO while LP and YP values were similar. Placing the bedding materials in storage (Figure 6) and treating with a mold inhibitor (Figure 7) had no apparent influence on mold populations. As reported in the literature, mold populations decrease significantly once a flock of birds have been grown on the bedding material.

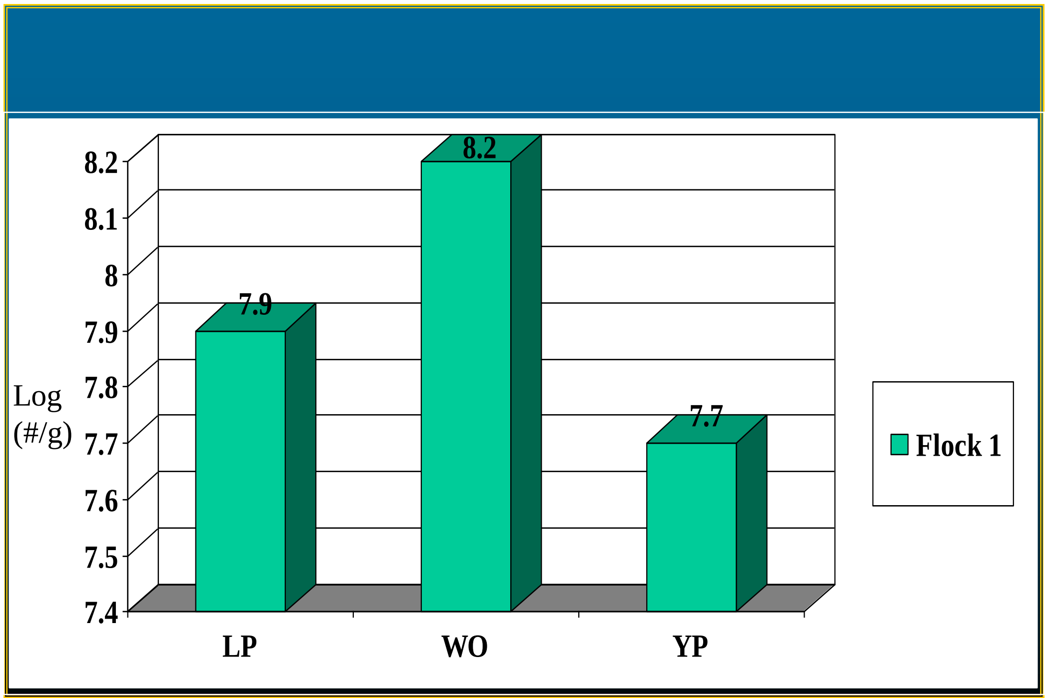

Figure 5.   Mold populations of each bedding type in Flock 1.

