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Effect of Different Litters Supplemented with Chemical Agents on Broiler Carcass Components

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Abstract

The objective of the study was to ascertain the effects of the litter type and its chemical supplementation on carcass characteristics, in broilers. An experiment was conducted based on a 3×3 factorial arrangement with three litter treatments (sand, wood shavings, and paper) and three chemical reagent treatments (no reagent, lime, and bentonite) with a total of 270 1-day old male Ross 308 broiler chicks, which were slaughtered at 42 days. Yields were not significantly affected (P<0.05) by the litter type, but there were statistically significant differences according to reagent treatments.

Keywords: Bentonite; Lime; Sand; Shavings; Chick; Crop

Introduction

Broiler litter is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding in poultry operations. This term is also used to refer to unused bedding materials. Poultry litter is used in confinement buildings used for raising broilers, turkeys and other birds. Common bedding materials include wood shavings and sawdust [1], peanut hulls [2], gypsum [3], rice and wheat straw [4], and other dry, absorbent, low-cost organic materials. Sand is also occasionally used as bedding [5-7]. The bedding materials help absorb moisture, limiting the production of ammonia and harmful pathogens [2,8], and thus may affect the body weight and immunity of broiler chicks. The materials used for bedding can also have a significant impact on carcass quality and bird performance [6,8]. Factors which can influence the efficiency of a type of litter include particle size, moisture content and buildup, rate of caking, and other physical characteristics of the material used [1]. However, there are few data on the yield of broilers reared on chemically treated litter materials. The objective of the experiment presented here was to evaluate the carcass characteristics of male broiler chicks when using different materials as a bedding source, treated with different chemical products. In this study, the effects of three different litters (sand, wood shavings, and paper) supplemented with three chemical reagents (no reagent, bentonite, and lime) on broiler performance were investigated. The objective of the study was to ascertain the effects of the litter and its chemical supplementation on carcass characteristics, in broilers.

Material and Methods

Facility and birds

All animal protocols for this experiment were reviewed and approved by the Institutional Animal Care and Use Committee at the Islamic Azad University, Rasht Branch, Iran. A total of 270 1-day old male Ross 308 broiler chicks were purchased from a local hatchery. The chicks were randomly allotted to 27 wire-floored land cages (100×150 cm) with 10 males per cage.

Treatments

The experiment was conducted based on a 3×3 factorial arrangement with three litter treatments (sand, wood shavings, and paper) and three chemical reagent treatments (no reagent, lime, and bentonite). There were nine treatments with three replicates per treatment. The nine treatments included:

Treatment 1: Litter (sand) supplemented (no reagent)

Treatment 2: Litter (sand) supplemented (bentonite)

Treatment 3: Litter (sand) supplemented (lime)

Treatment 4: Litter (wood shaving) supplemented (no reagent)

Treatment 5: Litter (wood shaving) supplemented (bentonite)

Treatment 6: Litter (wood shaving) supplemented (lime)

Treatment 7: Litter (paper) supplemented (no reagent)

Treatment 8: Litter (paper) supplemented (bentonite)

Treatment 9: Litter (paper) supplemented (lime)

Bentonite and lime were used at 3 and 1.5 kg/m^3 litter for all related treatments, respectively.

Diet and water

The formula and chemical composition of experimental diets are presented in Tables 1 and 2. The experimental period was 42 d and feed was supplied to birds as *ad libitum* basis during the entire experiment. Water was available at all times. Light was provided for 23 h per 24 h day-night cycle.

Measurement of carcass and gastrointestinal organ traits

At the age of 42 days and after 4 hours of fasting for complete evacuation of the gut, three birds from each replicate were selected. These animals were used for measuring the carcass yield and distribution of meat and gastrointestinal tract characteristics. Birds were fully pecked by the dry pecking method. The feet were separated from the carcass at the tibio-tarsal joint. The neck, wingtips, gut and liver were removed and the empty or edible carcass was weighed

