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EFFECTS OF BILE ACIDS ON BROILER FED LOW ENERGY DIET DURING STARTER PHASE ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY

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ABSTRACT

The research evaluated the effect of Bile Acids (BA) on broilers fed low energy diets during starter phase. A total 150-day old chicks were randomly assigned into five treatments with three replicates (n = 10), which included control (CO) group (2950kcal) and low metabolizable energy (LME=2800kcal), LME+BA-0.25 g/kg, LME+BA-0.30 g/kg, LME+BA-0.35 g/kg, respectively. The results indicated that live body weight (LBW), average daily gain (ADG) and feed conversion ratio (FCR) were significantly ($p > 0.05$) improved in BA-0.30 g/kg and BA-0.35 g/kg treated LME groups as compared to control. Whereas the average daily feed intake (ADFI) was gave no significant difference ($p < 0.05$) between amongst the groups. The dressing percentage (Dressing%), breast muscle percentage (BM%), leg muscle percentage (LM%) and abdominal fat percentage (AF%) were significantly increased ($p > 0.05$) in LME with BA-0.30 g/kg diet group. Moreover, the fat digestibility percentage (FD%) and metabolizable energy percentage (ME%) were significantly higher ($p > 0.05$) in BA-0.30 g/kg and BA-0.35 g/kg treated LME than control. Furthermore, the glucose (GLU), total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL) and low-density lipoprotein (LDL) were significantly improved ($p > 0.05$) in BA-0.35 g/kg treated LME group. In conclusion, the results indicated that addition of BA at the dose level 0.30 g/kg in LME diet had beneficial effects during starter phase on growth performance and nutrient digestibility.

Key words: Bile Acids, Starter Phase, Brooding period, Growth Performance, Nutrient Utilization in Broiler.

List of Abbreviations:
ADG = Average daily gain; AF = Abdominal fat; ADFI = Average daily feed intake; BA = Bile acids; BD = Blood; BM = Breast muscle; CO = Control; Dressing% = Dressing percentage; FCR = Feed conversion ratio; FD = Fat digestibility; GLU = Glucose; HDL = High density lipoprotein; LBW = Live body weight; LDL = Low density lipoprotein; LM = Leg muscle; LME = Low metabolisable energy; ME = Metabolisable energy; NRC = National research council; TC = Total cholesterol; TG = Triglycerides

INTRODUCTION

Bile Acids are major constituents of bile which work as fat emulsifier in the broiler. However, the fats are estimated least digestible component of feed especially during in a brooding period of broilers (Batal and Parsons, 2002). While, the feed is a mixture of various type of ingredients, that included grains, cereal by products, fats, animals by products, vitamins, minerals and some others additive. Balanced diet also plays a major role for poultry production, growth performance and health status (Ravindran *et al.*, 2016). Although, the amount of oil in feed is an important energy value. The fats (lipids and oils) are bulk sources of energy for birds and formulated in feed for energy purpose (Fascina *et al.*, 2009; Abudabos *et al.*, 2014). Fat contains two times more energy than carbohydrates. Information is limited if chick's development and growth are affected by high amount of fat indigestion during starter phase. Although, the bile acids, which contain amylase, lipase and trypsin act as fat emulsifier. But in young bird's secretion of bile is limited, mostly in the one week old hatchlings of birds (Noy and Sklan, 1995). Hence, this rhythmically increased during in first 3 weeks (Lamot *et al.*, 2019). Additionally, the bile acids formation occurs in liver from cholesterol. Secretion helps in the fat metabolisms, transportation of triglyceride molecules, and absorption of fat-soluble vitamin A, D, E, and K (Boesjes and Brufau *et al.*, 2014). However, the addition of more amount of fats in young chick's diet leads to problems of indigestion, drop feed intake and decline body weight and having an economic loss for poultry industry

(Abbas *et al.,* 2016). Furthermore, the addition of bile acids in feed produced the positive effects on fats digestion, absorption and utilization in chicks that are less than 4 week of age (Green and Thomas, 1986). The synthetic emulsifiers are cheaper and may be used for fat digestion (Roy *et al.,* 2010). The bile acids emulsifier in diet could be maintaining low-cost expense and more profitable for poultry industry (Ashraf *et al.,* 2007; Siyal *et al.,* 2017). However, on the basis of previous reports, less work has been conducted on bile acids in low-energy-diets. Therefore, this study has been designed with a basis objective if bile acids could affect the growth performance and nutrient digestibility fed to low-energy-diet during starter phase of the broiler.