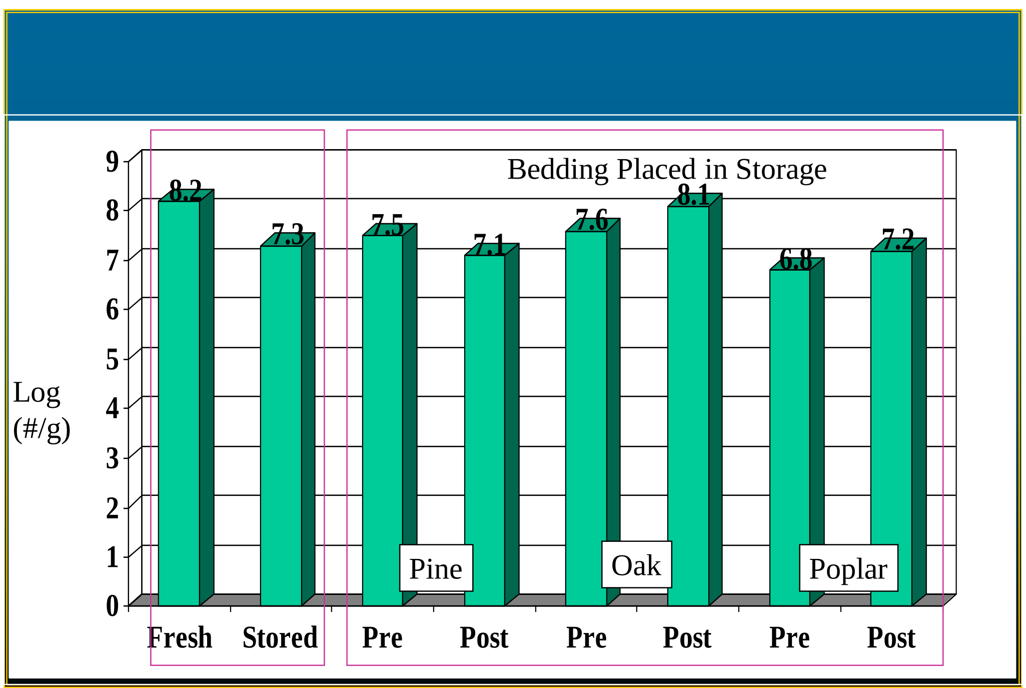

Figure 6. Mold population of the fresh and stored bedding materials.

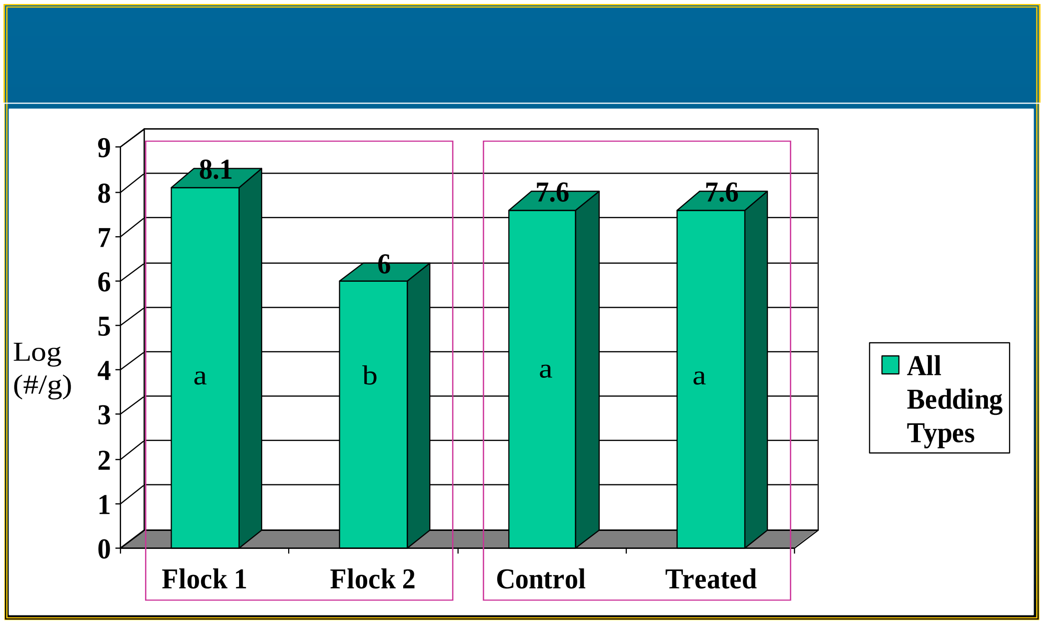

Figure 7. Influence of number of flocks and the use of a mold inhibitor on mold populations.

An examination of initial mortalities (Day 5) in Flock 1 found significantly higher incidence of lesions with chicks reared on WO that were suggestive mold and bacterial infections compared to those placed on LP or YP (Figure 8). When all ages and flocks were compared, the WO also had significantly higher respiratory-related mortalities compared to LP while the LP and YP had statistically similar values. Similar to the trend in mold populations, placing bedding materials in storage and treatment with the mold inhibitor had little influence on respiratory-related mortality in this study.

