AN ABSTRACT OF THE THESIS OF

Abdulmalek M. Modhish for the degree of Master of Science in Poultry Science presented on October 20, 1986.

Title: Comparison Between Wood Fiber Pellets and Wood Shavings as Broiler Litter

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Abstract approved: Dr. Harry S. Nakaue

Physical and chemical properties of wood (W) fiber (F) pellets (P) and wood (W) shavings(S) were determined in the laboratory prior to their use.

Laboratory results showed that WS were superior to WFP except for moisture holding capacity on volume basis which is one of the most essential properties of a good litter. WFP were also found to contain high levels of aluminum (311X), calcium (160X), iron (90X), arsenic (58X) and sulfur (42X) than these elements found in WS

An experiment was conducted in a conventional ventilated house to compare unused WFP and unused WS. No significant differences in mean atmospheric ammonia, respiratory dust particles, moisture levels, litter caking scores, body weights, feed conversion and mortality (49 days) were found between the two litter types. WFP were found to slightly reduce atmospheric ammonia for the first 6 weeks when used for the first time. Litter caking scores were better in pens with WFP than in pens with WS. Higher levels of respiratory dust were found in pens with WFP which did not have any adverse effect on birds' performance and health.

Two experiments of 7-week duration each and four treatments each were conducted to evaluate the utility of WFP as built-up broiler litter. Litter treatments were unused (U) WS, WFP built-up (B) top (T) dressed with unused WFP (WFPB + UWFPT), WS as base top dressed with unused WFP (WSB + UWFPT), and wood shaving built-up top dressed with UWS (WSB + UWST), respectively. Results from these experiments showed that WFPB+UWFPT did not result in the decrease of atmospheric ammonia when WFP was recycled. Respiratory dust particles were higher in the WFP treatments (WFPB + UWFPT and WSB + UWFPT) than the wood shavings treatments (UWS and WSB + UWST). Litter caking scores were better in pens with WFP treatments. In Trial 1 no significant differences among the treatments were found in body weights, feed conversion, and mortality. However in Trial 2, WSB + UWFPT and WSB + UWST had significantly heavier body weights than UWS and WFPB + UWFPT.

WSB+UWFPT had significantly higher mortality than UWS, WFPB+UWFPT and WSB+UWFPT. The trend for lower carcass grade A from broiler in pens with WFPB+UWFPT was noticed in both experiments.

Under the experimental conditions, WFP can be used successfully as unused or built-up broiler litter. Further research on the carcass downgrades and the effects of the deposition in the broiler meat of excessive levels of aluminum, calcium, iron, arsenic, and sulfur derived from WFP are suggested.

COMPARISON BETWEEN WOOD FIBER PELLETS AND WOOD SHAVINGS AS BROILER LITTER

by

Abdulmalek Mohamed Modhish

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CHAPTER I

INTRODUCTION

The high cost and scarcity from time to time of the traditional litter materials such as wood shavings and sawdust for use in broiler production have caused broiler producers to either continuously recycle the used litter or to investigate other alternative litter sources. Re-use of old litter with either chemical treatments to neutralize ammonia evolved from the litter or prevention of the activities of the microorganisms that decompose uric acid into ammonia or inoculation of poultry litter with selected microorganisms that result in producing non-ammonia products or cultivation or top dressing of litter to prevent caking have been investigated.

Several by-products of crop production such as straw, cane bagasse, corn cobs, rice hulls and chopped stalks have been investigated for use in broiler production with some success.

Recently, a by-product of the paper and pulp industry was introduced to the Pacific Northwest broiler producers. Wood fiber pellets are fiber materials from the manufacture of pulp and paper after conventional dewatering to 20% solids. The material is dried, pelletized and sold as litter material for domestic and farm animals.

The purposes of these studies were to investigate the physical and chemical properties of wood fiber pellets and to determine whether wood fiber pellets could be used either once or recycled several times in broiler production.

CHAPTER II

LITERATURE REVIEW

A number of potential materials has been investigated as litter materials. Corn cobs (Smith, 1956; Reed and McCartney, 1970); coffee husk, feathers, chopped dried grass and hessian (Trail, 1963); pine bark (Golan *et al*., 1969; Pope *et al*., 1967; Reed and McCartney, 1970; Ruszler and Carson, 1974); sugar cane pomace; peanut shells; crushed corn cobs (Ruszler and Carson, 1974); cane bagasse; oak shavings, ground flax stock; oak straw and a combination of straw plus rice hulls (Andrews and McPherson, 1963; Reed and McCartney, 1970); rice hulls (Andrews and McPherson, 1963; Stephenson, 1967; Reed and McCartney, 1970); pine shavings (Stephenson, 1967; Reed and McCartney, 1970; Carter *et al*., 1979); chopped corn cobs; wheat straw (Stephenson, 1967), sawdust mixed with peat moss; shavings, or wood chips, cocoa bean hulls; ground polystyrene; and chopped polyurethane (Loyd, 1967); pine straw; peanut hulls; pine stump chips; pine sawdust, chopped pine straw (Reed and McCartney, 1970); hardwood chips, pine chips, mixed chips (Carter *et al*., 1979); pine chips (Reed and McCartney, 1970; Carter *et al*., 1979); chopped cereal straw (Nakaue *et al*., 1978); softwood chips fine (Parsons and Baker, 1985); and paper products such as shredded newspaper and processed newspaper (Malone et al., 1982); and wood fiber pellets (Nakaue et al., 1985; Savage et al., 1986) have been tested for feasibility as a broiler litter.

Criteria of a Good Litter Material

A good litter material should be relatively inexpensive, readily available, relatively absorbent, resistant to caking, has reasonable particle size, release moisture, has cushioning ability (Ruszler and Carson, 1974). In addition to these, it should be light, soft, absorb minimum moisture from a humid atmosphere (Reed and McCartney, 1970), dust-free and easily shipped and handled (Parsons and Baker, 1985).

Litter Management

Claybaugh (1967) stated that:

> "Litter management is similar to whether a man shaves every day to present a smooth chin, or whether he develops a beard over a period of weeks. Those few minutes a day that it requires to shave prevents a person from appearing like a bum. Litter management is very similar."

Using a good litter type alone is not sufficient without good management practices.

Some of the problems associated with litter management are uneven litter coverage, undesirable size, non-absorptive, compacted, wet and dusty litter (Claybaugh, 1967). All but the last two problems can be managed by changing or adding more litter. Wet and dusty litter is difficult to deal with in winter and summer, respectively. The poultry industry has adapted to controlled environmental housing, thus wet or dusty litter can be controlled by adequate ventilation or humidification in an insulated house. Brewer (1985) reported that most decisions concerning litter management are subjective, but in general there are two criteria that should be included in litter management programs: Prevention of excessive litter moisture which contributes to foot and leg problems, enteric infections and breast blisters which are detrimental to bird performance; and prevention of excessively dry litter because this initiates dust production which consequently leads to respiratory infection and increased condemnations at processing. Claybaugh (1967) further mentioned that litter management becomes increasingly important due to the unavailability and very expensive prices of litter materials in order to bring about optimal condition for good performance of birds.

