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# SYNERGISTIC EFFECTS OF DIETARY SUPPLEMENTAL BILE ACIDS ON PERFORMANCE AND CARCASS CHARACTERISTICS OF SELECTED BREEDS OF BROILER CHICKENS

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**ABSTRACT**: *The competitive advantage of any feed manufacturing company is the trade secret which is usually driven by innovation. The quest to offer exceptional animal diets to farmers is the premise to which this experiment was carried out. It's an industry driven research geared towards reducing cost of feed and improve the profitability in the poultry agribusiness. The objective of the present study was to evaluate the effect of bile acids on the growth performance and carcass characteristics of the two popular broiler breeds in Nigeria. The experiment was designed in a 2×5 factorial. That is, two different breeds of broiler chickens and dietary supplemental levels of Bile Acids. A total of Nine Hundred & Ninety (990) day-old-chicks (38g ± 0.03) were used for the experiment. In order words, 495 Arbor Acer day-old-chicks were obtained from FIDAN hatchery farm and another 495 Ross 308 day-old-chicks from AGRITED hatchery farm. Each set of breed of birds were randomly assigned to five (5) treatments, with 33 birds per pen and three (3) replicates per treatment. The brooding temperature was kept at an average of 29.5$^0$C from the first to second week of age. Thereafter, the temperature was lowered to 22$^0$C for the rest of experimental period. The experimental diets were formulated as follows: control treatment (without bile acids but 77 kcal/kg higher in ME) and four levels of supplemented bile acids broiler diets with 77 kcal/kg shortfall in ME. There was no significant difference among the selected breeds of broilers. At 150g of dietary supplemental bile acids, the growth performance & feed conversion was improved and significantly optimized at P>0.01. In spite of high feed intake by birds on supplemental bile acids, there was high compensatory conversion to body weight. However, the dressing percentage, Head, Liver and Gizzard in carcass were significantly improved (P>0.05) for broilers fed diets supplemented with 100g & 150g bile acids. In contrast, abdominal fat weight was reduced significantly (P>0.05) across all the levels of supplemental bile acids. Thus, the primal cuts, intestine weight and length were unaffected by dietary supplemented bile acids. Again, the cost of feed was reduced by 2% approximately thereby improving the profitability of the value-chain players which drive the agribusiness activities. Therefore, supplementation of broiler diets with 100g – 150g bile acids per metric ton can effectively enhance the growth performance and carcass traits.*

**KEYWORDS**: Bile acids, growth performance, carcass characteristics, broiler chickens, breeds

## INTRODUCTION

Bile acids are the main active ingredient of bile. It is a series of sterols produced during cholesterol metabolism in animals with multiple biological activities. Bile acids, synthesized from cholesterol exclusively in the liver, are specific and quantitatively important organic components of bile (Marin et al., 2016). Before bile acids are secreted into canalicular lumen, they are conjugated with glycine or taurine. This conjugation process increases the amphipathic nature of the bile acids, making them more hydrophilic as well as less cytotoxic (Bellentani et al 1987; Russell, 2003; Li and Chiang, 2014; King, 2014). Bile acid chemistry is complex because of the great variety of chemical structures in naturally occurring compounds such as cholic acid, chenodeoxycholic acid, deoxycholic acid, and lithocholic acid. The primary bile acids are synthesized from cholesterol in the liver and the secondary bile acids are formed by bacterial modification of primary bile acids in the colon. Bile acids usually consist of a mixture of individual bile acids. In bovines, cholic acid and deoxycholic acid are the primary bile acids, while α-hydeoxycholic acid and chenodeoxycholic acid are predominant in swine bile. Avian bile acids mainly consist of chenodeoxycholic acid and cholic acid (Hofmann and Hagey, 2008).

Feed grade bile acids can promote the digestion, absorption and utilization of fat, thereby increasing the feed conversion rate and increasing feed compensation. Fat and oil constitute the main energy source of animals and possess the highest caloric value of all nutrients, with almost three (3) times higher apparent metebolizable energy (AME) than other feedstuff (NRC, 1994). With the continuous improvement of genetics, the nutritional requirements of modern broiler strains have increased, especially the need for high intake of energy, which necessitates the feeding of high-energy diets (Blanch et al, 1996). Hence, fats are widely added to poultry diets to meet the energy requirements. Digestion and absorption of dietary fat are poorly developed in young animals due to limited bile secretion (Krogdahl, 1985). Bile acids have multiple biological activities. In addition to the function of emulsifying fat in the body, they also have the functions of hepatic protection, anti-inflammatory, antitussive, anti-allergic and antibacterial effects. Therefore, additional bile acids are added to make up for the deficiency of endogenous emulsifiers. So, the objective of this study was to efficiently optimize the effect of Bile acids on third class (by-products) materials basal broiler diets across two different breeds via performance, carcass characteristics and microbial activities of broiler chickens.