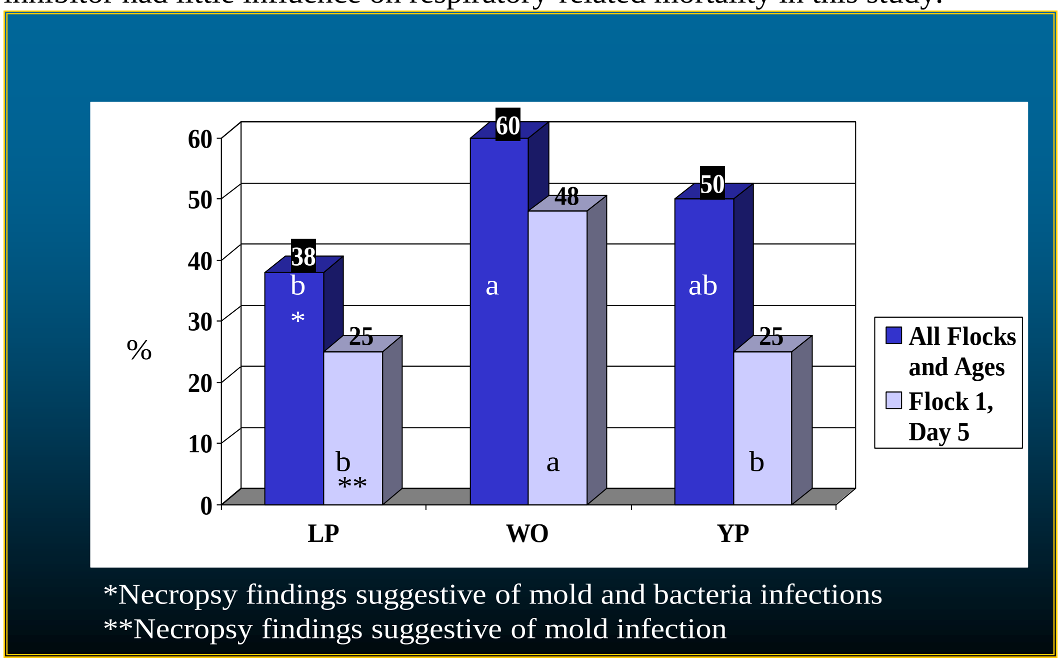

Figure 8. Percentage of respiratory-related mortality for broilers reared on each bedding type.

Previous research by the author has found young chicks may have a preference for consuming bedding materials of different wood species and particle sizes. When consumed in significant quantities, this causes a decrease in feed consumption and growth rate. These differences can be detected by examining the content and weight of the gizzards. Both the weight and content (Figure 9) of the gizzards at Day 7 suggest chicks have a preference consuming WO over LP and YP that could result in depressed growth rate. Bedding consumption was not influenced by storage or treatment with a mold inhibitor.

