ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 4 (4): 177-181, 2005
ISSN 1682-8356

Induction of Round Heart Disease in Turkey Poults by Feed Texture

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Abstract: Incidence of round heart disease was prevalent in starting turkey poults in studies at our experimental facility. Two experiments were conducted to evaluate two dietary factors that may have contributed to increased susceptibility of poults to round heart disease. Experiment 1 consisted of 4 dietary treatments in which dietary chlorine ranged from 0.17 to 0.29% as a result of salt addition, but dietary sodium was maintained at 0.17%. Experiment 2 consisted of poults fed the same pre-starter (0-3 wk of age) and starter (3-6 wk of age) feeds. The diets were fed either in a mash or crumbled form with or without a post-hatch supplement the first day of the experiment. Poults were placed approximately 4 hr after departure from the hatchery. There was no evidence of round heart disease mortality in Experiment 1. According to body weight data, the dietary chlorine requirement was estimated to be 0.21% when adequate dietary sodium and potassium are fed. Mortality was increased in Experiment 2 due to round heart disease when crumbles were fed. The addition of a post-hatch supplement did not affect growth or mortality. The results of these studies indicate that feeding crumbles to poults increased round heart disease incidence starting at 6 days of age due to faster growth rate.

Key words: Chlorine, crumbles, poult, round heart disease

Introduction

Magwood and Bray (1962) first described round heart disease (spontaneous turkey cardiomyopathy) in turkey poults which causes growth retardation, poor blood circulation and death due to heart deformation. The disease is characterized by enlargement of the heart with extensive development of connective tissue in the endocardium and accumulation of glycogen in the heart muscle (Czarneki and Jankus, 1974). Distortion of heart tissue is due to enlargement of the right ventricle and general flaccidness of heart tissue is common (Hofstad *et al*., 1972). Round heart disease typically occurs when poults are 2 to 4 wk of age (Schwartz, 1994).

Factors reported to be associated with the incidence of round heart disease are genetics (Hunsaker, 1971) and the drug furazolidone (Jankus *et al*., 1972). Onderka and Bhatnagar (1982) observed round heart disease and ascites in 8-day-old turkeys given 0.75% sodium chloride in distilled water. Mortality was observed after 3 days and changes in heart morphology were described as being similar to congestive heart failure observed when furazolidone induced cardiomyopathy. Other factors such as inadequate ventilation (Frame, 1991), continuous light and low disease challenge (Classen *et al*., 1994) have been reported to be associated with a higher incidence of round heart disease in turkeys.

Field recommendations often include reduction of dietary salt when round heart disease occurs in turkey poults. Morrison *et al*. (1975) showed evidence of myocardial distension in poults fed high levels of dietary salt. Dewar and Sillar (1971) found enlargement of the heart in turkeys fed diets containing up to 0.57% sodium. However, Leeson *et al*. (1976) did not observe any signs of round heart disease in poults fed diets containing up to 1.5% salt and 1.5% sodium.

Round heart incidence was observed in previous turkey experiments in which the author was involved. In those trials, feed was fed in crumbled form to 5-6 wk of age and dietary chloride was about 0.30%. In a later trial, feed was fed in a mash form and a portion of the dietary sodium was provided by sodium bicarbonate to keep dietary chlorine below 0.25% as recommended by a turkey breeding company. The objective of this study was to evaluate the effects of dietary cation:anion balance by varying dietary chlorine and the influence of feed texture on growth rate and the incidence of round heart disease. The use of a post-hatch supplement was also evaluated to determine if there may be a benefit to growth performance even under relatively low stress conditions and if this may affect the incidence of round heart disease.

Materials and Methods

Experiment 1: A total of 196 Large White B.U.T.A.[1] Big 6 male poults were obtained from a commercial hatchery[2] and placed into an electrically-heated battery brooder. Poults were housed at 8 per pen and there were 6 pens per dietary treatment. A corn-soybean meal basal diet (28% crude protein, 2,800 kcal/kg ME, by calculation) was fed with dietary sodium held constant at 0.17% and dietary chlorine was fed at 0.17, 0.21, 0.25 or 0.29% of