North (1984) listed several factors that affect litter:

1. Relative humidity and temperature of the outside air.

2. Relative humidity and temperature inside the poultry house.

3. Density, body weights of the birds.
4. Ventilation rate.
5. Water consumption.
6. Type and makeup and form of feed.
7. Stress in the birds.

Comparison of Physical Properties Among Various Litter Types

Few studies have been reported on the physical properties of different litter materials. Smith (1956) reported that corn cobs have a high capacity to absorb moisture; however, they must be ground to be a suitable litter material. Whole corn cobs cause chickens to have difficulty walking on them and cause higher incidence of breast blisters compared with sawdust and shavings. Ruszler and Carson (1974) studied the physical properties of pine bark, cane pomace, peanut shells, ground corn cobs, and wood shavings. These investigators stated that in some cases it is not the litter itself which is undesirable, but the physical conditions which it attains after continued use. Significant differences were observed in rate of caking, compaction time, moisture uptake, and moisture release among litter materials. For instance, cane pomace caked fast, absorbed the highest moisture, and retained its cushioning ability. On the other hand, ground corn caked last, but lost cushioning ability fast. Some litter materials absorb little moisture, but release it fast. Pine bark absorbs little moisture, but releases moisture readily. These differences can be attributed to particle size and structure of litter materials; the smaller the particle size, the less moisture it absorbs and the flatter the surface, the faster it compacts.

Performance of Broilers Reared on Different Types of Litter

Reed and McCartney (1970) and Ruszler and Carson (1974) reported that no significant differences were found in broilers reared on various litter materials (pine bark, cane pomace, peanut shells, ground cobs, and wood shavings, rice hulls, pine stump chips, pine sawdust, pine straw, clay) with reference to body weight, feed efficiency, incidence of breast blisters, and mortality. In addition, Reed and McCartney (1970) found no significant differences between new and re-used litter materials mentioned above.

Labosky *et al*. (1977) reported that with good management, bark litter can be used for as many as five broods of broilers without any apparent adverse effect on broiler performance.

Nakaue *et al*. (1978) reported that no significant differences among litter materials (wood shavings [WS], chopped straw [CS], and WS:CS, 1:1) were observed in mean body weight, feed conversion, incidence of breast blisters and leg abnormalities at 8 weeks of age. No significant difference in body weight, feed conversion and mortality were observed among the litter materials of pine shavings, hardwood chips, pine chips, and mixed chips (Carter et al, 1979). Malone et al. (1982) found that body weights at 49 days of age were significantly influenced by type of recycled paper products (shredded newspaper, processed newspaper, or processed cardboard) used as broiler litter. Broilers on shredded newspaper were the heaviest while those on processed cardboard were the lightest. However, feed conversion and mortality were not significantly different among the litter treatments.

Nakaue et al. (1985) reported that no significant differences in broiler performance were found between wood shavings and wood fiber pellets; however, Savage (1986) stated that market turkeys reared on wood fiber pellets had significantly ($P<0.05$) higher feed conversion at 16 weeks of age than wood shavings.

Problems Associated With Poor Litter Management or Recycle of Litter

Ammonia

Ammonia is a colorless, irritant gas produced by the decomposition of the nitrogenous fraction of animal wastes (Carlile, 1984).

Odors emanating from poultry houses result in unpleasant conditions for both caretakers and people who live in the neighboring area (Mote, 1984). The production of ammonia is influenced by moisture content, humidity, temperature, aeration, pH, and fecal content (Elliot and Collins, 1982), and re-using of old litter (Caveny et al., 1981). Nakaue et al. (1980) reported that adequate ventilation removes ammonia, carbon dioxide, hydrogen sulfide, and methane from poultry houses. Roller (1961) reported that good ventilation functions in getting rid of ammonia, moisture and dust.

Adverse effects of ammonia

Ammonia has been reported by many investigators to be detrimental to poultry especially during the cold seasons when sufficient ventilation to get rid of this gas can result in cooling the houses (Roller, 1961). Pathological conditions that have been attributed to high levels of ammonia are keratoconjunctivitis (Valentine, 1964); impairment of mucus flow and ciliary action in the trachea which result in lowered resistance to respiratory infection (Dalham, 1956); reduction in the size of bursa of Fabricius after infectious bronchitis vaccination and reduction in respiration rate and depth (Charles and Payne, 1966a); lower body weights (Kling and Quarles, 1974); reduction in feed efficiency (Caveny et al., 1981); lower egg laying capacity (Charles and Payne, 1966b); deterioration of interior egg quality (Cotterill and Nordksog, 1954); increase in the incidence of breast blisters (Carlile, 1984); and delay in sexual maturity (Charles and Payne, 1966a). Anderson et al., (1964) reported that ammonia levels of 20 to 50 ppm for 72 hours significantly enhanced the infection rate of chickens when exposed to an aerosol of Newcastle Disease virus. Carr and Nicholson (1980) reported that 100 ppm ammonia significantly reduced the growth rate of broilers. Deaton and Reece (1980) recommended that ammonia levels in poultry houses should not exceed 25 ppm. This can be achieved by careful litter management, adequate ventilation, and/or chemical treatments.

Chemical treatments

Paraformaldehyde

Seltzer et al. (1969) found that application of paraformaldehyde at the rate of 4.5 kg/26 square meters of litter reduced ammonia levels to 5 ppm, but this reduction lasted only for three weeks. Even though it reduced ammonia, the safety of using this chemical is equivocal. Veloso et al. (1974) reported no adverse effect of paraformaldehyde application up to 3% of the weight of the litter, while Swenberg et al. (1980) suggested that paraformaldehyde vapor has proven to be carcinogenic to rats.

Zeolites, ferrous sulfate and other chemicals

Koelliker et al. (1980) reported that zeolites have the ability to lose or gain moisture reversibly and exchange cations without structural changes. The empirical formula for zeolite is as follows:

$$Na_6 [(AlO_2)_6 (SiO_2)_{30}] \cdot 24 H_2O$$

The sodium ions are exchangeable for cations such as ammonium ions. These substances can be used to reduce ammonia and moisture. Nakaue et al. (1981) reported that application of clinoptilolite at 28 days of broiler production on the surface of clean wood shavings was better than application at early stage.