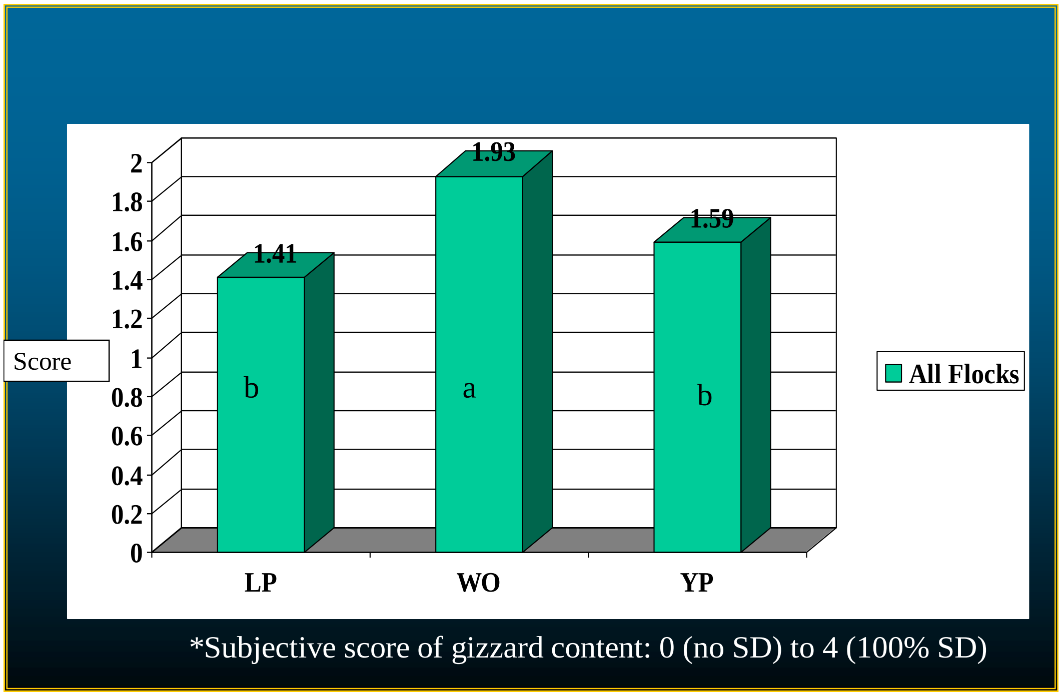

Figure 9. Percentage of sawdust of in the gizzards of 7 day old chicks grown on different bedding types.

Although the incidence of foot pad lesions were significantly less with YP and appeared to be less with the fresh compared to stored bedding, these difference can be partially explained by particle texture (Figure 10). Larger and splintery particles can cause abrasion on the foot pads of young chickens. As discussed previously and shown in Figure 2, most of these bedding materials were derived from sawmills using circular saws. The source of the fresh YP come from a mill with band saws and had smaller, more uniform particles that would result in minimal irritation to chicks walking on this material. Wood chips were reground to produce the pine that was placed in storage. This material had sharp splinters that likely caused more abrasion on the feet. The true influence of bedding type on foot pad lesions can not be fully determined until all bedding types can be obtained from a common, uniform source.