Table 1: Composition of the basal experimental diets

Ingredient	Experiment 1	Experiment 2
Corn	42.07	40.02
Soybean meal, dehulled	48.80	42.16
Wheat middlings	0.00	5.00
Menhaden meal	2.00	3.50
Meat and bone meal, pork	0.00	3.25
Soybean oil	2.07	0.00
Animal/vegetable fat	0.00	2.49
Monodicalcium phosphate	2.30	0.00
Dicalcium phosphate	0.00	1.68
Limestone	1.96	1.01
Salt	0.34	0.13
Sodium bicarbonate	0.00	0.10
DL-methionine	0.17	0.00
Methionine Hydroxy-analog	0.00	0.28
L-lysine-HCl	0.00	0.08
Vitamin premix[1]	0.15	0.15
Trace mineral premix[2]	0.10	0.10
Choline chloride, 60%	0.05	0.05

[1]Vitamin premix provided per kg diet: vitamin A (all-trans-retinyl acetate), 11,000 IU; cholecalciferol, 5,000 ICU; vitamin E (all-rac-α-tocopherol acetate), 35 IU; menadione (as menadione sodium bisultite), 2.75 mg; riboflavin, 10 mg; Ca pantothenate, 20 mg; nicotinic acid, 80 mg; vitamin B_{12}, 0.025 mg; vitamin B_6, 4.3 mg; thiamin (as thiamin mononitrate), 2.9 mg; folic acid, 2.2 mg; biotin, 0.2 mg; vitamin C, 0.10 g; selenium, 0.275 mg; and ethoxyquin, 125 mg.
[2]Mineral premix supplied per kg of diet: manganese, 100 mg; zinc, 100 mg; iron, 50 mg; copper, 10 mg; iodine, 1 mg.

the diet for a total of 4 dietary treatments (Table 1). Dietary chlorine was increased by the addition of salt and the diets were adjusted to maintain dietary sodium at a constant level. Dietary potassium was adequate (NRC, 1994) and fed at similar levels to all treatment birds. Feed and water was provided ad libitum to all birds and room temperature was maintained at about 23°C. Mortality was monitored daily for diagnosis and body weight of dead birds was recorded.

The poults were weighed at 7 and 14 days of age and feed consumption was monitored to calculate feed conversion. Net feed conversion is defined as the feed intake divided by the body weight gain of all live birds at the time the birds were weighed. Adjusted feed conversion is feed intake divided by total gain of all birds in the pen including the gain of birds that died during the trial. The probe of a digital thermometer was held onto the foot pad of each poult as it was weighed at 14 days of age until a stable temperature was measured. After weighing, all birds were killed by cervical dislocation and the heart of each bird was excised, cleaned and weighed on a wet basis. Hearts were dried overnight at 50°C and weighed to obtain a dry weight. The data were analyzed by the Proc GLM procedure of SAS (SAS Institute, 2003) using pen as the experimental unit and treatment differences were separated by the Duncan's Multiple Range Test (Steel and Torrie, 1980). A regression analysis was performed on levels of dietary chlorine to test for linearity. When appropriate, the NLIN procedure was conducted to estimate a dietary chlorine requirement.

Experiment 2: A total of 900 B.U.T.A. Big 6 male poults were procured from a commercial hatchery[3] and placed at day of age into floor pens (2.54 m X 3.08 m) covered with pine shavings. Placement of poults occurred about 4 hr after they were received at the hatchery for transport. Birds were fed corn-soybean meal based diets (nutrient composition similar to basal diet from Experiment 1) from 1 to 42 days of age in either a mash or crumbled form. Feed was mixed at a commercial feed mill[4] and each of the 2 diets was provided to 16 pens of approximately 56 poults each to 3 wk of age. A commercial post-hatch supplement[5] was added at 1 g/poult at placement by spreading the green gelatinous product over the feed. At 3 wk, each pen was divided in half to provide an equal number of poults into 32 pens to 6 wk of age. Feed was provided ad libitum to each pen and one bell-type automatic waterer was located in each pen.

The temperature and lighting programs were administered similar to commercial standards in the Midwestern U.S. The lighting program consisted of 24 hr of light until 6 days of age. Day length was decreased by 1 hr every day afterward until the birds were 15 days of age. At that point, the birds received 16L:8D until the end of the experiment. Room temperature was set at 28.3°C the first wk with infra-red heat lamps providing 35-37.8°C underneath the lamps the first 8 days. Room temperature was reduced to 26.7°C at 20 days of age and was reduced by 2.7°C each wk.

The birds were weighed at 7, 14, 21 and 42 days of age and feed intake was measured to calculate net and adjusted feed conversions. Mortality was monitored daily for diagnosis of death loss and weight gain of dead birds was used to provide an adjusted feed conversion value. Data were analyzed by SAS software (SAS Institute, 1981) using the Proc GLM procedure and evaluated as a 2 X 2 factorial arrangement.