## MATERIALS AND METHODS

The experiment was designed in a 2×5 factorial. The design simply implies two independent variables. That is, two different breeds of broiler chickens and dietary supplemental levels of Bile Acids. A total of Nine Hundred & Ninety (990) day-old-chicks (38g ± 0.03) were used for the experiment. In order words, 495 day-old-chicks Arbor Acers broiler chicken obtained from FIDAN hatchery farm and another 495 day-old-chicks ROSS 308 from AGRITED hatchery farm

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all from the western part of Nigeria. On arrival, each set of breed of birds were randomly assigned to six (5) treatments, with 33 birds per pen and three (3) replicates per treatment. The brooding temperature was kept at an average of 29.5$^0$C from the first to second week of age. Thereafter, the temperature was lowered to 22$^0$C for the rest of experimental period. Wood shaving was used as litter material. At DOC, antibiotic and anti-stress were given to the birds for three days. From week two to three, first and second Infectious Bursal Disease Vaccine (IBDV) was administered. The experiment was conducted for the period of three weeks. The daily feed consumption, weekly body weights, weight gain and feed conversion ratio were properly recorded. Carcass characteristics (both the external & internal organs) and microbial activities were measured.

***Table: 1 Percentage Ingredient Composition of Experimental Broiler Diets***

| | ***Inclusion Rates of Bile Acids per Metric Ton of Feed*** | | | | |
|---|---|---|---|---|---|
| ***Ingredients*** | ***Control*** | ***100g*** | ***150g*** | ***200g*** | ***250g*** |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Enzyme | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Methionine | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Maize | 35 | 22.5 | 22.5 | 22.5 | 22.5 |
| Soya Cake | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Toxin Blender | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| GNC | 20.7 | 20.7 | 20.7 | 20.7 | 20.7 |
| Wheat Bran | 10 | 10 | 10 | 10 | 10 |
| Maize Bran | 15 | 27.5 | 27.5 | 27.5 | 27.5 |
| Salt | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| Bone Meal | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Limestone | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Bile Acids | - | 0.01 | 0.015 | 0.02 | 0.025 |
| TOTAL | 100 | 100.01 | 100.015 | 100.02 | 100.025 |

***Analyzed Nutrients Composition of Experimental Diets***

| ***Parameters (%)*** | ***Control*** | ***100g*** | ***150g*** | ***200g*** | ***250g*** |
|---|---|---|---|---|---|
| Metabolizable Energy (Kcal/kg) | 3091 | 3014 | 3014 | 3014 | 3014 |
| Crude protein | 21.9 | 22.02 | 22.02 | 22.02 | 22.02 |
| Crude Fat | 5.5 | 6.12 | 6.12 | 6.12 | 6.12 |
| Crude Fibre | 7.92 | 9.47 | 9.47 | 9.47 | 9.47 |
| Ash | 5.17 | 5.55 | 5.55 | 5.55 | 5.55 |
| Calcium | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 |
| Av. Phosphorus | 0.71 | 0.73 | 0.73 | 0.73 | 0.73 |
| Methionine | 0.59 | 0.58 | 0.58 | 0.58 | 0.58 |
| Lysine | 1.35 | 1.37 | 1.37 | 1.37 | 1.37 |
| Methionine-Cystine | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 |

## RESULTS AND DISCUSSION

**Table: 2 Effect of Dietary Bile Acids on the Growth Performance of Broiler Chickens**

| Parameters | Control | 100g | 150g | 200g | 250g | SEM |
|---|---|---|---|---|---|---|
| Av. DOC Weight (g) | 38 | 38 | 38 | 38 | 38 | 0.02 |
| Av. Final weight (g) | 1360 | 1458 | 1504 | 1190 | 1265 | 0.06 |
| Weight gain/Diet (kg) | $1.32^{bc}$ | $1.42^{dc}$ | $1.47^{d}$ | $1.15^{a}$ | $1.23^{ab}$ | 0.08 |
| Feed Intake per Bird (kg) | $2.63^{a}$ | $2.98^{d}$ | $2.95^{cd}$ | $2.85^{bc}$ | $2.81^{b}$ | 0.06 |
| Feed Conversion Ratio/Diet | $2.00^{a}$ | $2.10^{ab}$ | $2.02^{a}$ | $2.52^{c}$ | $2.30^{bc}$ | 0.13 |
| Cost of Feed per (₦)/kg | 99.47 | 97.01 | 97.66 | 98.30 | 98.95 | |