MATERIALS AND METHODS

The current study was executed at the farm of Department of Poultry Husbandry, Faculty of Animal Husbandry and Veterinary Science, Sindh Agriculture University Tando Jam.

Management of the Birds

In this study 150, day-old Ross 308 chicks were used. The chicks were randomly allocated into five groups of 10 chicks each with three replicates. The chicks were reared under same conditions, and diets were prepared according to National Research Council (NRC 1994) (Table-1). The dietary groups were assigned as follows, control (CO) group received as basal diet without any additives, LME (CO – 150 Kcal/kg), other treatment groups were as follows; LME diet supplemented with 0.25 g/kg bile acid (BA-0.25), LME diet supplemented with 0.30 g/kg bile acid (BA-0.30), LME diet supplemented with 0.35 g/kg bile acid (BA-0.35) respectively. The birds of each experimental group were allowed *ad libitum* access to its own diet and water for whole experiment. The temperature of the experimental room was maintained at 33°C at first week and gradually reduced by 3˚C per week until the end of experiment. For the first three days, 24 h lighting was provided and then gradually decreased one hour per week. Ingredients in the basal diets presented in the Table 1.

Data Collection

Growth Performance

On 21day of the experiment, LBW was recorded on cage basis. The ADFI, ADG and FCR were calculated. The ADG and FCR were calculated by using the following formula. ADG = Final body weight – Initial body weight/Age in days and FCR = FI/ADG. Three birds aged 21 d were selected from each replicate.

Carcass Characteristics

In the last of trial three broilers from each replicate were slaughtered. After slaughtering and de-feathering of birds the carcass weight recorded. The Dressing%, BM%, LM% and AF% was recorded individually.

Digestibility

At the 18th day of age, three birds per replicate were transferred to a separated pan for feces collection. Fecal samples were collected in the morning and evening times for 3 repeated days from 18th to 20th days. The feces were dried in an oven at 65^{o}C for days. The dried sample was grinded and analyzed for the FD% and ME%. All procedures were followed according to methods of Association of Official Analytical Chemists (AOAC 2005).

Biochemical Attributes

At the end of the study period (day 21), two bird were selected randomly from each replicate for blood collection. Ten mL blood samples were collected in BD-vacutainers from the wing. The collected blood samples were centrifuged at 3000 rpm for 10 min and the sera were decanted into Eppendorf tubes and stored at –20˚C until further analysis. The serum samples were analyzed for GLU, TC, TG, HDL and LDL by using an automated system (7600 analyzers, Hitachi High Technologies Co., Tokyo, Japan) with standards following the protocols recommended by the manufacturer (Nanjing Jiancheng Bioengineering Institute, Nanjing, China).

Statistical Analysis

The differences among treatments were statistically analyzed by one-way ANOVA using IBM-SPSS Statistics 19.0. The significant differences among means of treatments were compared by the Tukey test. The means and their standard deviations were recorded. The significant level was set at $p<0.05$.

RESULTS

Growth Performance of the Broilers

The production performance results are presented in Table 2. The LBW, ADG and FCR were significantly ($p < 0.05$) higher in BA-0.30 g/kg compared to control. However, there was no difference found in ADFI among all groups.

Table 1. Basal Diet formulation for broiler chickens.

