IJAAAR 9 (1&2): 150-156, 2013 *International Journal of Applied Agricultural and Apicultural Research*

Lesions in Broiler Chicks Following Experimental Contamination with Battery Waste

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Abstract

The objective of the present study was to investigate the effect of feed contamination with battery waste on the performance, organs weights as well as the histology of some internal organs of broiler chicks. A total of 120 1-d old broiler chicks were allotted to four dietary treatments in a completely randomized design. The experiment lasted 21 days. The dietary treatments include a control diet with no battery waste (D1). Battery waste was included at 0.5%, 1.0% and 1.5%, in diets 2, 3, and 4, respectively. There were four treatments with three replicates per treatment of 10 birds per replicate. Data collected were used to evaluate feed intake, weight gain, and efficiency of feed utilization. The weights of liver, pancreas, kidney, heart, and lungs were also recorded and tissue samples of each collected for histological examination. Average daily food intake (ADFI), average daily gain (ADG), and feed conversion efficiency (FCE) were not influenced by the dietary treatments (P > 0.05). However, increasing the level of battery waste from 0.5% to 1.5% tended to increase ADFI. Weights of the kidney, liver, gizzard and heart were not influenced by the levels of contamination with battery waste (P > 0.05). Increasing the level of contamination from 0.5% to 1.5% resulted in numerical increases in the weights of the liver, and kidney. The weight of the spleen in chicks fed diets 1, 2, and 3 were similar and was significantly (P<0.05) lower than those fed diet 4. Histological results showed a range in the damage of the kidney and liver of chicks fed different level of inclusion of battery waste, this vary from mild to severe depending on the inclusion level. The kidney had mild to severe congestion of glomeruli and distention of the capillary vessels with numerous thrombi with increasing contamination with battery waste. The liver was characterized by marked coagulative necrosis and degeneration of the hepatocytes and was more pronounced in chicks fed diet 4. The structural alterations were attributed to intake of lead in diets contaminated with battery waste. It was concluded that contamination of feed for broilers chicks beyond 0.5% is detrimental to the performance of broiler chicks.

Introduction

Hazardous wastes are generated by nearly all manufacturing industries. Disposal of such wastes result in a serious pollution to the environment; a concern for human health challenges. Among these potential feed contaminants is battery waste which is found to be loaded with heavy metals. According to Hassan *et al*. (1998) "heavy metals" denotes the potential toxic source, and those elements generally included in this classification by nutritionists are cadmium, lead, mercury, vanadium, copper, cobalt, iron, manganese, magnesium and zinc. Some of these elements play essential roles in the physiological and biochemical processes in the living cells, when present in the required amount.

Dietary maximum tolerable levels have been generated which can serve as guidelines in ensuring safety for both domestic animals and humans. Lead poisoning generally results from well know occupational exposure; however, in some instances it may arise from unexpected sources (Sipos *et al*., 2003). Jain *et al*. (1985) reported that lead may cause colicky abdominal pain, weight loss and elevation of liver function. Similarly, iron, copper, and cobalt are essential in the formation of haemoglobin in animals. When present in lethal doses, they result in deleterious effects, such as reduced growth performance, malfunction of vital organs such as liver, kidney and spleen and consequently death of the animal. Although heavy metal toxicity has been extensively studied in animals, there is a dearth of information on the effect of battery waste contamination on the physiology of animals. A timely evaluation of the effects of exposure to animals will provide information relating to the disposal and management of the waste. Similarly, such information can be used to model human response to exposure to heavy metals. The present study was designed to investigate the effects of graded levels of battery waste on the performance, organ weights and histological responses of some internal organs of broiler chicks.

Materials and Methods

Experimental site: The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State.

Source of test material: The test material was obtained from an industrial site in Kumapayi village, a suburb of Ibadan city where Exide battery company is located. Other feed ingredients used for the experiment were obtained from a commercial feed mill.

Experimental diets

Isocaloric and isonitrogenous diets were formulated by incorporating 0.5%, 1.0% and 1.5% battery waste into broiler chicks starter diet. A corn-soybean meal diet served as control. All diets were supplemented with methionine and lysine to meet NRC (1998) requirements. The experimental diets and their proximate compositions are presented in Table 2.