$^{a, b, c, d}$ means within a row with different superscripts are significantly different at p>0.01

Bile acids are the principal constituents of bile and play an important role in the digestion and absorption of fat and lipid-soluble vitamins (Russell and Setchell, 1992). They are synthesized from cholesterol within hepatocytes, secreted into the bile canaliculi and subsequently stored in the gallbladder in birds and many other mammals. From here, they flow into the duodenum after ingestion of feed to emulsify dietary lipids. About 95% of bile acids are then absorbed by passive diffusion and actively transported from the ileum and to the liver via the portal vein through the enterohepatic circulation (Hofmann & Hagey, 2008). In the newly hatched chick, the ability to digest and absorb dietary fat is poorly developed as a result of limited secretion of bile. (Tancharoenrat et al; 2013). For this reason, synthetic bile acid and bile salts have been evaluated in diets of young broilers for the improvement of fat digestion. Alzawqari et al (2011) reported that dietary supplementation of tallow with ox bile at 5 g/kg resulted in higher weight gain and better feed conversion. Maisonnier et al (2003) and Parsaie et al (2007) found that supplementing diets with bile salts significantly increased body weight gain in broilers.

However, the present study used broiler starter diets supplemented varying levels of bile acids with two selected breeds of broiler throughout the five weeks of the experiment. This is quite different from other reported studies on bile acids, and the whole essence was to monitor the degree of performance trend. Meanwhile, these results are still consistent with our observations that dietary supplemental 100g and 150g of bile acids per metric ton of feed increased weight gain and improved the feed conversion ratio. The significant shift of the present study is on the feed intake, which could be attributed to the shortfall in the metaboilzable energy (ME) of supplemental bile acids diets as against the control treatment. In order words, at 150g of bile acids, the birds were able to compensate about 77 kcal/kg shortfall of energy, and efficiently optimized performance of broiler chickens. Again, the cost of feed was reduced by 2% approximately thereby improving the profitability of value-chain players and, hence drive the agribusiness activities. Generally, the growth performance slowed down immediately after 21 days compared to the expected standard growth pattern of broiler chickens.

Table 3: Effect of Dietary Bile Acids on Relative Live Weight Carcass Performance

| Parameters (%) | control | 100g | 150g | 200g | 250g | SEM |
|---|---|---|---|---|---|---|
| Bled weight | 94 | 94.94 | 95.45 | 94.08 | 93.92 | 0.27 |
| Defeathered weight | 95.6. | 96.08 | 95.88 | 94.73 | 95.97 | 0.21 |
| Eviscerated weight | $83.85^{ab}$ | $82.87^{bc}$ | $86.53^{a}$ | $86.16^{a}$ | $84.69^{ab}$ | 0.59 |
| Dressed weight | $71.41^{ab}$ | $73.48^{a}$ | $72.92^{a}$ | $74.68^{a}$ | $73.27^{a}$ | 0.65 |
| Dressing percentage | $67.11^{ab}$ | $69.75^{a}$ | $69.63^{a}$ | $70.26^{a}$ | $68.81^{ab}$ | 0.63 |
| Abdominal fat | $0.76^{a}$ | $0.09^{bc}$ | $0.13^{bc}$ | $0.45^{ab}$ | $0.05^{c}$ | 0.07 |

$^{a,b,c}$ means within a row with different superscripts are significantly different at P>0.05

Dietary bile acids improve the carcass performance in the broiler chickens. There was non-significant difference in the eviscerated weight and dressed weight between the supplemental bile acids diets and the control. But there was a strong positive trend in eviscerated weight and dressing percentage with 150g & 200g of bile acids supplemented diets as against the control. That is, supplementing with 100g to 200g of bile acids per metric ton of feed increased the carcass performance but decreased the abdominal fat significantly. This finding conformed to the recent study by (Wenqing Lai, Weigang Huang & Bing Dong 2017) but different in the inclusion level. However, it is interesting that bile acids can improve the absorption of dietary lipids which are not stored in abdominal fat. The abdominal fat pad is a reliable parameter for judging total body fat content because it is linked directly to total body fat content in avian species (Becker et al, 1979; Thomas et al, 1983).

