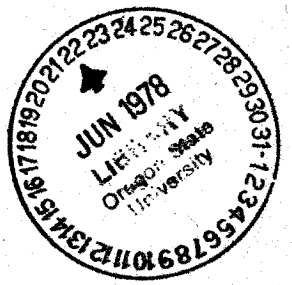
Chopped Cereal Straw as Broiler Floor Litter



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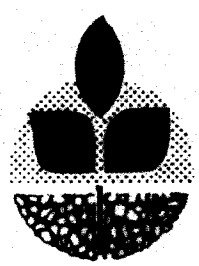

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CHOPPED CEREAL STRAW AS BROILER FLOOR LITTER

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INTRODUCTION

In the early 1970's, experts in the forestry industry predicted that by the end of the decade, wood shavings and sawdust would not be available for agricultural use because the materials would be completely utilized in the manufacture of further processed wood products such as particle board etc. The poultry industry in Oregon became alarmed at this prospect and requested the Department of Poultry Science at Oregon State University to begin experiments on alternative materials for use as poultry litter. The most likely substitute material that would be available in large quantities for an indefinite period in the future was cereal straw. A series of experiments were conducted to determine the feasibility of using chopped cereal straw as a substitute for wood shavings or sawdust for poultry litter. Procedures and results of those experiments follow.

EXPERIMENTAL PROCEDURE

Experiment 1

Broiler chicks in this experiment were housed in an uninsulated, concrete-floored house with adjustable side paneling for ventilation. Litter treatments were replicated three times with each pen 16 by 16 feet (4.88 by 4.88 meters) consisting of 348 Hubbard broiler chicks equally divided by sex. The bird density was 0.74 ft^2 (0.009 $meter^2$) per bird. Wood shavings (WS) and chopped straw (CS) (5 cm long) were spread in 3 pens each to a depth of 2 to 3 inches (5 to 7.5 centimeters). An electric hover 72 inches in diameter (1.8 meters) was used in each pen with the starting brooding temperature at 100°F (37.8°C) followed by a reduction of 5°F each week down to 65°F (18.5°C). The chicks were started by providing feed on flats for the first 5 days and followed by feeding in 4 tube feeders per pen, each 16 inches (40 centimeters) in diameter. The flats were removed after 5 days. Three portable water fountains were used in each pen for the first two weeks and gradually water was provided in one continuous-flow water trough, 65 inches (165 centimeters) long, providing 0.37 inches (0.94 centimeters) of drinking space per chick. A single stage broiler feed was mixed at the OSU Poultry Science Feed Mill (Table 1). Feed and water were provided free choice in this and all subsequent treatments.

Continuous artificial light was provided by one 40 watt white incandescent bulb in the center of each pen about 7.5 feet (2.3 meters) above the floor.

Body weight by sexes and feed consumption were obtained at 4 and 8 weeks of age.

Experiment 2

Broiler chicks in this experiment were housed in windowless positive pressure ventilated rooms. The chicks were brooded under infrared heat lamps using one 250 watt bulb per pen. Heat lamps were thermostatically controlled using room temperature starting at 85°F (29.4°C) which was manually lowered by 5°F each week through the fifth week, then set at 56°F (13.3°C) thereafter. Each pen (4 by 8 feet or 1.23 by 2.46 meters) contained a stove pipe hanging feeder and a 3 gallon water fountain. Incandescent lighting was provided continuously with the 40 watt light bulb suspended approximately 7.5 feet (2.3 meters) above the floor.

Each litter treatment was replicated 16 times with each replicate or pen containing 12 male and 12 female Hubbard broiler chicks. Each bird was allowed 1.08 ft^2 (0.013 $meter^2$) floor space. Each pen was covered with 30 pounds of either wood shavings or chopped straw (2 to 3 inches or 5 to 7 centimeters long) to a depth of 3 to 4 inches (7.5 to 8.2 centimeters). The same feeding and watering procedures were followed as in Experiment 1 and similar data collected.