Experimental birds

One hundred and twenty unsexed 1-d old broiler chicks of the Anak strain weighing 40 ± 0.05g/bird (mean ± SD) were used for this study. The chicks were randomly divided into 4 groups of 30 birds, and each group was assigned to 1 of the 4 dietary treatments (control, 0.5%, 1.0% and 1.5% battery waste) in a completely randomized design. A corn-soybean diet served as control. Each group was further subdivided into 3 replicates of 10 birds and each replicate kept on litter in pens measuring 2.4 m × 2.6 m. Experimental diets were fed from 1 to 21 days. Feed and water were provided *ad libitum,* and uniform light was provided continuously.

Measurements

Feed intake was recorded daily, and body weight was recorded weekly. Feed consumption, weight gain, and feed conversion efficiency were used as measures of chick performance. The study lasted for 21 d. On d 21, 2 birds per replicate (6 birds/treatment) were randomly selected, fasted for about 18 h to empty their gastrointestinal tract weighed individually, slaughtered, and eviscerated. The weights of the liver, kidney, heart, and lungs were recorded. For histological analysis, tissue samples of each organ were taken, immersed in formalin (1%), fixed in Bouin's solution for 24 h, and embedded in paraffin wax. Sections from each organ were made at a thickness of 5 µm with a microtome, stained with hematoxylineosin, and examined by light microscope.

Sample preparation and chemical analysis

Battery waste samples along with the diet samples were finely ground in a grinder to pass through 1-mm screen and thoroughly mixed prior to chemical analyses. Dry matter and organic matter were determined according to AOAC (1990). Nitrogen was determined using a N analyzer (Model NS – 2000; LECO Corporation, St Joseph, MI, USA). Battery waste samples for heavy metals analysis were ashed and digested according to AOAC (1990) procedures and read on a Varian Inductively Coupled Plasma Mass Spectrometer (Varian Inc., Palo Alto, CA, USA).

Data Analysis

Data collected were analyzed as a completely randomized design using the GLM procedures of SAS (SAS Inst. Inc., Cary, NC). When a significant *F*-value for treatment means ($P < 0.05$) was observed in the ANOVA, treatment means were compared using Duncan's multiple range test (Duncan, 1955).

Results and discussion

Minerals, whether macro or micro, are essential components of animal diets. They are required for various biochemical and physiological processes in animal body. However, all mineral elements can be toxic to the animals when supplied in concentrations higher than their requirements. Therefore, minerals must be supplied in the required quantities that will promote maximum performance of an animal. The concentrations of heavy metals in battery waste are shown in Table 1. Lead was present in the highest concentration of 540.13mg/L followed by copper (9.46mg / L). Nickel was the least, with a concentration of 0.10 mg/L. The concentrations of all the heavy metals determined in the battery waste, except lead, were within the maximum dietary tolerable levels recommended for poultry by NRC (1980). The analyzed proximate composition of the basal diet (Table 2) showed that the nutrient contents were 21.97 % CP, 3.78 % crude fat and 4.13 % crude fibre. The analyzed crude protein content was lower than the formulated value. This could be due to variations in the ingredients used in formulating the diets as compared to NRC (1998) nutrient contents of major ingredients. The fibre content fell within the level recommended for broiler chicks.

Performance characteristics of broiler chicks fed diets contaminated with battery waste are presented in Table 4. Average daily feed intake (ADFI), average daily gain (ADG), and feed conversion efficiency (FCE) were not influenced by the dietary treatments ($P>0.05$). However, increasing the level of battery waste from 0.5 % to 1.5 % tended to increase ADFI.

These findings are in agreement with the report of other authors (Hermayer *et al*., 1977, Damron *et al*., 1969). Furthermore, feed intake during the experiment was not reported and, therefore, it was not possible to convert dosages to a dietary concentration basis (Henry and Miles, 2001). Di Michelle (1984) reported that dietary components such as sodium citrate, ascorbic acid, amino acids, vitamin D, fat and lactose can bind to lead, and thus, enhance the absorption of lead.

The relative weights of the liver, kidney, spleen, gizzard and the heart as percentages of carcass weight are shown in Table 5. Weights of the liver, kidney, gizzard and heart were not influenced by the different levels of inclusion of battery waste. However, increasing the level of contamination from 0.5 % to 1.5 % resulted in numerical increases in the weights of the liver, and kidney. Dietary treatments significantly ($P<0.05$) influenced the weights of the spleen. Compared with the other dietary treatments, weights of the spleen was higher in birds fed diet 4 (1.5 %). Weights of the spleen in birds fed the control diet and those that were fed diet 2 were similar ($P>0.05$).

Histological results showed a range in the damage of the kidney and liver of chicks fed different levels of inclusion of battery waste; these vary from mild to severe depending on the inclusion level. The kidney showed mild to severe congestion of glomeruli and distention of the capillary vessels with numerous thrombi with increasing contamination with battery waste.