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Days	1-7	8-15	16-23	24-35	36-42
Corn	454	510	500	460	436
Wheat	90	100	140	190	255
Soybean meal	385	330	307	298	264
Soybean oil	20	20	20	20	20
Sodium bicarbonate	1.2	1.4	1.4	2	1.5
Ca%22 P%18	23	10	10	6	6
Oyster powder	12	-	-	-	-
Salt	2.3	2	1.8	2	1.7
Mineral Mixture[1]	2.5	-	-	2.5	2
Vitamin Mixture[2]	2.5	2.9	2.5	2.5	2
DL-Methionine	2.62	3.1	2	2.5	1
L-Lysine-Hydro-Chloride	2	2	2	0.5	0.5
Threonine	0.9	0.5	0.5	-	-
$CaCO_3$	-	15	12	12	10
Coccidiostat salinomycin	0.5	0.5	-	-	-
Multi-enzyme	0.5	-	-	-	-
Avizyme enzyme	-	0.5	0.5	0.5	-
Physasyme enzyme	-	0.1	0.1	0.1	0.1
Turmeric (*Curcuma longa*)	-	1.5	-	1.5	-
Probiotics (Technomos)	0.5	-	-	-	-
Anti fungus toxin binder	0.5	0.5	0.2	0.2	0.2

Table 1: Feed ingredients of the diets used in the experiment during growth (expressed in days).

[1]Calcium Pantothenate: 4 mg/g; Niacin: 15 mg/g; Vitamin B6: 13 mg/g; Cu: 3 mg/g; Zn: 15 mg/g; Mn: 20 mg/g; Fe: 10 mg/g; K: 0.3 mg/g

[2]Vitamin A: 5000 IU/g; Vitamin D3: 500 IU/g; Vitamin E: 3 mg/g; Vitamin K3: 1.5 mg/g; Vitamin B2: 1 mg/g

and intestinal segment dimensions were recorded. Care was taken to choose the most representative male birds with respect to body weight compared to the group mean body weight.

Various parts of the carcasses were dissected and weighed separately. Parts included the head, breast, wings, femurs, abdominal fat, pancreas, gizzard, crop, lungs, heart, liver, kidneys, and digestive tract. The length, width, and wall thickness of the different gut segments were also recorded. The head, breast, wings, abdominal fat, pancreas, full gizzard, full crop, lung, heart, liver, kidney, spleen, bursa fabricius, brain, testicles, duodenum, ileum, jejunum, colon, left and right cecum, vertebral column with the remaining neck, and proventriculus were all weighed. Economically relevant parts of the carcass were also analyzed. First, the breast muscle including the skin and sternum were dissected free from the carcass. Legs (thighs and drumsticks) were dissected by ex-articulation at the hip joint and dissecting tissue from the iliac bone. All abdominal fat, including that around the rectum, gizzard and proventriculus, was collected. The length (cm), width (mm) and wall thickness (mm) of the duodenum, ileum jejunum, left and right cecum, and colon were recorded.

The total weight of all dissected parts and the weights of various segments of the digestive tract were related to the totally eviscerated carcass. Ratios were calculated according to the following formula: [weight of component(s)/eviscerated carcass weight)×100].

Statistical analysis

Data were analyzed by analysis of variance using a 3×3 factorial arrangement with three litter (sand, wood shavings, and paper) and three chemical reagent treatments (no reagent, lime, and bentonite), using a two-way NPMANOVA procedure with a permutation of 9,999. Data were analyzed by PAST (Paleontological Statistics Software Package for Education and Data Analysis). An α-value of 0.05 was used to assess significance among means.

Results

The results of the two-way NPMANOVA are summarized in Table 3. The yields of broilers at 42 days were not significantly affected ($P<0.05$) by the litter type, but there were statistically significant differences according to reagent treatments (Tables 4 and 5).

Discussion

Low supplies, high cost, and unavailability of suitable materials have encouraged the search for alternative litter materials. As this study indicates, sand, wood shavings, and paper are substitute bedding materials with a similar degree of success. We think that chemical treatment of litter can improve litter quality and hence can have an effect on the welfare (and behavior) of broilers. When broiler welfare increases, production and its components (such as muscle growth, carcass quality, etc.) are improved. Therefore, there is an indirect relationship between chemical treatment of the litter and carcass characteristics.