Experiment 3

Broiler chicks were brooded and grown in the same room and same procedure as in Experiment 2. Three litter treatments that were compared were: WS, CS and an equal mixture of the two litter materials (WS-CS). Each litter material was added at 40 pounds per bird. The litter depth was approximately 4 inches (8.2 centimeters). In Experiment 3, each litter material was replicated 8 times with 24 straight run Hubbard broiler chicks per pen. Bird density was 1.08 ft^2 (0.013 $meter^2$) per bird. Moisture contents from each litter material were determined initially and weekly from 4 weeks of age by sampling the material from the same area of the same pens. Approximately 3 grams of litter samples were analytically weighed before and after drying at 100°F (37.8°C) for three days in an oven. Sample weights were recorded before and after drying and percent moisture computed.

A two-stage feeding program was used. Starter feed was fed for the first two pounds consumed per bird and thereafter the finisher feed was fed to market age (Table 1).

At 8 weeks of age, breast blister incidence was determined by randomly selecting three pens per treatment. The incidence of blisters on the keel bone and any other abnormalities were recorded.

Dust samples were measured weekly from 5 to 8 weeks of age. Quadruplicate dust samples were taken from pens for each litter material. A Rayco particle counter was used to determine the concentration of dust particles in the air above the floor pens (18 inches or 0.5 meters). The counter was used to count particles greater than 0.5, 1.0, 2.0, 3.0, 5.0, and 10.0 microns. Results were recorded in

numbers of particles per cubic foot of air. By subtraction, the counts were converted to number of particles having diameters of specific size ranges.

Ammonia absorption rates (mg/m^2 hr) were determined weekly from 5 weeks of age by exposing 25 milliliters of 0.02 N HCl solution to air in disposable beakers for one-half hour. The samples were returned to the laboratory in sealed test tubes for colorimetric determination. One milliliter of Nessler's reagent was used to develop the color which was read on a Coleman Junior spectrophotometer at 425 mu. When the color intensity was too dark, the samples were diluted and read again.

Experiment 4

Brooding and rearing procedures and the feeding program were the same as Experiment 3. The only difference was the bird densities on the three litter materials. The densities were: 0.6 ft^2 (0.007 $meter^2$); 0.75 ft^2 (0.009 $meter^2$); and 1.08 ft^2 (0.013 $meter^2$) per bird. Each treatment was replicated three times.

Litter caking scores were recorded weekly after the initial 3 weeks. A score of 1 was given to pens without any litter caking, and the score of 5 was given to pens with over 2/3 of the area caked. Scores between these two values were judged according to the degree of caking.

Breast blister incidence was determined for all birds from two pens of each treatment.

Analyses of variances were carried out for body weight, feed conversion and feed consumption data for all experiments (1).

Laboratory Tests To Determine Litter Properties

Moisture uptake and release for the litter materials were determined as outlined by Ruszler and Carson (2). Quadruplicate samples for each of the two litter materials were used to determine moisture uptake by weighing 45 grams of each litter and soaking each in a 2 liter beaker with 1000 ml of distilled water for 3 days. The water was decanted after soaking each day, and the beaker and the wet litter were weighed. The total water uptake was calculated by subtracting the dry litter from the final wet litter weights.

Moisture release was determined by taking the same water soaked litter materials and drying the samples in a drying oven at 100°F (37.7°C) for 3 days. The samples were weighed daily for 3 days.

Combustibilities of the litter materials were determined by weighing 5 gram samples of each litter material in a crucible and then placing it in a muffle furnace. The temperature was gradually

elevated until the first sign of combustion was noticed. The temperature at this point was recorded. Triplicate determinations were carried out for each litter material.

RESULTS

Average body weight and feed conversion data for the four experiments are presented in Tables 2 and 3. In all experiments, both average body weight and feed conversion at 8 weeks of age were not significantly different ($P > 0.05$) between broilers grown on any litter types. However, broilers reared on either CS or WS-CS were numerically heavier than those grown on WS in Experiments 1, 3 and 4. Average litter moisture levels were higher in pens with CS than in pens with WS (Experiment 3). The pens with WS-CS had average litter moisture intermediate to CS and WS.