Similarly, NRC (1980) reported that the clinical signs of lead poisoning include feed refusal, anaemia, intestinal problems and kidney dysfunction. Sipos *et al*. (2003) reported that higher concentrations of lead caused severe periportal inflammation in chicken liver. This author further concluded that long-term lead exposure could result in liver damage in animals and humans. Our results showing marked coagulative necrosis and degeneration of the hepatocytes and were more prominent in chicks fed diet 4, and this is in agreement with the report of others (Blazovics *et al*., 2001; Sipos *et al*., 2003). The structural alterations were attributed to intake of lead in diets contaminated with battery waste. It was concluded that contamination of broiler feed chicks beyond 0.5 % is detrimental to the performance of broiler chicks. These results affirm the earlier observations of Di Michelle (1984) and Ercal (2001). In the present study, contamination of feed with battery waste caused vascular necrosis and degeneration of the hepatocytes in the kidney and liver. The damage ranged from mild to severe. This observation is consistent with the reports of Hathcock *et al*. (1966) and Sell *et al*. (1986), who observed high concentrations of heavy metals in the liver and kidney, which causes degeneration of the hepatocytes. The severe degeneration of the hepatocytes and vascular necrosis found in the liver and the severe distention of the capillary vessels were observed in chicks fed diet containing 1.5 % contamination with battery waste. Birds that received 0.5 % and 1.0 % battery waste contamination showed mild and moderate vascular necrosis and distention of the capillary vessels respectively. In the control diet (Diet 1) there were no changes in the kidney and liver cells.

Table 1: Concentration of heavy metals in battery waste

Minerals	**Concentrations (mg/L)**
Lead	540
Cadmium	0.43
Manganese	3.11
Copper	9.46
Zinc	6.50
Nickel	0.10
Magnesium	7.17

Table 2: Composition of the experimental diet (%)

	Dietary treatments			
Ingredient	Control (0%) D1	Diet 2 (0.5%)	Diet 3 (1.00%)	Diet 4 (1.5%)
Maize	50.00	50.00	50.00	50.00
Soybean meal	36.50	36.00	35.50	35.00
Fish meal	5.00	5.00	5.00	5.00
Wheat offal	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Battery waste	0.00	0.50	1.00	1.50
Calculated nutrient content (%)				
Crude protein	23.40	23.40	23.40	23.40
Calcium	1.3	1.3	1.3	1.3
Phosphorus	0.5	0.5	0.5	0.5
ME Kcal/kg	2890	2890	2890	2890

Premix composition are 15,000,000 IU Vitamin A, 3,000,000,IU Cholecalciferol, 70g Vitamin E, 3g Thiamine, 6g Riboflavin, 5g Pyridoxine, 0.03g Choline chloride, 1g Folic acid, and 12g Ca- D pantothanate / 12kg premix.

Table 3: Analyzed proximate composition of basal diet

Parameters	Percentage (%)
Dry matter	90.66
Crude protein	21.97
Crude fat	3.78
Crude fibre	4.13
Ash	9.82

Table 4: Performance of broiler chicks fed diet contaminated with battery waste (g/b/d)

	Diet 1(0%)	Diet 2(0.50%)	Diet 3(1.00%)	Diet 4(1.50%)	SEM	*P-value*
ADFI	36.70	38.53	40.83	39.73	0.65	0.11
ADG	15.81	15.47	15.20	13.73	0.64	0.73
FCE	4.26	4.02	3.69	3.43	0.16	0.30

Table 5: Organ weights of broiler chicks fed diet contaminated battery waste (%live weight)

	Dietary treatments					
Organs (g)	1	2	3	4	SEM	P-Value
Liver	8.70	8.71	9.63	10.64	0.39	0.28
Kidney	0.78	0.85	0.90	0.92	0.06	0.86
Spleen	0.30^{b}	0.32^{b}	0.30^{b}	1.70^{a}	0.27	0.02
Gizzard	13.12	13.58	15.02	18.02	0.63	0.22
Heart	2.36	2.08	2.38	2.63 0.10	0.26	

^{a,b} Means with the different superscripts along the row are significantly different ($P < 0.05$).

Conclusion

It can be concluded from this study that the levels of battery waste had no significant effect on the performance of the chicks. The organ weights were also not affected, except for the spleen. The structures of the organs were distorted, hence the function of the organs starting from diets 2 to 4.

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