Materials	Control	LME	LME BA-0.25 g/kg	LME BA-0.30 g/kg	LME BA-0.35 g/kg
Corn	58	50	50	50	50
Soybean meal	30.4	26.3	26.3	26.3	26.3
Canola meal	4	8	8	8	8
Rice polish	0	8	8	8	8
Fish meal	4	4	4	4	4
Soy oil	1.83	0.74	0.74	0.74	0.74
DCP	0.49	0.41	0.41	0.41	0.41
Lysine sulphate	0.28	0.3	0.3	0.3	0.3
Limestone	1.08	1.05	1.05	1.05	1.05
Salt	0.25	0.24	0.24	0.24	0.24
Methionine	0.26	0.24	0.24	0.24	0.24
L-Threonine	0.08	0.08	0.08	0.08	0.08
Premix	0.22	0.22	0.22	0.22	0.22
Soda bicarbonate	0.06	0.07	0.07	0.07	0.07
Total	100	100	100	100	100
Calculated Analysis of Nutrients					
Met. Energy	2950	2800	2800	2800	2800
Crude Protein	21	21	21	21	21
Fat	4.8	4.3	4.3	4.3	4.3
Methionine	0.61	0.6	0.6	0.6	0.6
L Threonine	0.89	0.91	0.91	0.91	0.91
Lysine	1.2	1.29	1.29	1.29	1.29
Calcium	1	1	1	1	1
Available Phosphorus	0.45	0.45	0.45	0.45	0.45

The premix provided (for 1 kg of diets) VA 10,000 IU, VB1 1.8 mg, VB2 40 mg, VB12 0.71 mg, VD3 2000 IU, VE 10 IU, VK3 2.5 mg,
biotin 0.12 mg, folic acid 0.5 mg, D-pantothenic acid 11 mg, Cu (as copper sulfate) 8 mg, Fe (as ferrous sulfate) 80 mg, Mn (as manganese
sulfate) 60 mg, Zn (as zinc sulfate) 40 mg, I (as potassium iodide) 0.0.35 mg and Se (as sodium selenite) 0.15 mg.

Carcass Characteristics

The Table 3 showed Dressing%, BM% and LM% were significant enhanced ($p < 0.05$) in BA-0.30 g/kg treated LME diet as compared to other groups. The AF% was significantly decreased ($p < 0.05$) in BA-0.30 g/kg treated LME than control.

Digestibility Test

The outcome of digestibility test is shown in Table 4. The outcome indicates that FD% and ME% were significantly higher ($p < 0.05$) in BA-0.30 g/kg treated LME diet as compared to control.

Blood Biochemical Indices

The effect of BA with LME diet on blood parameters are summarized in Table 5. The outcomes indicated that GLU, TG and HDL were significantly improved ($p < 0.05$). However, the LDL was significantly reduced ($p > 0.05$) in broiler among all groups. Although, the TC was significantly higher ($p < 0.05$) in LME with BA-0.35 g/kg diet as compared to control.

Table 2. Growth performance of the broilers chickens supplemented with Bile Acids.

Parameters	Control	LME	BA-0.25 g/kg	BA-0.30 g/kg	BA-0.35 g/kg	SEM ±	*P* value
LBW	910^{bc}	858.50^{d}	895.5^{c}	945.07^{a}	918.67^{b}	5.508	0.0001
ADG	43.33^{b}	40.88^{d}	42.64^{c}	45.00^{a}	43.71^{ab}	0.262	0.0001
FCR	1.20^{c}	1.31^{a}	1.26^{b}	1.20^{c}	1.24^{bc}	0.007	0.0001
ADFI	52.87^{a}	53.59^{a}	53.87^{a}	52.91^{a}	53.20^{a}	0.201	0.518

Table 3. Carcass characteristics of the broilers supplemented with Bile Acids.

Parameters	Control	LME	BA-0.25 g/kg	BA-0.30 g/kg	BA-0.35 g/kg	SEM ±	*P* value
Dressing%	61.36^{bc}	60.04^{c}	62.41^{ab}	63.07^{a}	62.83^{ab}	0.268	0.0001
BM%	26.00^{ab}	24.48^{c}	25.26^{b}	26.91^{a}	24.68^{c}	0.185	0.0001
LM%	22.86^{a}	21.29^{c}	22.37^{b}	22.79^{a}	21.52^{c}	0.064	0.017
AF%	1.89^{a}	1.69^{b}	1.59^{c}	1.53^{c}	1.64^{b}	0.057	0.099

Table 4. Digestibility Tests of the broilers supplemented with Bile Acids.

Parameters	Control	LME	BA-0.25 g/kg	BA-0.30 g/kg	BA-0.35 g/kg	SEM ±	*P* value
FD%	61.36^{bc}	60.04^{c}	62.41^{ab}	63.07^{a}	62.83^{ab}	0.268	0.0001
ME%	26.00^{ab}	24.48^{c}	25.26^{b}	26.91^{a}	24.68^{c}	0.185	0.0001

Table 5. Blood parameters of the broilers supplemented with Bile Acids.

