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RESEARCH ARTICLE

Ethanol through Crop Route in Broilers: Effects on FCR, Live Weight and on Different Organs

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ABSTRACT

In this study, we investigated the effects of ethanol on different parameters in broilers. A-day- old broiler chicks (n = 90) were randomly divided into five groups from A to E (negative control) at 22 days of age. Ethanol (2, 4 and 6 ml) and tap water (6ml) were administered into the crop from 22 to 42 days of age daily. Administration of ethanol through a crop tube at experimental dose levels showed a better feed conversion ratio, while lower live body weight in all treatment groups in almost a dose-related manner. Results of different organs also revealed significant decrease in the relative weight of most of the organs including heart, proventriculus, kidneys, intestine, brain and pancreas. Similar were the effects on ventricular volume (left and right). The relative weight of the intestine decreased significantly at 28 days of age, while increased significantly at 35 and 42 days of age. There was a significant decrease in diameter of duodenum, jejunum and ileum. The results of the present study showed less effect on gizzard weight, especially at 42 days. While the relative weight of liver and lungs were not affected. We were unable to find consistent significant gross and microscopic pathological changes in organs/tissues under study. The study revealed that ethanol at these dose levels through crop route has effects on live weight and relative weights of most body organs/tissues.

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INTRODUCTION

The poultry sector is providing employment (direct/indirect) to about 1.5 million people of the country with its contribution in agriculture growth of 4.81%. Poultry meat contributes 19% of the total meat production in the country (Anonymous, 2008-09; Kamran *et al*., 2010). Although poultry industry has progressed in Pakistan yet it is facing some serious problems including outbreaks of different diseases. Farmers have gained experience in managing diseases and are doing few things on their own. One of such practice is the use of ethanol in broilers as a speculated growth promoter, for the treatment of mild respiratory infections and better FCR (Bashir and Javed, 2005). Ethanol has effects on different body systems (Klassen and Persaud, 1978) and its long-term usage cause damage to central nervous system (Betz and Goldstein, 1984). In quails, ethanol has been found to cause decrease in live weight (3-35%), brain weight (4-10%), brain volume (25-51%) along with serum sodium and potassium, while a significant increase in relative weight of the pancreas (Bashir and Javed, 2005). Alcohol intoxication can cause rhabdomyolysis and acute renal failure (Heidland *et al*., 1985). The renal damage has been related with the rise in blood pressure (Heidland *et al*., 1985). In the esophagus, alcohol can cause disturbances in motility, reduced tone, gastro-esophageal reflux, and esophagitis. Ethanol has been found responsible in inhibiting the protein synthesis and related pathological derangements in intestine including changes in motility, diarrhea and malabsorption (Thompson and Adams, 1994). In stomach, it can cause hemorrhagic gastritis (Petzold, 1981).

Wide range of effects of ethanol and its use in broiler industry in Pakistan, prompted the authors to carry out this rare study in poultry to determine adverse effects of ethanol administered through crop route on live weight, weights of different organs and FCR in broilers along with gross and histological changes in different organs.

MATERIALS AND METHODS

In this experiment, a-day-old broiler chicks (n = 90) were purchased from a commercial hatchery and were kept in cages under identical conditions of feeding and management. All the birds were given commercial feed

and water *ad libitum* up to 22 days. They were vaccinated against ND and IBD with commercial vaccines. These chicks were randomly divided into five equal groups from A to E at 22 days of age.

Ethanol (40% v/v) and tap water was administered into the crop by a soft rubber tube fitted with a syringe from 22 to 42 days of age, once daily in the morning. Birds of group A, B and C were given 6, 4 and 2 ml ethanol, respectively. Birds of group D (positive control) were given 6 ml tap water, while the birds of group E were not given ethanol or water through crop route and thus acted as negative control group.

The following parameters were included in the experiment. Live body weight, organ's weight, ventricular volume (right and left), intestinal diameter (duodenum, jejunum, ileum), feed conversion ratio (FCR). For this purpose, six birds from each group were killed humanely by cutting jugular vein at 28th, 35th and 42nd days of age. Organs including heart, lungs, liver, brain, kidneys, intestine, proventriculus and gizzard were collected and weighed. Since the organ weight is dependent on body weight, therefore, relative weight of each organ in relation to body weight was calculated by dividing actual weight of organs with live body weight of the bird and multiplying by 100. The heart ventricles were exposed; evacuated and normal saline was filled with an insulin syringe. The volume of normal saline accommodated by ventricles was recorded. Intestinal diameter of three portions of intestine including duodenum, jejunum, and ileum was measured with the help of Vernier caliper after flushing the intestine with normal saline to remove the ingesta. All the organs were examined for gross lesions and then preserved in 10% formalin for histopathological studies (Bancroft and Gamble, 2008). Daily feed consumption and weight gain was recorded to measure the FCR at weekly interval.