Iheanacho (1984) reported that ferrous sulfate-heptahydrate applied on built-up litter at a rate of 0.76 kg/square meter reduced atmospheric ammonia and lowered pH for 28-35 days after application.

Other chemical materials have been investigated to lower ammonia such as superphosphate and phosphoric acid (Reece et al., 1979), acetic and propionic acids, gentian violet, and calcium propionate (Arafa et al., 1979; Dilworth et al., 1979).

Wet Litter

Wet litter conditions can be caused by diarrhea, excessive salt consumption that triggers excessive water consumption, leaking waterers, spillage of waters by birds, poor ventilation, and litter that does not release moisture (Naber, undated). Harms and Simpson (1975) and Martland (1985) reported that wet litter induced foot pad dermatitis and breast blisters in broiler chickens. The latter investigator reported that chickens grown on wet litter were dirty, inactive, and weighed less compared with those on dry litter. Wet litter can cause economical losses to the broiler and turkey growers through carcass condemnation and lower feed efficiency, severe leg disorders in turkeys and broilers and their remedy can be attained by giving much attention to the litter.

Dust

Dust is defined as particles floating in the air which are originated from feathers and skin debris, feed and litter.

Grub *et al*. (1965) reported that dust was a function of relative humidity and increased in the first six weeks of the growing period then tends to level off. Anderson *et al*. (1968) reported that turkeys exposed to high level of dust had higher incidence of air sacculitis. Solano-Martagon (1964) reported that dust contained large number of microorganisms which includes several pathogens.

Shaffner (1968) reported that broiler performance was far superior in dust-free pens than the presence of dust. This probably was due to airborne disease affecting the respiratory tracts of birds. Anderson et al. (1966) reported that dust concentration in the air is highly related to relative humidity, litter moisture, ventilation rate and population density. Controlling these factors will keep dust to a minimum.

Litter Consumption

Malone et al. (1983) reported that chicks have a tendency to consume litter during the first two weeks, but it decreases with age. Texture, visual properties, and particle sizes of the litter may enhance litter consumption. When litter consumption exceeded 4% of the total feed, body weights were reduced. Reducing litter consumption during the first two weeks can be minimized by selecting reasonable particle size, or using rolled brooding paper (Bower, 1984) which has been shown to improve litter condition and reduce feed spillage besides minimizing the contamination of feeders, and waterers with litter materials.

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CHAPTER III

COMPARISON OF PHYSICAL AND CHEMICAL PROPERTIES OF WOOD FIBER PELLETS AND WOOD SHAVINGS IN THE LABORATORY

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Abstract

Physical and chemical properties of wood (W) fiber (F) pellets (P) and wood shavings (S) were investigated in the laboratory to determine the quality of these litter materials as a broiler litter. WFP contain more elements, hold more moisture on a volume basis, and have higher pH than WS. However, WS absorb more moisture on weight basis and release moisture faster than WFP. These differences might be attributed to their differences in shapes, particle sizes, and density. Under the conditions of these experiments, assuming the costs for WFP and WS were the same and the supplies were unlimited, WFP show promise as a suitable litter material for broiler production.

Introduction

Evaluation of litter materials are based on measurements taken while the birds are grown on them. This is time consuming and does not differentiate one material from another. Thus, comparison of physical properties are more objective (Ruszler and Carson, 1974), in addition to chemical properties. The desirable physical properties of a good litter material have been cited by several investigators. Reed and McCartney (1970) reported that the materials should be light in weight, highly absorbent, dry quickly, soft and compressible, have low thermal conductivity, and absorb minimal moisture from a humid atmosphere. Ruszler and Carson (1974) indicated that a good litter material should be inexpensive and easily obtained, able to absorb moisture without caking, hold moisture on the particle surface in order to release it under drying conditions, have a small particle size, and maintain cushioning ability under high density stress. Parson and Baker (1985) further mentioned that it should be dust-free and easily shipped and handled. Elliott and Collins (1982) noted that pH of the litter is an important factor that affects the ammonia volatilization.

Wood fiber pellets were introduced to the broiler producers of Oregon and Washington. This material has been used in stalls and pens at county fairs. Wood fiber pellets are made up mainly of cellulose with the following chemical formula, $(C_6H_{10}O_5)n$. It has a light gray to black color with typical kraft pulp odor, contains less than 10% moisture and does not constitute a fire hazard due to its high ignition temperature ($>500^oF$).

In order to learn more about this litter material, preliminary studies on the comparative physical and chemical properties of wood shavings and wood fiber pellets were investigated in the laboratory.

Materials and Methods

Chemical Properties

Nitrogen determinations in litter materials were as follows. Samples of 0.4 gram each of wood fiber pellets and wood shavings were used. Nitrogen levels were determined by following the procedures outlined by Schuman *et al*. (1973) with some modifications in catalyst, tubing sizes and mixing coils.

Determinations of other elements in the litter materials were as follows. Samples of wood fiber pellets and wood shavings were dried at 70°C for two days then ground through 20 mesh screen. Samples were redried at 60°C prior to weighing. One gram of each litter type was placed into porcelain crucibles to be ashed in a muffle furnace at 500°C for 6 hrs. The ash samples were cooled then 5 cc 20% nitric acid were added to each sample and the mixtures were allowed to stand for 2 to 4 hrs. Fifteen mls of distilled water was added, stirred thoroughly and allowed to stand overnight. The clean portion of each sample was placed in auto sampler tubes and run through the Inductively Coupled Argon Plasma Spectrometer (ICAP-9000). By using the respective wave lengths for each element, the percent transmission was recorded and concentrations calculated. Phosphorus, potassium, sulfur, calcium, and magnesium were expressed on percent dry weight.

Manganese, iron, copper, zinc, aluminum, sodium, selenium, and arsenic were expressed on parts per million.

Physical Properties

Water holding capacity by Weight

Moisture holding capacity was determined as outlined by Ruszler and Carson (1974) and Nakaue et al. (1978). Three 50 gram samples each of wood fiber pellets and wood shavings were placed in 1000 ml beakers then soaked in 400 mls distilled water for 72 hrs. The water was decanted after soaking for 24 hrs and the wet weight was recorded. This procedure was carried out for three consecutive days. The total water absorbed was calculated by the difference between the wet weight and the original weight of each sample. The total water absorbed was divided by the original weight to get water holding capacity per one gram of litter at room temperature.

Water holding capacity by volume

Comparison on volume basis seems more logical since litter materials are placed on the floor of broiler house by volume. Two 500 cc samples each of wood fiber pellets and wood shavings were weighed and placed in 16 cm X 16 cm X 5 cm (1280 cm^3) aluminum tray. Each sample was soaked in 800 mls of distilled water for 72 hrs. The weight of total water absorbed after decanting was calculated by subtracting the original weight from the wet weight at 24 hr intervals for 72 hrs. The average water absorbed was calculated and divided by the volume of each sample to obtain water holding capacity per each cubic centimeter.