Parameters	Control	LME	BA-0.25 g/kg	BA-0.30 g/kg	BA-0.35 g/kg	SEM ±	*P* value
GLU	254.17^{b}	239.00^{c}	249.67^{bc}	267.33^{a}	263.83^{a}	2.488	0.001
TC	145.67^{ab}	126.50^{c}	139.83^{bc}	144.67^{ab}	148.33^{a}	1.620	0.001
TG	101.50^{ab}	94.33^{c}	97.83^{bc}	102.67^{a}	101.17^{ab}	0.712	0.001
HDL	28.67^{ab}	26.50^{c}	27.83^{bc}	30.09^{a}	29.17^{ab}	0.302	0.001
LDL	91.67^{a}	90.33^{ab}	89.67^{ab}	87.17^{b}	92.00^{a}	0.468	0.002

DISCUSSION

The addition of BA in diets may influence broilers LBW at the age of 21 days. According to studies, the BA improves LBW during brooding phase (Niu *et al.*, 2009; Kermanshahi *et al.*, 2011). Besides, the supplement emulsifiers (0.20% cholic acid and chenodeoxycholic acid) shows increased in LBW gain and fat absorption during in first week (Atteh and Leeson, 1985). In agreement with our finding dietary BA significantly increased the ADG. However, the research of (Polin *et al*., 1980; Alzawqari *et al.,* 2011) reveals that the ADG is higher in BA treated group at 7 to 21 days. Although, the ADFI shows no numerical difference in BA treated group with comparison to control. Whereas the BA-0.40 g/kg in feed has no effect on ADFI after starter phase of broilers (EI-Katcha *et al.,* 2019). Furthermore, the main objective of using BA compound in broiler diets is to improve their FCR of Maiorka *et al.* (2004), as was observed in this study. The research showed that the fats are used less as the key energy provider in broilers diet because fat is considered as a least digestible nutrient, especially in first 3 weeks. It may speculate that BA improve FCR due to availability of more ME% in body. In addition, the results of shows that the LME diets significantly improved the Dressing% BM% and LM% in BA treated groups as compared to control. However, the AF% significantly increased in control group as compared to BA treated LME groups. In agreement of our study Zaefarian *et al.* (2015); Wang *et al.* (2016) and Ge *at al.* (2018) showed that the Dressing%, BM% and LM% significant improved in BA treated groups. However, Lamot *et al.* (2019) reported that the control diet without BA reduced the Dressing%, BM% and LM% in broiler during starter phase. Hence, it may be assumed that lipase enzymatic activity enhances the formation of protein channels and permeability of the cell membrane. Likewise, the BA includes cholic acid, chenodeoxycholic acid, taurocholate and sodium salt at 0.025% and 0.05% in diet increases the fat digestion of saturated long chain fatty acids (Gomez and Polin, 1976). Moreover, the 0.40 g/kg dried ox bile with addition of vitamins in laying hens increases the FD% and ME% in the diet (EI-Katcha *et al.*, 2019). It may be expected that BA increases the activity of lipolytic enzymes and potentiating absorption by the intestinal mucosa. Additionally, the research of our finding shows the blood GLU, TG and HDL in significant improved in BA-0.30g/kg treated LME diets. But, the LDL reduced in BA treated groups as compared to control. Although, the TC was significantly higher ($p < 0.05$) in LME with BA-0.35 g/kg diet group. Therefore, it may be hypothesized that the emulsification reduces the level of fat in serum through lowering the emission of lipoprotein molecules in blood. That's why there is no effect of BA found on blood parameters. However, the more studies are required by using the unique fat emulsifiers and dosages to discover their results on the growth performance and nutrient digestibility of broiler chickens in various phase of age.

Conclusion

It may be concluded that inclusion level of BA-0.30 g/kg in LME diet improves the growth performance and nutrient digestibility in broiler chickens during starter phase. Moreover, the BA treated diet improves blood biochemical indices in broiler chicks. Furthermore, the addition of BA-0.30 g/kg alleviates the result of LME diet by improving the nutrient utilization and reduces the feed cost. However, this experiment leading better benefits of poultry industry and welfare of mankind.

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