There are specific practices that must be followed to properly maintain the litter and maximize the health and productivity of the

Days	1-7	8-15	16-23	24-35	36-42
Dry Matter (%)	85.470	86.390	86.760	87.040	87.249
Metabolizable energy (kcal/kg)	2.924	3.058	3.096	3.100	3.145
Crude protein (%)	22.091	19.573	18.939	18.727	17.794
Ether Extract (%)	4.274	4.458	4.473	4.407	4.405
Linoleic Acid (%)	2.222	2.333	2.325	2.263	2.235
Crude fiber (%)	2.712	2.649	2.633	2.630	2.601
Calcium (%)	1.064	0.888	0.769	0.684	0.601
Total Phosphorus (%)	0.830	0.571	0.569	0.496	0.492
Available Phosphorus (%)	0.148	0.141	0.139	0.138	0.135
Potassium (%)	0.957	0.867	0.835	0.827	0.780
Chloride (%)	0.219	0.201	0.189	0.173	0.155
Manganese (mg/kg)	404.795	27.440	26.781	401.594	326.492
Sodium (mg/kg)	0.118	0.103	0.096	0.104	0.094
Zinc (mg/kg)	326.935	24.050	24.155	324.500	264.745
Choline (g/kg)	1.650	1.582	1.521	1.526	1.445
Folic acid (mg/kg)	2.153	2.070	1.911	1.883	1.667
Arginine (%)	1.564	1.400	1.340	1.322	1.232
Glycine (%)	1.003	0.917	0.895	0.900	0.869
Serine (%)	1.179	1.070	1.035	1.029	0.977
Glycine + Serine (%)	2.567	2.317	2.237	2.226	2.109
Histidine (%)	0.617	0.562	0.539	0.529	0.494
Iso-Leucine (%)	0.999	0.906	0.877	0.875	0.834
Leucine (%)	1.977	1.838	1.780	1.753	1.663
Lysine (%)	1.442	1.298	1.244	1.115	1.034
Methionine (%)	0.613	0.636	0.518	0.564	0.402
Cyseine (%)	0.382	0.355	0.347	0.347	0.335
Methionine + Cysteine (%)	0.995	0.991	0.866	0.910	0.737
Phenylalanine (%)	1.137	1.037	1.008	1.007	0.964
Tyrosine (%)	0.925	0.840	0.809	0.801	0.755
Phenylalanine + Tyrosine (%)	2.062	1.877	1.817	1.808	1.720
Threonine (%)	0.884	0.802	0.771	0.761	0.714
Tryptophan (%)	0.328	0.293	0.282	0.282	0.267
Valine (%)	1.092	1.000	0.970	0.965	0.921

Table 2: Nutrient analysis of the diets used in the experiment during growth (expressed in days).

Source	Sum of sqrs	df	Mean square	F	p
Litter	1.26E-05	2	6.29E-06	1.1804	0.3850
Treatment	3.20E-05	2	1.60E-05	3.0040	0.0045
Interaction	8.03E-06	4	2.01E-06	0.3766	0.9462
Residual	9.59E-05	18	5.33E-06		
Total	0.000149	26			

Table 3: Results of two-way NPMANOVA (permutation N=9,999) using a 3×3 factorial arrangement with three litter types (sand, wood shavings, and paper) and three chemical reagent treatments (no reagent, lime, and bentonite).

No reagent	BW	Defeathered	Full abdomen	Empty	Eviscerated
Mean	2848.3	2576.7	2301.1	1841.7	80.0
StD	192.5	413.7	127.2	122.4	3.1
CV	6.8	16.1	5.5	6.6	3.9
Bentonite					
Mean	3031.7	2554.9	2377.2	1923.3	80.9
StD	280.5	254.7	242.7	191.0	1.5
CV	9.3	10.0	10.2	9.9	1.8
Lime					
Mean	3075.0	2615.0	2446.7	2049.4	83.7
StD	183.2	158.5	160.6	148.6	1.3
CV	6.0	6.1	6.6	7.3	1.5

Table 4: Results (yield) for the entire carcass between three different chemical treatments (no reagent, bentonite and lime). Means are expressed in g.
BW=Body Weight; Defeathered=Defeathered body weight; Full abdomen=Full abdomen carcass weight; Empty=Empty abdomen carcass weight; Eviscerated=Eviscerated carcass weight; CV=Coefficient of Variation (%).