Water releasing capacity

Moisture releasing capacity was determined as described by Nakaue _et al_. (1978) but on hourly basis. The same samples used for determination of water holding capacity on a volume basis were utilized to evaluate water releasing capacity for both litter types. Wet litter weights were recorded prior to drying to estimate total water absorbed. All samples were put in a Theco oven at 37^{o}C (100^{o}F) for 2, 3, 4, 8 hrs, and the litter weights recorded after each period. Percent loss of absorbed moisture for each period was calculated by subtracting the dry weight from the initial wet weight then divided by the initial weight. The value was multiplied by 100 to calculate percent loss of moisture for each drying period.

pH

pH of the litter is an important property which affects the volatilization process of ammonia. The pH determination of a substance requires a liquid medium; therefore, the only means of obtaining the pH of a solid dry substance is by adding liquid (Westcott, 1979). The pH's were determined as outlined by Westcott (1979) with the Sargent-Welch pH meter, model NX. Two one-gram samples of each type of litter were each placed in 50 ml beakers and twenty mls of distilled water were added to each sample and stirred for one hr. During the stirring, the electrode of the Sargent-Welch pH meter was submerged in the distilled water-litter mixture, and the pH read and recorded. Prior to measuring the pH, the instrument was calibrated as directed.

Compressibility

Compressibility or softness of litter materials is another important physical property. Compressibility was determined as outlined by Reed and McCartney (1970). Three samples each of wood fiber pellets and wood shavings were each placed in cylinders (5.3 cm diameter). Litter weights for each sample were recorded and the litter materials placed in the cylinder and the volumes recorded. Equal pressures were applied against the whole top surface (5.3 cm diameter) by using a cylinder (4 cm diameter). Volumes occupied by the litter material after pressing were recorded and the percent compressibility were calculated by subtracting the volumes after pressing from volume before pressing. The differences of each sample were divided by the volume before pressing.

The resulting figures were multiplied by 100 to derive at the percent compressibility.

The data for litter pH and water holding capacity were subjected to one-way analysis of variance as outlined by Snedecor and Cochran (1980).

Results and Discussion

Chemical Properties

Data in Table III.1 show the chemical composition of wood fiber pellets and wood shavings. All elemental levels were much higher in wood fiber pellets than wood shavings. Wood fiber pellets contained more sulfur (42x), calcium (160x), iron (90x), aluminum (311x) and arsenic (58x) than present in wood shavings. Thus before commercial use of new litter, litter samples and carcass analyses are highly recommended to make sure that deposition of toxic elements as a result of litter consumption does not exceed the limit that can be tolerated by human.

Physical Properties

Table III.2 shows the moisture holding capacity of the saturated wood fiber pellets and wood shavings. On a weight basis, wood shavings held significantly more water than wood fiber pellets.

By volume basis, wood fiber pellets held significantly more moisture than wood shavings. These differences may be related to their density, shape, and particle sizes of the litter materials. Wood fiber pellets have higher density, and cylindrical shape, absorb more moisture when compared with wood shavings on volume basis. On the other hand, wood shavings are less dense with flatter particle surfaces and absorb more moisture than wood fiber pellets on a weight basis.

Data for water releasing capacity for both litter materials are presented in Table III.3. Water releasing capacity is not necessarily correlated with moisture holding capacity. Wood fiber pellets absorb (when 100% saturated) much more moisture but do not release it as fast as wood shavings. The reason might be due to the differences in their particle shapes and higher density. The flatter particle surface of wood shavings allows a more rapid release of moisture while the moisture of wood fiber pellets is absorbed in the cylindrical shaped pellets which require more time to release in the environment.

Table III.4 shows the pH's of wood fiber pellets and wood shavings. Wood shavings have lower pH value than wood fiber pellets, 5.5 vs. 7.2, respectively. The pH of wood shavings is in agreement with the typical range of sawdust and wood shavings, 5-6.5. (Turnbull and Snoeyenbos, 1973). Litter with low pH reduces the volatilization process of ammonia by suppressing the breakdown of uric acid. The maximum breakdown of uric acid occurs at pH 9.0 and decreases in a nearly linear fashion with either more acidic or alkalinity of the litter (Baum et al., 1956). For instance, loss of ammonia from urea* at neutrality was about half the rate at pH 8.5 (Wahhab *et al*., 1960).

Table III.5 presents the data for compressibility of wood fiber pellets and wood shavings. Wood shavings are more compressible (51%) than wood fiber pellets (18%) thus providing soft floor for broilers. High compressibility or softness of wood shavings can be attributed to their flatter surfaces and particle sizes. On the other hand, wood fiber pellets' cylindrical shapes are not highly compressible.

Summary and Conclusion

The summary of the chemical and physical properties of wood shaving and wood fiber pellets as a broiler litter are listed in Table III.6. Wood shavings were superior to wood fiber pellets in all criteria except for the water holding capacity and density. Particle shapes for both materials are different. These three factors may be the most important criteria in the evaluation of a litter material. Water

*Produced from uric acid by microorganisms in the litter.

releasing, compressibility and cushioning abilities are related to the particle shape of the material.

The levels of particular elements in wood fiber pellets were higher than in wood shavings. This can be of a great concern because of litter consumption by broilers and the excessive bioaccummulation of the elements in the dressed carcasses.

Another important criteria that was not measured in the laboratory was the production of dust by the litter material. This will be measured in subsequent trials.

The chemical and physical properties measured in the laboratory give some indication on the quality of the litter material. If the costs were the same, and the supplies of these litter materials were unlimited, wood fiber pellets show promise as a suitable litter material for broiler production based on laboratory analysis.

Table III.1. Chemical composition of wood (W) fiber (F) pellets (P) and wood shavings (S) (dry weight basis)

Elements	WFP	WS	WFP/WS
	%	%	
Nitrogen	0.32	0.14	2.3
Phosphorus	0.05	0.00	
Potassium	0.21	0.01	21
Sulfur	0.42	0.01	42
Calcium	6.39	0.04	160
Magnesium	0.16	0.00	
	ppm	ppm	
Manganese	307	11	28
Iron	2529	28	90
Copper	21	1	21
Zinc	45	2	23
Aluminum	9963	32	311
Sodium	706	32	22
Selenium	.15	.01	15
Arsenic	58	1	58
Chromium*	17	?	
Lead*	55	?	