Data thus obtained in the experiment were analyzed using an analysis of variance technique and the means were compared by Dunnett's test for difference from negative and positive controls using SAS 6.12 statistical software (SAS Institute Inc., 1996).

RESULTS

The results showed a better FCR in broilers given 4 and 6 ml ethanol through crop route (Table 1). Live weight of treated groups was significantly lower ($P<0.05$) than both the control groups (positive and negative) at 28, 35 and 42 days (Table 2). However, the live weight of positive control was also significantly lower ($P<0.05$) than the negative control group at 28 and 35 days (Table 2).

The relative weight of heart was significantly lower ($P<0.05$) in all the treatment groups than both the control groups (positive and negative) at 35 and 42 days, while at 28 days in broilers given 6ml ethanol (Table 3). The left and right ventricular volume at 28 days was significantly lower ($P<0.05$) in broilers given 4 and 6 ml ethanol than control groups, while it was significantly lower ($P<0.05$) at 35 and 42 days in all the treatment groups than both the control groups (Table 3). Relative weights of proventriculus and gizzard were significantly lower ($P<0.05$) in all treatment groups than both the control groups at 35 and 42 days, while at 28 days in broilers given 4 and 6 ml ethanol (Table 4). Relative weight of intestine was significantly lower ($P<0.05$) in groups given 4 and 6 ml ethanol than both the control groups at 28, 35 and 42 days. Relative weights of liver and lungs did not show significant difference between treatment and control groups. Relative weight of kidney was significantly lower ($P<0.05$) in all treatment groups than both the control groups at 28, 35 and 42 days (Table 4). The diameter of the duodenum was significantly lower ($P<0.05$) in all treatment groups than the negative control group at 28, 35 and 42 days, while in groups given 4 and 6 ml ethanol than the positive control group at 28, 35 and 42 days (Table 5). The diameter of jejunum was significantly lower ($P<0.05$) in all treatment groups than the negative control group at 28, 35 and 42 days except given 2 ml ethanol at 35 days (Table 5). However, it was lower in groups given 4 and 6 ml ethanol than the positive control group at 28, 35 and 42 days. The diameter of ileum was significantly lower ($P<0.05$) in groups given 4 and 6 ml ethanol than both the control groups at 28, 35 and 42 days, and in group given 2 ml ethanol than the negative control group at 42 days (Table 5). Relative weight of brain at 28 days was significantly lower ($P<0.05$) in groups given 4 and 6 ml ethanol than both the control groups; In all treatment groups at 35 and 42 days and in positive than the negative control group at 42 days (Table 6). Relative weight of the pancreas was significantly lower ($P<0.05$) in groups given 4 and 6 ml ethanol than both the control groups at 28, 35 and 42 days (Table 6). It may be clarified that we were unable to find consistent significant gross and microscopic pathological Changes in organs/tissues under study other than occasional slight congestion in some organs in some birds but not in all birds sacrificed at one time in each group.

Table 1: Comparison of feed conversion ratio during treatment period between groups fed different levels of ethanol through crop route.

Groups	28 days	35 days	42 days
A (6ml ethanol)	0.94	0.91	0.93
B (4ml ethanol)	0.95	0.98	0.98
C (2ml ethanol)	1.18	1.11	1.11
D (6 ml water; positive control)	1.41	1.28	1.46
E (negative control)	1.41	1.3	1.48

DISCUSSION

Administration of ethanol by crop tube at experimental dose levels showed better FCR, while lower live weight in all treatment groups, in almost dose-related manner. The decrease in live weight was also observed in positive than the negative control group but the decrease in treatment groups was significantly lower than the positive control group. This lower weight in ethanol treated birds may be because of the lower feed intake as these birds remained depressed and sleepy for about 6-8 hours after the administration of ethanol and thus could eat less as compared with control groups. Lower weight due to ethanol in quails (Bashir and Javed, 2005) and rats (Lansdown and Dayan, 1987) has been reported previously.

Ethanol also resulted in significant decrease in weights of other body organs including heart, proventriculus, kidneys, brain and pancreas. Similar were the effects

Table 2: Comparison of body weight (g; mean±SD) at each week during the treatment period between the groups administered different doses of ethanol through crop route and controls.

	Age of birds (days)		
Groups	28	35	42
A	647.9±2.6[ab]	835.2±3.9[ab]	1277.0±2.8[ab]
B	657.7±1.5[ab]	869.3±5.1[ab]	1471.7±3.5[ab]
C	658.2±4.3[ab]	882.0±5.3[ab]	1497.7±2.5[ab]
D	674.6±4.1[b]	904.0±5.3[b]	1507.7±2.5
E	683.9±4.1	939.3±2.5	1511.0±1.8

Groups A, B and C were maintained on 6, 4 and 2ml ethanol, respectively; Group D (positive control) was given 6 ml water while group E (negative control) was neither given ethanol nor water through crop route; Where a= significant difference (P<0.05) compared with positive control group (group D); and b=significant difference (P<0.05) compared with negative control group (group E).