Results

Experiment 1: Body weight was increased quadratically at 7 ($p = 0.021$) and 14 ($p = 0.010$) days of age as dietary chorine increased (Table 2). There was a trend ($p = 0.071$) for improved feed conversion at 7 days of age as dietary chorine increased, but there was no treatment effect at 14 days of age. Foot pad temperature at 14 days was increased ($p = 0.023$) quadratically as dietary chlorine increased. There were a linear trend ($p = 0.080$) for increased heart weight as dietary chlorine increased. A similar response was seen for dry heart weights as dry heart weight was consistently 17.8% of wet heart weight (data not shown). The estimated dietary chlorine requirement for maximum body weight was 0.21%.

Table 2: Effect of dietary chlorine level on growth performance, foot pad temperature and heart weight of turkey poults (Experiment 1)

Dietary Cl (%)	7-days		14-days		Foot pad temp. (°C)	Wet heart wt (% of BW)
	BW (g)	Feed:gain (g:g)	BW (g)	Feed:gain (g:g)		
0.17	161[c]	1.20	347	1.39	26.8	2.92
0.21	175[a]	1.17	370	1.37	28.4	3.09
0.25	173[ab]	1.19	374	1.39	27.9	3.15
0.29	163[bc]	1.23	358	1.37	27.0	3.25
SEM	4	0.01	7	0.02	0.4	0.25
ANOVA	Probabilities					
Treatment	0.027	0.553	0.051	0.744	0.348	0.822
Regression analysis						
Linear	0.446	0.608	0.194	0.439	0.537	0.080
Quadratic	0.021	0.071	0.010	0.504	0.023	0.241

[a-c]Means within a column with no common superscript differ significantly ($p<0.05$).

Experiment 2: Body weight of poults was increased ($p<0.04$) at every age the birds were weighed in the trial when crumbles were fed (Table 3). Although there was a trend ($p = 0.066$) for improved net feed conversion at 14 days when crumbles were fed, there were no treatment differences at 21 days of age. However, when adjusted for the body weight losses of dead birds, feed:gain was consistently decreased ($p<0.01$) when crumbles were fed. This response was due to higher ($p<0.04$) mortality of poults fed crumbles compared to mash feed throughout the experiment. About 90% of the mortality of poults fed crumbles was due to round heart disease (resulted in 12% mortality) and half of the birds that died consuming mash fed were diagnosed with round heart disease (resulted in 1% mortality). Body weight continued to be higher (2,493 vs. 2,557 g, $p = 0.031$) when crumbles were fed compared to the mash diet at 42 days of age (data not shown). Mortality did not increase between 21 and 42 days of age for either feed type resulting in similar comparative responses for feed conversion (net feed:gain averaged 1.55 at 42 days). There were no treatment effects due to feeding the post-hatch supplement.

Discussion

Cold feet and enlarged hearts are symptoms of round heart disease in young turkeys. Although the foot pads of poults fed high (0.29%) dietary chlorine were cooler than when 0.21% chlorine was fed and hearts tended to weigh more as dietary chlorine increased, mortality was low (<4%) and there was no indication of round heart disease in Experiment 1. Hunsaker *et al.* (1971) found that the wet ventricular weight of poults with round heart disease was 0.80% of body weight compared to 0.45% for normal poults. Leeson *et al.* (1976) reported that dietary salt did not affect the incidence of round heart disease in turkey poults although Morrison *et al.* (1975) did observe a relationship between high dietary salt and round heart disease in poults.

The NRC (1994) recommends a dietary chlorine requirement of 0.15% for growing turkeys 0 to 4 weeks of age. The body weight data in Experiment 1 clearly shows that 0.17% dietary chlorine is too low. Dietary sodium was fed at 0.17% which is the NRC (1994) requirement for starting turkeys. The growth data also demonstrate that dietary chlorine should be kept below 0.29% in the first diet for turkeys. The breeding company for the turkeys used in this study recommends that dietary chlorine be fed at 0.18 to 0.24% to starting turkey poults up to 21 days of age (B.U.T.A., 2000).