* not known

Table III.2. Comparison of water holding capacity by weight and volume bases of wood shavings and wood fiber pellets

Litter Type	Water holding capacity	
	By Weight gms H_2O/gm	By Volume gms H_2O/cc
Wood shaving	1.9^b	0.2^a
Wood fiber pellets	1.2^a	0.4^b

Columns with different superscripts are statistically significant ($P<0.05$).

Table III.3. Comparison of water releasing capacity of wood shavings and wood fiber pellets

Description	Wood fiber	Wood shavings
Volume of water, cc	500	500
Average wts, g	170.3	38.2
Total water absorbed, g	211.2	75.6
H_2O released, %		
after 2 hrs	16	50
after 3 hrs	26	69
after 4 hrs	37	84
after 8 hrs	67	97

Table III.4. Comparison of the pH of wood fiber pellets and wood shavings

Litter Type	pH
Wood fiber pellets	7.2[b]
Wood shavings	5.5[a]

significant at $P<0.05$.

Table III.5. Comparison of compressibility of wood fiber pellets and wood shavings

Parameters	Wood fiber	Wood shavings
Weights, g	117	20
Fluffy volume, cc	306	303
Compacted volume, cc	251	147
Difference, cc	55	156
Compressibility, %	18	51

Table III.6. Summary of litter criteria between wood (W) fiber (F) pellets (P) and wood shavings (S)

Criteria	Types of litter material	
	WFP	WS
Cost	more expensive	cheaper
Supply	readily available	readily available
Absorbability (water holding)	more	less
Cushioning ability	fair	good
Density	more	less
Particle shape	cylindrical	flat
Compressibility	fair	good
Water releasing	slow	fair
pH	basic	acidic
Elemental content	high	low

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CHAPTER IV

COMPARISON OF UNUSED WOOD FIBER PELLETS AND WOOD SHAVINGS AS LITTER MATERIALS FOR BROILER PRODUCTION

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Abstract

A study was conducted in a conventional ventilated poultry house to compare unused of wood (W) fiber (F) pellets (P) and wood shavings (S) as broiler litter material. One group of broilers was reared on unused WFP (65 mm dia.) and the other on WS to 49 days of age.

Mean body weights, feed conversion, mortality, foot pad lesions (49 days of age), mean atmospheric ammonia levels, mean litter pH, and mean litter moisture were not significantly different ($P>0.05$) among the litter materials. However, WFP suppressed the volatilization of atmospheric ammonia numerically for the first 6 weeks. Respiratory dust particles were numerically higher and mean litter moisture levels were numerically less than WS. WFP had significantly better litter caking scores toward the end of growing period than WS.

Under the conditions of this experiment, WFP show promise as a suitable broiler litter.

Introduction

Availability of traditional broiler litter materials at reasonable costs is becoming a problem in broiler production (Veltmann *et al*., 1984). Therefore, utilization of by-products from industries that provide potential litter materials is becoming very important. The waste from pulp and paper industry is one example where by-products can be a source of litter material. Wood fiber pellets have been used as a bedding material for a variety of animals at county and state fairs throughout the Pacific Northwest. Testimonials claimed that wood fiber pellets reduce ammonia, absorb more moisture than wood shavings or wood chips.

Considerable interest evolved from the claims of wood fiber pellets that several broiler growers from the Pacific Northwest needed more information about this alternate litter source. Therefore, this experiment was designed to compare unused wood fiber pellets and wood shavings as litter materials in broiler production.

Materials and Methods

One thousand three hundred and eighty day-old straight run commercial broiler chicks were allocated equally among four pens in a conventionally ventilated house. Two pens (4.9 m x 4.9 m) were covered with 5 cm deep unused wood shavings while two other pens were covered with 5 cm deep unused wood fiber pellets (65 mm diameter). Each bird was allowed 0.07 m^2 floor space. Brooding and rearing procedures were followed as outlined by Dorminey and Nakaue (1977). Light was provided continuously with 25-watt bulb in each pen from day-old until 49 days of age. Feed and water were provided ad libitum during the experiment. A well balanced starter ration consisted of 23% crude protein was fed from day-old to 21 days of age, followed by a balanced finisher ration containing 21% crude protein from 22 to the 49 days of age. These rations were mixed at the Department of Poultry Science feed mill and fed in the mash forms. Zinc bacitracin was mixed in the rations (40g/ton).

The levels of atmospheric ammonia, respiratory dust particles, litter moisture and litter pH in each pen were determined by the procedures as outlined by Iheanacho (1984). The litter caking scores were determined by visual observation by two investigators. Each individual scored the litter independently using a score of 1 to 5. The two scores were recorded for each pen and then averaged. Litter caking scores were as follows:

1 = all the pen caked

2 = 3/4 of the pen caked

3 = 1/2 of the pen caked

4 = 1/4 of the pen caked

5 = no caking

These parameters were measured at weekly intervals until the end of the experiment.

Mortality was recorded daily, and dead birds were sent to the Oregon State University Veterinary Diagnostic Laboratory for necropsy. Body weights and feed consumption were measured at the end of 28 and 49 days of age. Foot pad lesions were determined by examining the bottoms of feet for 100 broilers (50 males and 50 females) in each pen for the presence or absence of lesions at 49 days of age.

Data were subjected to one-way analysis of variance as outlined by Snedecor and Cochran (1980).

Results and Discussions

Mean atmospheric ammonia and respiratory dust levels are presented in Table IV.1. No significant differences ($P>0.05$) in mean atmospheric ammonia levels were noticed between wood shavings and wood fiber pellets; however, the mean levels of atmospheric ammonia from 3-7 weeks were slightly lower in pens with wood fiber pellets than wood shavings. The reason might be attributed to the lower moisture levels of wood fiber pellets in the pens than that of wood shavings which are unsuitable for microbial activity (Turnbull and Snoeyenbos, 1973).

Respiratory dust levels in pens with wood fiber pellets were higher than wood shavings during the experiment. This is probably due to the lower moisture level in pens with wood fiber pellets (Modhish and Nakaue, 1986). This low moisture is related to adequate aeration between particles of wood fiber pellets. Low moisture results in low relative humidity which has inverse relation with respiratory dust particles (Grub et al., 1965).

Table IV.2 presents the mean litter moisture, litter caking scores and litter pH. The litter moisture of wood fiber pellets was lower than wood shavings throughout the experiment and significantly lower during the third week. This can be attributed to the particle sizes of wood fiber pellets. Mean litter pH's at 28 and 49 days of age for wood fiber pellets and wood shavings were not significantly different. Litter caking scores of wood fiber pellets were significantly better than the wood shavings during the 21-49 day period. During the last 14 days of the experiment, litter caking scores were significantly better in the wood fiber pellet than the wood shaving pens.