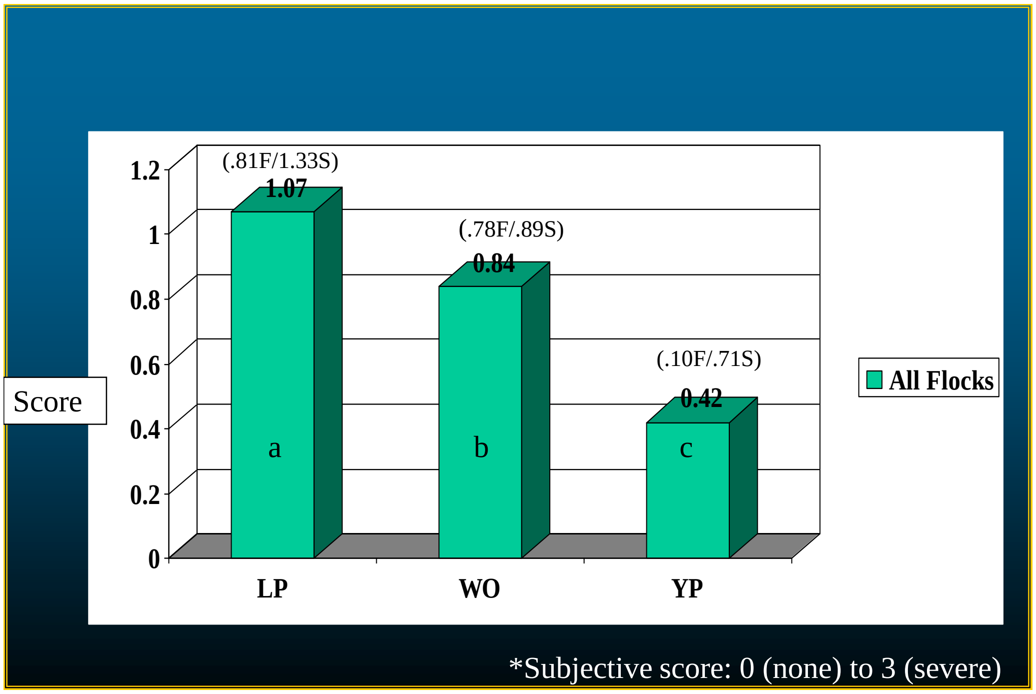

Figure 10. Influence of bedding type on the incidence of foot pad lesions.

Texture and consistency of the bedding particles along with moisture absorption properties can influence the incidence of fecal matting or caking in wet areas of the house such as under the drinker lines. The severity of caking based on a subjective score and the actual number of loads of "cake" removed with a crusting machine in Flock 2 found YP had less incidence than LP (Figure 11). The greater severity of caking with LP can be partially explained by the splintery texture of that used for the storage treatment.

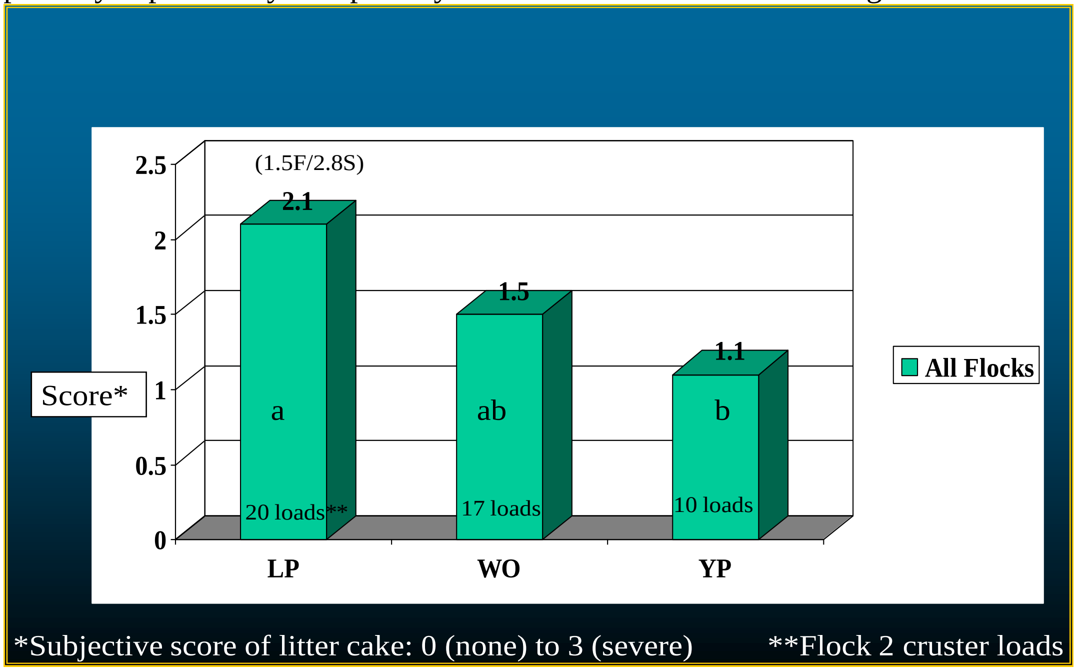

Figure 11. Influence of bedding type on incidence of litter caking.

Due to lack of control of production factors, the implications of bedding types, storage and mold inhibitors on production and processing parameters could not be assessed in this study.

In summary, the physical, chemical and biological data suggest YP may be a viable alternative to LP in regions facing a bedding shortage. The higher incidence of mold, respiratory-related mortalities and consumption of WO will limit its use as bedding. Under conditions of this demonstration, using a mold inhibitor or placing a bedding material in storage had no distinct advantage as a treatment strategy to reduce these health-related concerns. Bedding texture more than the species of sawdust appeared to influence carcass and litter quality factors.