Incidence of breast blisters and abnormalities observed on broilers at 8 weeks of age for Experiment 3 are listed in Table 4. There were no differences in the breast blister incidence, perosis and incidences of curled toe among litter materials. Incidences of foot pad lesions appeared slightly higher in the CS than the WS, but WS-CS was even lower.

Dust and ammonia levels, room temperature and relative humidity for the periods between 4 and 8 weeks of age are presented in Table 5. CS seems to produce less total dust than the WS except for the sixth week readings when it was slightly higher. WS-CS produced less total dust than either WS or CS during 6 and 8 weeks. Ammonia absorption data revealed no real differences in ammonia levels between the types of litter; however, as the birds were reared longer on the litter materials, both ammonia and dust levels tended to increase as expected.

Average litter caking score, incidence of breast blisters and comments of litter conditions for Experiment 4 are presented in Table 6. There were no differences in average litter caking scores between the litter materials at bird densities 0.75 ft^2 and 1.08 ft^2 (0.009 and 0.013 $meters^2$) per broiler. Some caking and wet litter were noticed around the waterers at 8 weeks for these two bird densities. At 0.6 ft^2 (0.007 $meter^2$) per broiler, litter caking started at 5 and 6 weeks for the CS and WS-CS, respectively. WS initial caking was not observed until 7 weeks. All pens with the three types of litter was severely caked at 8 weeks. No valid comparison on incidence of breast blisters can be made from the data since the numbers of birds examined from one density group to another were not the same.

Three properties of WS and CS were examined in the laboratory, and the data are listed in Table 7. Average moisture uptake for the

CS was approximately three and one-half times greater than WS. The moisture release of both litter materials was rapid. The high moisture uptake and rapid release are good properties of a litter material. CS seems to have these properties. Temperatures at which the first sign of combustion were noticed for CS and WS were approximately 175°F (79.4°C). Combustibility of these materials are important because broiler farmers use artificial heat sources such as natural gas, electric hovers and infrared heat lamps to brood chicks.

From the data obtained in these experiments, chopped cereal straw may be used for broiler litter; however, this litter material should not be used with less than 0.75 ft^2 (0.009 m^2) per bird.

SUMMARY

Four broiler experiments were carried out to determine the feasibility of chopped cereal straw as a source of broiler floor litter. CS was compared with WS and WS-CS. CS (5 centimeters long) and WS-CS were comparable to WS in producing average broiler body weights, feed conversion, number of breast blisters, dust and ammonia levels. At bird density of 0.6 ft^2 (0.007 $meter^2$) per bird, all three types of litter were caked at 8 weeks; however, CS started caking first followed by WS-CS. At 0.75 and 1.08 ft^2 (0.009 and 0.013 $meters^2$) per bird, pens with CS, WS and WS-CS did not cake severely. CS absorbed three and one-half times more water than WS, and both litter materials released water rapidly. CS and WS appear to have the same ignition points. Chopped cereal straw may be used for broiler litter; however, with not less than 0.75 ft^2 (0.009 m^2) per bird.

REFERENCES

1. Steel, R. G. D. and J. H. Torrie, 1960. Principles and Procedures of Statistics, McGraw-Hill Book Company, Inc. New York, NY.

2. Ruszler, P. L. and J. R. Carson, 1974. Methods of Evaluating The Potential Usefulness of Selected Litter Materials. Poultry Science 53:1420-1427.