Table 3: Comparison of relative weight (%; mean±SD) of heart at each week during the treatment period between the groups administered different doses of ethanol through crop route and controls

Organ/	Age of birds in days		
Groups	28	35	42
Heart			
A	0.97±0.05ab	0.57±0.02ab	0.56±0.01ab
B	0.99±0.04	0.60±0.01ab	0.59±0.02ab
C	1.00±0.04b	0.63±0.01ab	0.61±0.01ab
D	1.00±0.04	0.65±0.02	0.63±0.01
E	0.99±0.03	0.66±0.02	0.64±0.04
Left Ventricular Volume			
A	0.20±0.01ab	0.15±0.02ab	0.20±0.01ab
B	0.22±0.02ab	0.17±0.01ab	0.23±0.02ab
C	0.25±0.02b	0.19±0.015ab	0.26±0.02ab
D	0.25±0.02b	0.22b±0.01	0.28±0.01b
E	0.23±0.01	0.24±0.01	0.30±0.01
Right Ventricular Volume			
A	0.10±0.01ab	0.10±0.02ab	0.15±0.01ab
B	0.15±0.02ab	0.13±0.01ab	0.20±0.02ab
C	0.20±0.02b	0.16±0.01ab	0.23±0.01ab
D	0.20±0.02b	0.20±0.01b	0.26±0.01b
E	0.21±0.01	0.22±0.01	0.28±0.03

Footnote is the same as that of Table 2.

Table 4: Comparison of relative weights (%; mean±SD) of proventriculus, gizzard, intestine, liver, lungs and kidneys at each week during the treatment period between the groups administered different doses of ethanol through crop route and controls.

Organ/	Age of birds in days		
Groups	28	35	42
Proventriculus			
A	0.57±0.01ab	0.44±0.02ab	0.61±0.01ab
B	0.57±0.01ab	0.47±0.03ab	0.63±0.01ab
C	0.58±0.03	0.49±0.01ab	0.64±0.01ab
D	0.58±0.02	0.50±0.02	0.67±0.02
E	0.59±0.02	0.52±0.01	0.67±0.03
Gizzard			
A	1.87±0.01ab	1.45±0.01ab	1.07±0.01
B	1.87±0.01ab	1.46±0.02ab	1.08±0.12
C	1.86±0.03	1.47±0.01ab	1.09±0.01
D	1.86±0.03	1.48±01.02	1.12±0.02
E	1.86±0.02	1.49±0.01	1.11±0.02
Intestine			
A	5.91±0.31ab	6.02±0.02ab	7.04±0.01ab
B	6.82±0.27ab	5.97±0.01ab	6.93±0.03ab
C	7.88±0.16	5.93±0.01	6.86±0.04
D	7.96±0.14	5.91±0.04	6.83±0.06
E	8.29±0.10	5.89±0.03	6.81±0.06
Liver			
A	5.79±1.15	3.50±0.09	5.09±3.48
B	5.80±0.6	3.05±0.33	2.98±2.1
C	5.85±1.70	3.57±0.89	4.03±2.40
D	4.80±1.62	3.94±0.62	4.43±2.63
E	6.37±1.48	3.85±0.95	4.16±1.45
Lungs			
A	0.72±0.15	0.60±0.14	0.66b±0.20
B	0.80±0.21	0.52±0.04	0.62±0.10
C	0.88±0.25	0.47±0.02	0.53±0.22
D	0.63±0.07	0.73±0.23	0.52±0.31
E	0.59±1.48	0.44±0.10	0.39±0.45
Kidneys			
A	0.91±0.03ab	0.66± 0.02ab	0.89± 0.01ab
B	0.92±0.03 ab	0.69± 0.01ab	0.90± 0.01ab
C	0.94±0.02 ab	0.72± 0.01ab	0.92± 0.01ab
D	0.95±0.02	0.74±0.01	0.94±0.01
E	0.96±0.03	0.75±0.02	0.95±0.04

Footnote is the same as that of Table 2.

on left and right ventricular volume. Another study on ethanol in chicken showed left ventricular dilation, the results otherwise observed in present study. However, they also reported left ventricular muscle hypertrophy, interstitial fibrosis and necrosis of myocytes (Morris *et al*., 1999). It may be possible that hypertrophy of cardiomyocytes occur in few weeks causing lower ventricular volume as observed during present study with single dose of ethanol in 24 hours. However, when ethanol in higher dose is given for whole day and for longer period (12 weeks) may result into hypertrophy of myocytes along with other changes described with left ventricular dilation. These results of the present study suggest effects of ethanol on the weight of these organs perhaps not directly but due to the low feed intake although the FCR in these birds was better but they ate less feed (data not shown) compared to control group.