Mean body weights, feed conversions, percentage mortality, and percentage foot pad lesions were not significantly ($P>0.05$) different between the two litter types (Table IV.3). Body weights and feed conversions at 28 and 49 days of age were in agreement with body weights and feed conversions reported in NRC (1984) at the same age. The incidence of foot pad lesions were not significantly (P>0.05) higher in wood shavings than the wood fiber pellets. Foot pad lesions cause the birds to sit on their breasts for long period of time resulting in breast and hock lesions (Harms and Simpson, 1975) and consequently increased economic loss due to condemnations (Martland, 1985). The higher incidence of foot pad lesions in wood shavings might be attributed to the wetter and more caking of wood shavings than wood fiber pellets (Table IV.2).

Jensen et al. (1970) and Nair and Watson (1972) reported that litter-derived irritants like ammonia or corrosive substances and the adhesion of feces to the feet could be other factors responsible for foot pad lesions in both types of litter.

Under the conditions of this experiment, wood fiber pellets suppressed the level of atmospheric ammonia, held less moisture, caused less caking and produced lower incidence of foot pad lesions than wood shavings. However, pens with wood fiber pellets had higher respiratory dust levels than in pens with wood shavings, however, this was not significantly (P>0.05) different.

Wood fiber pellets seemed to be a better litter material in broiler production than wood shavings except for the higher dust level.

Table IV.1. Comparison of wood shavings and wood fiber pellet litter materials on the weekly mean levels of atmospheric ammonia and respiratory dust in broiler pens

	Mean Atmospheric Ammonia[2]						Mean Respiratory Dust Level[1,2]						
	Weeks on test						Weeks on test						
Litter Materials	3	4	5	6	7	3-7	2	3	4	5	6	7	2-7
	ppm						$\times 10^8/m^3$						
Wood Shavings	5.7	26.3	20.3	35.1	24.0	26.7	1.23	1.95	3.50	2.86	2.74	3.62	2.65
Wood Fiber Pellets	6.6	18.9	17.7	28.0	25.6	15.3	3.13	1.53	4.54	3.28	3.99	5.54	3.84

[1]Dust count based on particle sizes ranging from 0.5 to 10uM diameter for a one-minute sampling period.

[2]Mean values in each column were not significantly different among the treatments ($P>0.05$).

Table IV.2. Comparison of wood shaving and wood fiber pellet litter materials on weekly mean litter moisture, caking litter scores and litter pH in broiler pens

	Mean Litter Moisture[2]							Mean Litter Caking Score[1,2]						Mean Litter pH[2]	
	Weeks on test							Weeks on test						Weeks on Test	
Litter Materials	2	3	4	5	6	7	2-7	3	4	5	6	7	3-7	4	7
	%														
Wood Shavings	20	25[b]	33	31	32	34	29[b]	4	3	3.8	2.8[a]	2.8[a]	3.3[a]	8.51	8.19
Wood Fiber Pellets	17	22[a]	27	28	29	30	25[a]	4.5	4	4.5	4.0[b]	4.0[b]	4.2[b]	8.95	7.99

[1]Litter score based on: 1 = all pen caked
2 = severely caked (less than 3/4 of pen caked)
3 = some caking (less than 1/2 of pen)
4 = slightly caked (less than 1/4 of pen)
5 = no caking

[2]Mean values in each column with different superscripts are significantly different ($P>0.05$). Columns with no superscripts are not significantly different among the treatments.

Table IV.3. Effect of wood shavings and wood fiber pellet litter materials on broiler performance at 4 and 7 weeks of age

	4 Weeks				7 Weeks					
	Mean body weights				Mean body weights					
Litter Materials	Male	Female	M&F	Feed Conv.	Male	Female	M&F	Feed Conv.	Mortality	Foot Pad Lesion
	g				g				%	%
Wood Shavings	919	814	860	1.69	2057	1755	1908	2.07	3.2	70
Wood Fiber Pellets	906	816	858	1.71	2055	1742	1892	2.06	3.9	65

Mean values in each column were not significantly different ($P>0.05$).

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CHAPTER V

COMPARISON OF WOOD FIBER PELLETS AND WOOD SHAVINGS AS BUILT-UP BROILER LITTER

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Abstract

Two broiler trials of 7 week duration with four treatments each were carried out to compare the feasibility of wood fiber pellets (WFP) and wood shavings (WS) as built-up broiler litter. Litter treatments were unused (U) WS, WFP built-up (B) top (T) dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT) and WS built-up top dressed with UWS (WSB+UWST).

Levels of mean atmospheric ammonia, respiratory dust particles, litter moisture, and feed conversion were not significantly different among litter treatments in the two trials. Litter caking scores of WFPB+UWFPT in Trial 1 were significantly better than UWS, WSB+UWFPT and WSB+UWST at 4 weeks of the trial. WFPB+UWFPT were also significantly better than WSB+UWST at 6 weeks of the trial. No significant differences in body weight and mortality occurred among treatments in Trial 1. In Trial 2 WSB+UWFPT and WSB+UWST had significantly heavier body weights than UWS or WFPB+UWFPT. Mortality in Trial 2 was significantly higher in WSB+UWFPT than the other treatments. Trend for lower carcass grade A was noticed in WFPB+UWFPT treatment in both trials.

Under the conditions of these trials, recycled WFP litter seems to be suitable for broiler production. However, WFP caused a dustier environment in the broiler house with less

caked litter problem. Carcass quality may be reduced by the use of WFP litter.

Introduction

The short supplies and high prices of wood shavings and sawdust to poultry producers have necessitated the reuse of old litter (Caveny *et al*., 1981) as many as four or five times. This practice increases the potential for spreading disease (Parkhurst *et al*., 1974; Lovett *et al*., 1971; Bacon and Burdick, 1977) and the production of unacceptable levels of ammonia (Reece *et al*., 1979). However, with good litter management, these two adverse effects can be overcome.

Wood fiber pellets are available, and remain dry, uncaked for a long period in the pen, but the problem is their high cost compared with wood shavings. In the earlier studies, unused wood fiber pellets were compared with unused wood shavings as a broiler litter. Unused WFP slightly reduced atmospheric ammonia levels in the pens for the first 6 weeks of production with lower litter moisture levels and better litter scores toward the end of the growing period than WS. However, WFP increased respiratory dust particles in the broiler pens. Bird performance was not affected between the two types of litter (Modhish, 1986).

The purpose of these trials was to evaluate wood fiber pellets as built-up broiler litter material with unused and built-up wood shavings.