**Table 4: Effects of Dietary Bile Acids on external and internal Offal's of Broiler Chickens**

| Parameters (g) | Control | 100g | 150g | 200g | 250g | SEM |
|---|---|---|---|---|---|---|
| Head | $41.50^{ab}$ | $46.50^{a}$ | $39.25^{ab}$ | $39.00^{ab}$ | $36.50^{b}$ | 1.24 |
| Neck | 77.5 | 87.25 | 89.75 | 75.5 | 78 | 2.51 |
| Shank | 67 | 65.5 | 72.5 | 60.75 | 61.75 | 2.43 |
| Liver | $40.75^{ab}$ | $45.75^{a}$ | $37.00^{ab}$ | $36.70^{ab}$ | $32.00^{b}$ | 1.54 |
| Heart | 8.75 | 9.25 | 9.5 | 9 | 7.5 | 0.4 |
| Spleen | 1.5 | 1.25 | 1.75 | 1.25 | 1.25 | 0.12 |
| Bile | $1.25^{b}$ | $1.25^{b}$ | $2.50^{a}$ | $1.50^{b}$ | $1.25^{b}$ | 0.13 |
| Gizzard | $40.25^{b}$ | $48.75^{a}$ | $44.25^{ab}$ | $44.00^{ab}$ | $41.25^{b}$ | 0.95 |
| Empty gizzard | $25.75^{bc}$ | $30.25^{a}$ | $27.50^{abc}$ | $26.00^{abc}$ | $23.75^{c}$ | 0.66 |
| Intestine weight | 118.75 | 116.25 | 120.75 | 113.25 | 135.75 | 4.28 |
| Intestine length | $227.50^{ab}$ | $227.25^{ab}$ | $236.00^{a}$ | $207.50^{b}$ | $220.75^{ab}$ | 4.03 |

$^{a,b,c}$ means within a row with different superscripts are significantly different at P>0.05

Bile acids improve significantly the bile secretion of the broiler chickens. Statistically, the supplemental dietary bile acids at 150g/ton of feed increased the bile secretion by 0.07% (1.25 grams of weight) and which was significantly different from the control treatment, 100g & 250g/ton of the supplemented bile acids but similar to 200g/ton at 5% significant level. Again, supplemental dietary bile acids efficiently improve the empty gizzard (Gizzard) of the broiler chickens at 100g/ton of feed. That is, at 100g of bile acids inclusion, the weight of the empty gizzard was higher and significantly different control treatment and 250g supplemented bile acids diet but similar to 150g and 200g inclusion rates. Explicitly, the less level of bile acids supplemented in broiler starter rations, the higher weight of gizzard. Interesting, supplemental dietary bile acids affected the head of the broiler chickens, as the inclusion rates of bile acids increases, the weight of the head decreases. Moreover, same trend also existed with respect to the liver of the broiler chickens in this present study. As the level of supplemental bile acids increases the liver weight decreases. The heavier relative liver size at 100g/kg of supplemented diet presumably enable birds to metabolized nutrient more efficiently, due to the drop in ME and endogenous enzyme secretions.

**Table 5: Effects of Dietary Bile Acids on relative live weight of primal cuts**

| Parameters (%) | Control | 100g | 150g | 200g | 250g | SEM |
|---|---|---|---|---|---|---|
| Thigh | $10.63^{ab}$ | $10.45^{ab}$ | $11.00^{ab}$ | $9.37^{b}$ | $11.49^{a}$ | 0.27 |
| Drumstick | 9.08 | 9.6 | 9.46 | 9.95 | 9.56 | 0.13 |
| Back | $14.85^{a}$ | $14.08^{ab}$ | $12.62^{b}$ | $14.18^{ab}$ | $13.17^{b}$ | 0.24 |
| Breast | $26.59^{ab}$ | $26.82^{ab}$ | $27.96^{a}$ | $25.55^{ab}$ | $24.19^{b}$ | 0.46 |
| Wings | 7.62 | 7.86 | 8.01 | 8.05 | 7.64 | 0.12 |

$^{a,b,}$ means within a row with different superscripts are significantly different at P>0.05

At 150g supplemental bile acids, the breast weight was improved by 1.37% as compared to the control treatment. Perhaps, there was no constant trend on the relative weight of primal cuts.

In conclusion, dietary supplementation of bile acids from swine in broiler chicken diets can effectively improve the growth performance, and carcass characteristics. The results indicate that 100g to 150g bile acids have the potential to improve absorption of dietary fat, carcass characteristics, and growth performance of broiler chickens.

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