The changes in these organs were not discernable by routine microscopic examination of these tissues. Similarly, no gross changes of toxicity or damage in these organs were observed. Thus, we were unable to find toxic damage both at gross and microscopic levels in these organs. There may have been some changes at ultra cellular levels as indicated by few studies on brain tissues (Walcher and Miller, 2008). Similarly, another study reported in chick embryos exposed to 10% ethanol on gestational days 1-3 of significant reduction in all body parameters when compared with controls (Rao and Chaudhuri, 2007). The significant decrease in heart ventricular volume correlated with decrease in heart weight. The present results were also similar to findings in other animal species where ethanol caused significant reduction in the heart index in young senescent mice given ethanol (60%) at a dose rate of 2g/Kg (Tamai *et al*., 2000; Shi *et al*., 2001). Edes *et al*. (1987) reported dilatation of heart and congestive cardiomyopathy in alcoholic turkey birds. Similarly, our results in broilers of low kidney weights were in congruence with findings in rat offspring's where ethanol treated rats displayed a decrease in kidney weight (Tamai *et al*., 2000).

Table 5: Comparison of diameters (means±SD) of duodenum, jejunum and ileum at each week during the treatment period between the groups administered different doses of ethanol through crop route and controls

Organ/	Age of birds in days		
Groups	28	35	42
Duodenum			
A	0.34±0.04ab	0.34±0.03ab	0.43±0.03ab
B	0.45±0.03ab	0.42±0.02ab	0.50±6.00ab
C	0.53±0.025b	0.48±0.015b	0.56±0.02b
D	0.58±0.03	0.52±0.04	0.60±0.03
E	0.61±0.04	0.55±0.07	0.63±0.02
Jejunum			
A	0.30±0.04ab	0.33±0.03ab	0.42±0.03ab
B	0.41±0.03ab	0.41±0.02ab	0.49±0.02ab
C	0.49±0.02b	0.46±0.03	0.55±0.02 b
D	0.54±0.01	0.48±0.01	0.59±0.02
E	0.57±0.01	0.51±0.03	0.62±0.03
Ileum			
A	0.32±0.04ab	0.32±0.03ab	0.41±0.03 ab
B	0.43±0.03ab	0.36±0.05ab	0.48±0.02 ab
C	0.51±0.09	0.46±0.01	0.54±0.02 b
D	0.55±0.08	0.50±0.01	0.58±0.03
E	0.59±0.07	0.53±0.01	0.61±0.04

Footnote is the same as that of Table 2.

Table 6: Comparison of relative weights (mean±SD) of brain and pancreas at each week during the treatment period between the groups administered different doses of ethanol through crop route and controls

Organ/	Age of birds in days		
Groups	28	35	42
Brain			
A	0.2947±0.0059ab	0.2821±0.0057ab	0.2484±0.0012ab
B	0.3162±0.0115ab	0.2871±0.0032ab	0.2599±0.0024ab
C	0.3244±0.0015	0.2953±0.0053ab	0.2559±0.0014ab
D	0.3297±0.0019	0.3248±0.0061	0.3002±0.0019b
E	0.3319±0.0031	0.3351±0.0043	0.3187±0.0039
Pancreas			
A	0.3844±0.0092ab	0.3986±0.0050ab	0.4025±0.0053ab
B	0.3587±0.0055ab	0.3665±0.0071ab	0.3562±0.0037ab
C	0.3438±0.0056a	0.3443±0.0076	0.3509±0.0037
D	0.3330±0.0031	0.3310±0.0059	0.3327±0.0009
E	0.3386±0.0031	0.3323±0.0019	0.3323±0.0010

Footnote is the same as that of Table 2.

The relative weight of the intestine decreased significantly at 28 days of age and increased significantly at 35 and 42 days of age. There was a significant decrease in diameter of duodenum, jejunum and ileum. This increase of intestinal weight, while decrease in diameter of duodenum, jejunum and ileum are difficult to be explained. It may be possible that as the live weight of the birds was significantly lower and the weight of the intestine did not decrease proportionally. The decrease in diameter of duodenum, jejunum and ileum might be associated with loss of contractile protein synthesis as reported by Marway and Preedy (1995) or due to inhibition of cell production in these intestinal portions as described by Lansdown and Dayan (1987).

The results of present study showed less effect on weight of a gizzard, especially at 42 days, i.e., after three weeks of treatment. While the relative weight of liver and lungs were not affected. This probably suggests that these organs are not affected by ethanol treatment in poultry.

It can be concluded from the present study that the ethanol treated birds at the studied dose levels had lower live weight and decease in relative weights of most of the body organs/tissues.

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