Materials and Methods

Two trials of 7 week duration were conducted using one thousand four hundred and eighty day-old straight run commercial broiler chicks for each trial. The chicks were housed in eight windowless negative pressure fan ventilated pens. Each pen was measured at 3.1 m x 4.3 m with a bird density of 0.07 m^2 floor space per bird. Similar techniques for brooding and rearing, measurements for levels of atmospheric ammonia, respiratory dust particles, litter moisture and litter caking scores, mortality, body weights and feed conversion were carried out for both trials as described earlier (Modhish, 1986).

In these trials, the chicks were distributed equally into four litter treatments of two replicates each. Treatments were 10 cm deep unused wood shavings (UWS) after each trial, wood fiber pellets built-up (B) after the removal of top (T) layer (2.5 cm) and wet spots and top dressed with 2.5 cm deep unused wood fiber pellets (WFPB+UWFPT), wood shavings as base after the removal of the top layer and wet spots and top dressed with 2.5 cm deep unused wood fiber pellets (WSB+UWFPT), and wood shavings built-up after the removal of the top layer and wet spots and top dressed with 2.5 cm deep unused wood shavings (WSB+UWST).

In Trial 1, feed was provided by a commercial feed manufacturer in the crumble and pellet form, whereas feed in Trial 2 was mixed at the Poultry Science feed mill and fed in the mash form. Zinc bacitracin was not mixed in the feeds for Trial 2.

Data were subjected to two-way analysis of variance as described by Snedecor and Cochran (1980) to determine the interaction between treatments and sampling periods. When no significant interactions between treatments (T) and periods (P) were found, the mean values for all sampling periods for each parameter were pooled. When significant T x P interactions were found, the mean values for each treatment were presented by each sampling period. Duncan's multiple range tests (Duncan, 1975) were used to separate significant treatment means for each significant parameter ($P<0.05$).

Results and Discussions

No significant T x P interactions were observed; therefore, the data were pooled for mean atmospheric ammonia, and respiratory dust levels. Pooled mean values of atmospheric ammonia, respiratory dust particles, and carcass grade for Trial 1 are shown in Table V.1. No significant differences occurred among the treatments for atmospheric ammonia and respiratory dust particles. Although dust levels were not significantly different (P>0.05), respiratory dust particles seemed to be higher in WFP treatments (WFPB+UWFPT and WSB+UWFPT) than WS treatments (UWS and WSB+UWST). The reasons might be due to the ability of WFP to resist caking for a longer period than WS. The shape of WFP allows more aeration between pellets in addition to preventing compactness.

WFP also disintegrated with time into smaller particles more than WS, thus producing more respiratory dust particles.

WFPB+UWFPT seemed to cause lower carcass grade A than the other treatments. The reason might be attributed to the activity of the birds reared on this treatment. Birds tend to spend more time crouched down on the litter and consequently have more breast blisters which resulted in more downgrading.

The carcass grade A in Trial 1 was very low compared with grade A in Trial 2 (Table V.6). Broilers in Trial 1 were reared during the fall season while broilers in Trial 2 were reared during the winter-spring seasons. Seasonal effect may be a factor in lower percent carcass grade A. North (1984) reported that birds reared in the fall had 50 percent more bruising than those reared in the winter or spring. The birds in Trial 1 were heavier than birds in Trial 2. Also, shipping birds to the processing plant on the same day directly after weighing in Trial 1 may have caused some downgrades. North

(1984) reported that improper handling during the 24-hour period prior to slaughter may cause the most bruises.

Mean moisture levels are shown in Table V.2. A significant T x P interaction ($P<0.05$) was found; therefore, the data were presented on weekly basis. No significant differences were found among the treatments at 2, 4, 5, 6, and 7 weeks of the trial. Allowing the built-up litter from the preceding trial to dry and the addition of UWS and UWFP as top dressing could have attributed to this close similarity in litter moisture levels among the treatments.

Table V.3 presents the litter caking scores. Significant T x P interaction ($P<0.05$) was found. On a weekly basis, the litter caking scores of WFPB+UWFPT (Trial 1) were significantly better than the other litter treatments at 4 weeks and WSB+UWST at 6 weeks of age. This may be related to their resistance to caking, high absorbability of moisture, and the ability to remain loose due to their less binding properties. WFP as built-up or as top dressing on WS had better litter scores during the whole growing period.

The mean body weights of male and female, feed conversion, and mortality at 7 weeks of age for Trial 1 are presented in Table V.4. No significant differences were noticed among the different litter treatments in mean body weights, feed conversion, and mortality. Mean body weights and feed conver- sion were within the standard range, whereas mortality was a little higher than normal. Post-mortem examinations indicated that the preponderance of the mortality was from heart attack (flipped over syndrome).

In Trial 2, a significant T x P interaction was found in mean atmospheric ammonia levels (Table V.5). Analysis of variance on weekly bases showed no significant differences among treatments.

Table V.6 presents respiratory dust particles, litter moisture levels, litter caking scores and carcass grade. No significant interactions were found in mean respiratory dust particles, moisture levels, and litter caking scores; therefore, the data were pooled. No significant differences in the pooled mean levels of respiratory dust particles, litter moisture levels, and litter caking scores were found. The level of respiratory dust particles seemed to be higher, and litter caking scores better in WFP treatments (WFPB+UWFPT and WSB+UWFPT), than WS treatments (UWS and WSB+UWST). This might be due to the shape of WFP, and the ability to absorb water. Also carcass grade A appeared lowest in WFPB+UWFPT treatment.

Mean body weights of male and female, feed conversion, and mortality for Trial 2 are shown in Table V.7. The mean body weights of the straight-run chickens were significantly heavier in WSB+UWFPT and WSB+UWST than UWS or WFPB+UWFPT. The reason for these differences cannot be explained. Mean body weights in this trial were lower compared with that of Trial 1. The texture of the feed and the omission of feed additives may be the reasons. Feeds in Trial 1 were provided by a commercial feed manufacturer in the pellet and crumble forms while feeds in Trial 2 were mixed in the Poultry Science feed mill without zinc bacitracin and was in the mash form.

Under the conditions of these trials WFPB+UWFPT had significantly better litter caking scores at 4 weeks of the trial than UWS, WSB+UWFPT, and WSB+UWST in Trial 1. At 6 weeks of this trial, WFPB+UWFPT had significantly better litter caking scores than WSB+UWST. All other parameters were not significantly different among the treatments.

In Trial 2, broilers reared on WSB+UWFPT and WSB+UWST had significantly heavier body weights than broilers reared on UWS or WFPB+UWFPT. Mortality was significantly higher in pens with WSB+UWFPT treatment than UWS, WFPB+UWFPT, and WSB+UWST. No significant differences in mean levels of atmospheric ammonia, respiratory dust particles, litter moisture, litter caking scores and feed conversion were observed among the litter treatments. Although no significant differences were found in respiratory dust levels, the pens with WFPB+UWFPT had higher levels of respiratory dust particles and lower carcass grade A than the other litter types.