Turkeys in the U.S. are typically fed a crumbled diet for at least the first two formulations which usually goes to about 5 or 6 weeks of age. Crumbled feed encouraged higher feed intake and resulted in heavier birds. However, the higher rate of growth observed when poults were fed crumbled feed resulted in cardiovascular related deaths by 6 days of age. Pelleted feeds have been suggested as a causative factor in sudden death syndrome in broilers possibly due to a more rapid growth rate (Leeson and Summers, 1991). Other factors which accelerate growth may increase round heart disease in turkeys such as lighting programs of constant 23 hours bright light or in new barns with no disease challenge (Classen *et al.*, 1994). The fact that a few poults consuming the mash diet also died due to round heart disease indicates that there are other environmental factors involved to a smaller degree. Frame (1991) stated that inadequate ventilation would increase the incidence of round heart disease in turkeys. Early poult mortality may increase when oxygen is less than 20.3%, carbon dioxide is greater than 2,500 ppm or carbon monoxide is greater than 20 ppm. Julian *et al.* (1992) observed a higher incidence of round heart disease in poults when 16.3% oxygen was present in hypobaric chambers. Carbon dioxide was measured[6] in the middle of each room during the second week of

Table 3: Effect of feed texture with or without post-hatch supplement (Gro-gel) on growth performance and mortality of turkey poults (Experiment 2)

Treatment	7 days		14 days			
	BW (g)	Mortality (%)	BW (g)	Feed:gain (net) (g:g)	Feed:gain (adjusted) (g:g)	Mortality (%)
Mash	164	2	360	1.14	1.14	2
Mash + Gro-gel	163	1	363	1.16	1.15	2
Crumbles	183	6	413	1.09	1.05	8
Crumbles+Gro-gel	185	9	416	1.10	1.06	10
SEM	3	2	4	0.02	0.01	2
Main effect means						
Feed texture						
Mash	164[b]	1[b]	362[b]	1.15[a]	1.14[a]	2[b]
Crumbles	183[a]	8[a]	412[a]	1.10[b]	1.06[b]	9[a]
Gro-gel						
No	173	4	384	1.12	1.09	5
Yes	174	5	390	1.13	1.11	6
ANOVA	Probabilities					
Feed texture	0.001	0.002	0.001	0.011	0.001	0.006
Gro-gel	0.728	0.598	0.279	0.525	0.187	0.637
Feed texture X Gro-gel	0.439	0.290	0.636	0.831	0.901	0.761

	21 days			
	BW (g)	Feed:gain (net) (g:g)	Feed:gain (adjusted) (g:g)	Mortality (%)
Mash	650	1.37	1.37	2
Mash + Gro-gel	676	1.36	1.35	3
Crumbles	720	1.35	1.31	10
Crumbles+Gro-gel	746	1.36	1.28	15
SEM	17	0.03	0.02	2
Main effect means				
Feed texture				
Mash	663[b]	1.37	1.36[a]	2[b]
Crumbles	733[a]	1.36	1.30[b]	13[a]
Gro-gel				
No	685	1.36	1.34	6
Yes	711	1.36	1.32	9
ANOVA	Probabilities			
Feed texture	0.001	0.668	0.009	0.001
Gro-gel	0.151	0.932	0.321	0.277
Feed texture X Gro-gel	0.977	0.797	0.858	0.352

[a-c]Means within a column with no common superscript differ significantly ($p<0.05$).

Experiment 2 and was about 1,500 ppm. Since brooder stoves were not used, carbon monoxide was not a concern.

The post-hatch supplement used in this trial is designed to assist young birds that have been stressed and may be dehydrated. The time of placement relative to transport from the hatchery was a relatively short period. Although the green color of the product encourages feed intake by poults the first day, the conditions of this study were minimally stressful for young turkeys and did not produce an environment in which a post-hatch supplement was necessary. The use of a post-hatch supplement has been reported to be beneficial to chicks that have been deprived of feed for 48 hr (Batal and Parsons, 2002). The absence of a growth response to the post-hatch supplement in the current study prevented any exacerbation to the incidence of round heart disease.

The high incidence of round heart disease in some poults previously grown at the Michigan State University Poultry Teaching and Research Center appears to be due to factors accelerating growth of the birds. The barn utilized for Experiment 2 was built about 5 years before the trial was conducted and there is minimal disease challenge in the facility. The primary factor involved in round heart disease at our facility according to this study is the use of crumbled feed in the starter period.

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[2]Janssen Farms Hatcheries, Inc., Zeeland, MI
[3]Cooper Hatchery, Inc., Oakwood, OH
[4]Hamilton Farm Bureau, Hamilton, MI
[5]Gro-Gel, Dawe's Laboratories, Arlington Heights, IL
[6]Dräger CMS Analyzer, Dräger Safety, Inc., Pittsburgh, PA