Objective 4:

1. *Assess composting as a treatment strategy for mixed-wood residues.*

The physical characteristics of the two bedding materials are presented in Table 1. Although initial moisture was less with compost (9%) compared to pine sawdust (25%), the final moisture content at 42 days was the same. The compost bedding had a higher percentage of fine particles (49% of the total material had a diameter of 0.50 mm or less) and could pose an issue with dust due to its size and initial dryness.

Table 1. Physical characteristics of bedding materials.

Moisture (%)	Compost	Sawdust
Initial	9	25
Final	26	27
Initial particle size (%)		
(Screen size, mm)		
2.00	27	62
0.85	23	29
0.50	18	5
<0.50	31	4
Bulk density (g/ml)		
Initial (wet-weight)	5.7	0.2

Initial mold counts were five times higher in the compost bedding (Table 2). However, by 42 days the counts were the same between treatments. Any future test should characterize the mold populations to determine the incidence of pathogenic species.

Table 2. Mold counts of bedding materials.

Sample period	Compost	Sawdust
Initial (#/g)	7,285,000	1,950,000
Final (#/g)	61,500	72,000

Nutrient composition of the compost and sawdust litters at 42 days of age is presented in Table 3. Except for aluminum and iron, the litter from both sources was similar in composition. Although aluminum and iron was approximately three times higher in the compost, these differences will decrease with fecal dilution over consecutive flocks on built-up litter. It would be interested to determine if these elements would aid in binding soluble phosphorus in compost-base litter. Although ash of the compost litter was nearly double that of sawdust, this difference would also decrease with fecal dilution over multiple flocks.

Table 3. Litter composition at 42 days*.

Componet	Compost	Sawdust
Nitrogen (%)	2.34	2.22
Ammoniacal N (%)	0.27	0.27
Phosphate (%)	1.80	1.61
Potash (%)	1.60	1.70
Calcium (%)	1.27	1.08
Magnesium (%)	0.32	0.30
Sulfur (%)	0.37	0.34
Aluminum (ppm)	2607	800
Boron (ppm)	23.6	22.0
Copper (ppm)	79.2	76.9
Iron (ppm)	2752	941
Manganese (ppm)	271	251
Zinc (ppm)	239	220
Dry matter (%)	76.8	76.7
Ash (%)	15.6	9.0
Carbon (%)	31	34
C:N	13.4	15.3

*Reported on a wet-weight basis.

The use of portable plastic netting pens inside a commercial poultry was our first attempt at providing limited replication of bedding treatments under field conditions. Keeping the plastic netting sealed around the feed and drinker lines posed a challenge particularly for one compost pen. There was a tendency for birds from outside the pens to enter this pen and on 3 occasions the bird density had to be re-adjusted. This factor was taken into consideration when compiling the broiler performance data (Table 4). Body weights of the compost and sawdust pens were similar at 7 days (.33 vs. .33 lbs), 14 days (.77 vs. .75 lbs) and 42 days (5.27 vs. 5.30 lbs). However, note the 42 day weights exclude the compost pen biased by having the higher bird density.

Average 42 day mortality was higher with compost (4.8%) compared to sawdust (2.7%). However this difference was due to higher mortality in just one compost pen and may reflect a minor difference in equipment function or chick source for this pen. Since the other compost pen had mortality similar to the sawdust treatment, this may not be a concern. When the birds were weighed in groups of five at 42 days there was respiratory noise in 3% of the compost groups and 17% of the sawdust groups. This observation may warrant further study.