Table 1. Composition and calculated analyses for the broiler feeds used

Ingredients	Experiments 1 & 2 Single-stage	Experiments 3 & 4 Starter	Experiments 3 & 4 Finisher
	%	%	%
Yellow corn	64.95	55.74	60.62
Soybean meal - 47.5%	29.00	32.25	27.50
Meat and bone meal (50%)	-	5.00	5.00
Animal fat	-	4.00	4.00
Dehydrated alfalfa meal - 17%	2.00	1.00	1.00
Dicalcium phosphate (32% Ca, 18% P)	1.85	.75	.75
Limestone flour	1.60	.60	.50
Salt, iodized	.30	.25	.25
Vitamin premix[1]	.20	.20	.20
Trace mineral premix[2]	.05	.05	.05
Methionine hydroxy analogue (90%)[3]	.05	-	-
DL-methionine - 98%	+	.16	.13
Zinc bacitracin[4]	+	+	+
Zoamix[5]	-	+	+
Amprol[6]	+	-	-
	100.+	100.+	100.+
Calculated analyses:			
Protein, %	21.0	22.9	21.1
Metabolizable energy, kcal/kg	2977.	3100.	3149.
Calcium, %	1.23	1.16	1.11
Available phosphorus, %	.45	.54	.53
Methionine + cystine, %	.55	.90	.82

1. Supplies per kg of diet: 3300 I.U. vitamin A; 1100 I.C.U. vitamin D_3; 3.3 mg. riboflavin; 5.5 mg. d-pantothenic acid; 22 mg. niacin; 191 mg. choline; 5.5 mcg. vitamin B_{12}; 1.1 I.U. vitamin E; .55 mg. vitamin K; .22 mg. folacin.
2. Supplies per kg of diet: 60 mg. manganese; 20 mg. iron; 2 mg. copper; 1.2 mg. iodine and 27.5 mg. zinc.
3. Provided gratuitously by Monsanto Chemical Co., St. Louis, MO.
4. Provided gratuitously by Commercial Solvent Co., Terra Haute, IN.
5. Provided gratuitously by Dow Chemical Co., Midland, MI and supplied at the level of 0.05%.
6. Provided gratuitously by Merck and Co., Rahway, NJ and supplied at the level of 0.05%.

Table 2. Average body weight and feed conversion of broilers grown on wood shavings and chopped cereal straw litter for 8 weeks.

Litter types	Experiment 1 (12/74) F Bird density	Body wt.[1]	Feed conversion[1]
	ft^2/bird	lbs	
Wood shavings (WS)	0.74	4.25[a]	2.30[a]
Chopped straw (5cm long) (CS)	0.74	4.29[a]	2.33[a]

Litter types	Experiment 2 (1/75) C Bird density	Body wt.[1]	Feed conversion[1]
	ft^2/bird	lbs	
Wood shavings (WS)	1.08	4.12[a]	2.64[a]
Chopped straw (5cm long) (CS)	1.08	4.11[a]	2.67[a]

Litter types	Experiment 3 (12/75) Bird density	Body wt.[1]	Feed conversion[1]	Litter moisture (weeks) 0	 4-8
	ft^2/bird	lbs		%	%
Wood shavings (WS)	1.08	4.42[a]	2.23[a]	6.6	19.6
Chopped straw (5cm long) (CS)	1.08	4.48[a]	2.18[a]	7.7	23.1
WS:CS, 1:1	1.08	4.49[a]	2.21[a]	7.1	20.8

HSN:3-43

1. Values with different superscripts are significantly different at $P < 0.05$.

Table 3. Influence of three broiler densities and three litter materials on body weight and feed conversion at 8 weeks of age.

Experiment 4

Litter types	Bird densities	Ave. body wt.[1]	Ave. feed conversion[1]
	ft^2/bird	lbs	
Wood shavings (WS)	0.6	4.23[a]	2.24[a]
Chopped straw (CS) (5cm long)	0.6	4.22[a]	2.18[a]
WS-CS, 1:1	0.6	4.22[a]	2.21[a]
Wood shavings (WS)	0.75	4.24[a]	2.17[a]
Chopped straw (CS) (5cm long)	0.75	4.41[a]	2.18[a]
WS-CS, 1:1	0.75	4.45[a]	2.13[a]
Wood shavings (WS)	1.08	4.39[a]	2.15[a]
Chopped straw (CS) (5cm long)	1.08	4.44[a]	2.16[a]
WS-CS, 1:1	1.08	4.28[a]	2.17[a]
Wood shavings (WS)	all densities	4.28[a]	2.19[a]
Chopped straw (CS) (5cm long)	all densities	4.36[a]	2.17[a]
WS-CS, 1:1	all densities	4.32[a]	2.17[a]

1. Values with different superscripts are significantly different at $P < 0.05$.

Table 4. Incidence of breast blisters and other abnormalities observed in Experiment 3.