WFP as sole built-up or top dressing on WS can be a suitable broiler litter material for several growouts, but further research on the factor(s) that cause lower carcass grade A is suggested.

Table V.1 Comparison of unused (U) wood (W) shavings (S), wood fiber (F) pellets (WFP) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on pooled means of atmospheric ammonia, total respiratory dust particles, and carcass grade A (Trial 1)

	Parameters[1]		
Litter Treatment	Mean atmospheric ammonia	Total respiratory dust particles[2]	Carcass grade A
	------ppm------	--x10^8/m^3/min--	%
UWS	20.8	1.2	64
WFPB+UWFPT	20.6	1.5	59
WSB+UWFPT	17.3	1.6	69
WSB+UWST	18.4	1.3	61

1. Mean values in each column are not significantly different (P>0.05).

2. Dust count based on particle sizes ranging from 0.5 to 10 uM diameter for a one-minute sampling period.

Table V.2 Comparison of unused (U) wood (W) shavings (S), wood fibe(F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on mean litter moisture levels (Trial 1)

Litter Treatment	Weeks of Age				
	2	4	5	6	7
	%				
UWS	17	29	25	28	26
WFPB+UWFPT	19	26	27	28	27
WSB+UWFPT	18	27	26	30	27
WSB+UWST	19	29	31	30	27

Mean values in each column do not differ significantly at $P>0.05$.

Table V.3 Comparison of unused (U) wood (W) shavings (S), wood fiber (F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on mean litter caking scores[1] (Trial 1)

Litter Treatment	Weeks of Age				
	2	4	5	6	7
UWS	5	3.3[a]	3.2	3.2[ab]	2.6
WFPB+UWFPT	5	4.5[c]	4.1	4.1[b]	3.6
WSB+UWFPT	5	4.0[b]	3.4	3.4[ab]	3.4
WSB+UWST	5	4.0[b]	3.4	2.6[a]	2.9

Mean values in each column with different superscripts are significantly different at $P<0.05$.

1. Litter caking scores were based on 0 to 4 range
   1 = all of the pen caked
   2 = 3/4 of the pen caked
   3 = 1/2 of the pen caked
   4 = 1/4 of the pen caked
   5 = no caking

Table V.4 Comparison of unused (U) wood (W) shavings (S), wood fiber (F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on mean body weights, feed conversion, and mortality at 49 days of age (Trial 1)

Litter Treatment	Mean body weights			Feed Conversion	Mortality
	Males	Females	M+F		
	----------g---------				----%----
UWS	2418	2000	2209	2.01	5.4
WFPB+UWFPT	2440	1950	2195	2.04	5.7
WSB+UWFPT	2495	2037	2266	1.98	5.2
WSB+UWST	2463	1996	2230	2.01	4.9

Mean values in each column are not significantly different at P>0.05.

Table V.5 Comparison of unused (U) wood (W) shavings (S), wood fiber (F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on mean atmospheric ammonia (Trial 2)

Litter Treatment	Weeks of Age					
	2	3	4	5	6	7
	ppm					
UWS	6	24	16	20	18	26
WFPB+UWFPT	6	23	17	30	28	37
WSB+UWFPT	7	26	20	23	30	32
WSB+UWST	11	25	13	17	23	35

Mean values in each column are not significantly different (P>0.05).

Table V.6 Comparison of unused (U) wood (W) shavings (S), wood fiber(F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on pooled mean total respiratory dust particles, litter moisture, litter caking scores and carcass grade A (Trial 2)

Litter Treatment	Parameter: Total dust respiratory particles[2]	Litter moisture	Litter caking scores[1]	Carcass grade A
	--x10^8/m^3/min--	---%---		---%---
UWS	2.0	31.5	3.4	80
WFPB+UWFPT	2.6	31.5	4.1	74
WSB+UWFPT	2.5	32.5	4.0	79
WSB+UWST	2.2	32	3.5	84

Mean values in each column are not statistically significant (P>0.05).

1. Litter caking scores--see Table V.3.

2. Dust count based on particle sizes ranging from 0.5 to 10 uM diameter for a one-minute sampling period.

Table V.7 Comparison of unused (U) wood (W) shavings (S), wood fiber (F) pellets (P) built-up top dressed with UWFP (WFPB+UWFPT), WS as base top dressed with UWFP (WSB+UWFPT), and WS built-up top dressed with UWS (WSB+UWST) on mean body weights, feed conversion, and mortality at 49 days of age (Trial 2)

Litter Treatment	Mean body weights			Feed conversion	Mortality
	Males	Females	M+F		
	----------g---------				----%----
UWS	2048[ab]	1671	1860[a]	2.35	2.1[a]
WFPB+UWFPT	2011[a]	1639	1825[a]	2.34	1.0[a]
WSB+UWFPT	2075[bc]	1775	1925[b]	2.26	5.5[b]
WSB+UWST	2102[c]	1725	1914[b]	2.27	2.6[a]

Mean values in each column with different superscripts are statistically different at $P<0.05$.

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CHAPTER VI

CONCLUSION AND SUGGESTIONS

The evaluation of wood shavings and wood fiber pellets as a broiler litter in the laboratory, and growout experiments with broilers clearly indicated that WFP litter were more absorbent and resistant to caking than WS litter. These characteristics are essential attributes of any broiler litter material. Unused WFP contained much higher levels of aluminum (311x), calcium (160x), iron (90x), arsenic (58x), and sulfur (42x) than these elements found in wood shavings. This may be a problem and needs attention because broilers consume litter especially at early age which might cause excessive accumulation of these elements in the dressed carcasses.

Unused WFP litter slightly reduced the volatilization of ammonia for the first 6 weeks in the first experiment but did not hold true for WFP as a built-up litter in Trials 1 and 2.

WFP litter resulted in higher production of respiratory dust levels than WS, but the dust did not appear to adversely affect the performance of the birds. However, reducing the levels of respiratory dust particles resulting from WFP can be achieved by increased ventilation, which may lead to increased cost of electricity and, in the winter time, difficulty of maintaining the optimal house temperature. The other method that might be more practical especially with large operation is installing fogging system that operate on time clock in such a way that maintains maximum humidity without causing wet litter.

WFP can be used successfully as broiler litter without adverse effects on birds' performance or health. Further research on the cause of carcass downgrade, and the effect on the deposition in the broiler meat of excessive levels of aluminum, calcium, iron, arsenic and sulfur derived from WFP are suggested. The final decision in the use of WFP by the broiler producers will depend on supply and cost when compared with other litter materials.

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