No reagent	Head	Breast	Drumsticks (thighs)	Wings	Abdominal fat	Pancreas	Gizzard	Lungs	Heart	Kidneys	Brain	Testes	Back thoracic vertebrae	Pro ventriculus	Neck	Crop	Duodenum	Jejunum	Ileum	Colon	Right cecum	Left cecum	Rectum
Mean	1.9	24.7	29	6	1.5	0.3	3	0.5	0.6	0.6	0.1	0	2.7	0.5	2.9	1.4	1.1	3.2	0.8	0.1	0.3	0.3	0.1
StD	0.2	7.2	2.9	0.7	0.4	0	0.4	0.1	0.2	0.1	0	0	0.6	0.1	0.4	1.9	0.3	0.8	0.2	0	0.1	0.1	0
CV	11.8	29.2	10.1	11.6	24	14.7	13.2	11.4	28.1	22.8	9.8	28.4	23.4	19.9	13.1	136.6	24.1	24.3	21	25.4	32	35	47.7
Bentonite																							
Mean	1.9	27	30.5	6.3	2.1	0.3	2.9	0.5	0.6	0.7	0.1	0	2.4	0.5	3	1	1	3.7	0.8	0.1	0.4	0.5	0.1
StD	0.1	1.8	1.6	0.2	0.5	0	0.4	0.1	0.1	0.1	0	0	0.3	0.2	0.2	0.7	0.2	0.8	0.2	0	0.1	0.1	0
CV	5.6	6.5	5.1	3.1	21.6	13.4	14.6	10.9	23.5	11.9	14.4	25.9	14.2	33.3	5.2	66.4	15.4	22.8	24.7	37.2	15.1	21	47.1
Lime																							
Mean	2	30	31.3	6.5	1.6	0.3	2.5	0.5	0.7	0.6	0.1	0	2.5	0.5	3	0.6	0.9	3.2	0.7	0.1	0.3	0.4	0.1
StD	0.1	2.1	0.6	0.4	0.4	0	0.3	0.1	0.1	0.1	0	0	0.3	0.1	0.2	0.2	0.2	1	0.1	0	0.1	0.1	0
CV	6.1	7	2	6.4	25.5	8.6	13.7	17.4	19.3	12.5	9.8	41.3	13.5	10.7	5.6	41.6	16.3	31.7	21	15.9	15.9	17.1	21.9

Table 5: Results (yields) for parts of the carcass between three different chemical treatments (no reagent, bentonite and lime). Means are expressed in %.

flocks raised on it. Many factors must be considered in successful litter management, including the time of year, depth of the litter, floor space per bird, feeding practices, disease, the kind of floor, ventilation, watering devices, litter amendments, and even the potential fertilizer value of the litter after it is removed from the house. Most poultry are grown on dirt floors with some type of bedding material. Concrete floors and some specialized raised flooring are used at some facilities. In many areas of the country, shavings from pine or other soft woods have historically been the bedding of choice for poultry production. Regionally, other materials have been the bedding material of choice due to regional cost and availability, such as rice hulls in the lower Mississippi River poultry production areas of Arkansas and Mississippi.

Broiler farmers consider a number of factors when determining which material to use as bedding in their facilities, with cost and availability being the major considerations. Bedding materials generally need to be very absorbent, and must have a reasonable drying time. Many paper products, for instance, absorb moisture well but do not dry out appropriately. The material should also have a useful purpose once it has been used as a bedding material. Without a useful purpose for the used litter, poultry growers would need to dispose of unmanageable quantities of old litter. Large accumulations of litter stored unused for long periods of time are not ecologically acceptable even on a small scale, and would be non-sustainable from an industrial perspective.

Poultry bedding materials also have to be reasonably available. Some materials may meet industrial goals once under the birds, but if it is difficult to obtain, it will not find favor as a poultry litter. Finally, if a material is not cost competitive with currently utilized materials, it will also not be used as a litter material. However, if the new material has increased value once removed from the poultry house compared to current litters, or if the current litter material becomes difficult to obtain or the quality decreases, poultry growers may decide to use the new litter material.

Bedding material must not be toxic to poultry or to poultry growers. The effect on other livestock, pets, wildlife, and even plants must also be considered. Poultry can consume as much as 4% of their diet as litter; therefore, any bedding material must not contain contaminants such as pesticides or metals. Consumption by the birds due to litter eating

or other bird behavior could affect production and potentially cause the meat or rendered products to become unusable. Pine shavings have been the bedding of choice because of performance, availability, and cost.

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