Litter types	Incidence of breast blisters (blisters/examined)	Other abnormalities
Wood shavings (WS)	0/69	14 foot pad lesions 3 perosis 1 curly toe
Chopped straw (CS)	2/70	17 foot pad lesions 2 perosis 3 curly toe
WS-CS, 1:1	0/68	9 foot pad lesions 3 perosis 3 curly toe

Table 5. Dust particle counts of three litter materials in a broiler house (Experiment 3).

Litter types	Age	Ave. particle counts, X $10^3/ft^3$ air* Particle size, microns						Ave. ammonia absorption	Room	
		.5-1.0	1-2	2-3	3-5	5-10	Total		Temp.	R.H.
	(weeks)							(mg/m^2hr)	(°F)	(%)
Wood shavings (WS)		300	200	800	1090	470	2860	25.5	60	68
Chopped straw (CS)	5	100	300	400	1290	490	2480	26.5	60	68
WS-CS, 1:1		0	400	700	1240	600	2940	27.4	60	68
Wood shavings (WS)		200	300	1100	1700	750	4050	57.8	56	55
Chopped straw (CS)	6	500	150	1300	1540	710	4200	49.1	56	55
WS-CS, 1:1		0	200	800	1410	640	3050	52.5	56	55
Wood shavings (WS)		0	400	1300	2120	1130	4950	61.8	64	66
Chopped straw (CS)	7	0	400	1400	1780	940	4520	59.5	64	66
WS-CS, 1:1		0	500	1300	2000	1050	4850	62.7	64	66
Wood shavings (WS)		0	400	1700	2400	1150	5650	108.4	64	75
Chopped straw (CS)	8	0	900	1600	2100	960	5560	101.8	64	75
WS-CS, 1:1		100	700	1100	2020	810	4730	113.4	64	75

*Particle counts are averages of four samples.

Table 6. Influence of three broiler densities and three types of litter on litter caking score, litter condition and breast blister incidence (Experiment 4).

Litter types	Bird density	Ave. caking scores[1] weeks 4	5	6	7	8	Breast blister[2] incidence	Comments on litter condition
	ft^2/bird							
Wood shavings (WS)	0.6	1	1	1	2	3	7/85	Caked around waterer
Chopped straw (CS) (5cm long)	0.6	1	2	1	2	4	3/85	Matted and caked around waterer
WS-CS, 1:1	0.6	1	1	2	2	3	16/86	Litter wet and whole pen caked
Wood shavings (WS)	0.75	1	1	1	1	1	1/34	Caked around waterer
Chopped straw (CS) (5cm long)	0.75	1	1	1	1	2	1/68	Wet litter from waterer
WS-CS, 1:1	0.75	1	1	1	1	1	5/73	Matted and caked around waterer
Wood shavings (WS)	1.08	1	1	1	1	1	1/48	
Chopped straw (CS) (5cm long)	1.08	1	1	1	1	1	1/48	
WS-CS, 1:1	1.08	1	1	1	1	1	0/47	

1. Caking score: 1 = pen litter not caked
   5 = over 2/3 of pen caked
   Caking scores are averages of 3 pens per treatment.
2. Number of birds with breast blisters/number of birds examined.

Table 7. Three properties of wood shavings and chopped cereal straw.

Litter types	Ave. moisture uptake for 3 days	Moisture[1] released from soaked litter	Ignition temp.[2]
	gm	%	°F
Wood shavings (WS)	30.0	100	175
Chopped straw (CS) (5cm long)	101.5	100	175

1. Moisture released the first day of three days of drying.
2. Temperature at which first sign of combustion was noticed.

HSN 3-46 & 47