Although the incidence of foot pad lesions "appeared" to be higher with compost bedding at 7 and 14 days of age, this may be due to the difficulty in distinguishing a mild lesion from discoloration caused by the dark colored compost. Considering the dryness and fine particle size of the compost and the fact the incidence of foot pad lesions were similar at 42 days of age, it suggests it was a discoloration issue rather than abrasion on the feet. Furthermore, for the first several weeks of age there was some discoloration on the backs of the chicks reared on compost bedding. This disappeared as the birds feathered-out. Incidence of caking was minimal and the same for both bedding types.

Table. 4. Broiler performance for bedding treatments.

Parameter	Age (d)	Compost	Sawdust
Body weight (lbs)	7	0.33	0.33
	14	0.77	0.75
	42	5.27[1]	5.30
Mortality (%)	1-7	0.8	0.7
	8-14	1.0	0.5
	15-42	3.0	1.5
	1-42	4.8[2]	2.7
Foot pad score (%)[3]	7	2.5[4]	0
	14	9.1[4]	1
	42	1.5	1

[1]One pen with excessive bird density was deleted from this average weight.
[2] Increase mortality due to one pen on compost bedding.
[3]Subjective score: 0 = none, 1 = slight lesion and 2 = severe lesion.
[4]Difficult to distinguish between a slight lesion (#1) and staining caused by the compost.

Based on this ***preliminary evaluation*** there is little indication to suggest the compost bedding has a detrimental effect on performance. A larger scale evaluation of this material was recently implemented by the cooperating poultry and composting companies on a commercial broiler farm. Initial observations suggest the compost bedding used for this demonstration was too dusty and had a musty odor that will require different screening and aging process. Once corrected, composting as a treatment strategy of these mixed-wood grindings may offer potential as a bedding supplement.

Objective 5: Provide outreach programs to the forest and poultry industries on the opportunities of utilizing hardwood sawdust as a poultry bedding material.

The following is a listing of outreach activities to inform the forest and poultry industries on opportunities for utilizing hardwood sawdust and mixed wood products as potential bedding materials:

- Met with local (Delmarva region) poultry and bedding suppliers for a progress and situation update. August 2006.
- Presentation at the Georgia Poultry Conference in Athens, GA on “Bedding Alternatives and Options”. September 2006.
- Following closure of largest pine sawmill in the region, met with a regional bedding broker to discuss availability and options for using hardwood sawdust. December 2006.
- Presentation at the International Poultry Scientific Forum in Atlanta, GA on “Management strategies for utilizing hardwood sawdust as poultry bedding”. January 2007.
- Presentation to Delmarva poultry company managers in Delmar, MD on “Management strategies for utilizing hardwood sawdust as poultry bedding”. February 2007.
- Informal meeting of the Association of Forest Industries to discuss prospect of utilizing poplar sawdust in the poultry industry. August 2007.
- Phone conversations with 3 regional sawmills on study results and potential market for poplar sawdust in the poultry industry. August 2007.
- Summary of study results presented to the Dorchester County (MD) Forestry Board. September 2007.
- Presentation at the Delmarva Poultry Conference in Ocean City, MD on “Delmarva bedding update”. September 2007
- Presentation at the Pennsylvania Sales and Service Conference in Lancaster, PA on “Bedding alternatives and options”. September 2007.
- Interview for a national poultry cast document on “Poultry bedding alternatives”. September 2007.
- Popular press article in WattPoultryUSA entitled; “Bedding alternatives and options”. September 2007.
- Meetings with Mountaire Farms Inc. and Blessing Compost to discuss results of compost bedding study. September 2007.
- Presentation scheduled for the Virginia Poultry Health and Management Conference in Roanoke, VA on “Bedding alternatives and options”. April 2008.

Impact Statement

Results from this study and the rapid dissemination of information have contributed to increased awareness and usage of yellow popular sawdust as a viable alternative poultry bedding material. Treatment strategies to reduce potential health and production-related issues associated with white oak sawdust require further study.

Reference

Malone, G. W. and G. W. Chaloupka. Composted municipal garbage for broiler litter. 1983 Poultry Sci. 62:414-418.

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