Animal Feed Science and Technology 195 (2014) 92–100

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Effect of supplemental lipotropic factors on performance, immune responses, serum metabolites and liver health in broiler chicks fed on high-energy diets

V. Azadmanesh, R. Jahanian*

Department of Animal Sciences, College of Agriculture, Isfahan University of Technology, Isfahan 84156-83111, Iran

ARTICLE INFO

Article history:
Received 21 December 2013
Received in revised form 5 April 2014
Accepted 8 June 2014

Keywords:
Aspartate- and alanine-aminotransferases
Broiler chicks
Choline and carnitine
Immunological response
Liver health
Malondialdehyde

ABSTRACT

The present study was performed to investigate the effects of supplemental choline and carnitine on performance, antibody responses and some serum metabolites related to liver health in broiler chicks fed on high-energy diets. A total of 540 day-old Ross 308 chicks were randomly distributed between 9 experimental diets according to a 3 × 3 factorial arrangement of treatments including three dietary metabolizable energy (ME) levels (control, and 0.42 and 0.84 MJ/kg greater) and three status of dietary supplementation with lipotropic agents (control diet, or diets supplemented with either 1000 mg/kg choline as choline chloride or 100 mg/kg carnitine as L-carnitine) with 5 replicates of 12 birds each. Average daily feed intake (ADFI), average daily weight gain (ADWG) and feed conversion ratio (FCR) were recorded during the 42-day feeding trial. At the end of experiment, two randomly-selected birds per each replicate were slaughtered to measure liver fat. Also, serum samples were taken after immunization against Newcastle (NDV) and infectious bronchitis (IBV) disease viruses. The results showed that increase in dietary ME level caused an increase ($P<0.05$) in ADWG and decrease ($P<0.01$) in ADFI, whereby improved ($P<0.01$) FCR values. Similarly, dietary supplementation with lipotropic agents (particularly choline) decreased ($P<0.001$) ADFI and improved FCR values especially in birds fed on diets containing 0.42 MJ ME/kg greater than control. Although increase in dietary ME level improved ($P<0.05$) antibody responses to NDV (only at Day 12 postvaccine inoculation) and IBV compared with control diet, choline or carnitine supplementation of diets did not affect antibody production titers against both viral antigens. Supplemental lipotropic factors decreased ($P<0.01$) serum thiobarbituric acid-reactive (TBARS) substances, but increasing dietary ME level had an incremental effect ($P>0.05$) on TBARS value compared with control diet. While increase in dietary ME level resulted ($P<0.001$) in higher activity of serum alanine-aminotransferase (ALT), the activity of ALT as well as aspartate-aminotransferase were reduced ($P<0.05$) as a result of introducing lipotropic agents into the diets. Interestingly, dietary supplementation of lipotropic factors increased serum triiodotyronin concentration and reduced liver

Abbreviations: ADFI, average daily feed intake; ADWG, average daily weight gain; ALT, alanine-aminotransferase; AST, aspartate-aminotransferase; BWG, body weight gain; CP, crude protein; FCR, feed conversion ratio; HDL, high-density lipoproteins; IBV, infectious bronchitis virus; LDL, low-density lipoproteins; ME, metabolizable energy; NDV, Newcastle disease virus; TBARS, thiobarbituric acid-reactive substances; TG, triglycerides; T_3, triiodotyronin.

* Corresponding author. Tel.: +98 311 391 3511; fax: +98 311 391 3471; mobile: +98 913 233 3039.
E-mail addresses: r.jahanian@gmail.com, r.jahanian@cc.iut.ac.ir (R. Jahanian).

http://dx.doi.org/10.1016/j.anifeedsci.2014.06.004

fat percentage (P<0.01). Dietary inclusion of carnitine caused a marked (P<0.01) increase in serum triglycerides at Day 42 of age. The present findings suggest that while high-energy diets improve broiler growth performance, dietary supplementation of choline and/or carnitine could remove probable unfavorable impacts of these diets via reducing liver fat and probably maintaining liver health.

1. Introduction

Increase in human population size and subsequent increase in requirements for food exhorted the poultry industry to improve the growth rate and production intensity in broilers. Intensive selection of broiler chicks for higher body weight gains (BWG) has been one of these strategies over the last five decades. This selection strategy has resulted in a greater growth rate and also improved feed conversion efficiency (Leeson and Summers, 2005). Genetic improvements of broiler flocks for higher growth rate have increased their sensitivity to stresses and metabolic disorders such as sudden death syndrome and ascites, especially at the finisher stages (Leeson et al., 1995). Using high-energy diets to lower rearing period may decrease the issues related to long production periods, but these types of diets are accompanied with additional problems such as fatty liver that may also damage the liver health (which is very important in bird's metabolism). Increase in abdominal fat pad, and incidence of leg problems and metabolic disorders (Buyse et al., 2001) are some other undesirable responses related to these types of diets.

One of the best nutritional strategies to handle high-energy diets for broilers is the application of lipotropic factors. Lipotropic agents are the compounds that may help rapid growth species to efficiently utilize high-energy diets. In addition, these compounds have a critical role in lipid turnover. These molecules can reduce fat deposition in liver, in part, due to increasing the liberation of them from liver. Choline, L-carnitine, methionine, inositol, betaine, biotin and vitamin B_{12} have been known as the important lipotropic agents (Scott et al., 1982; Leeson and Summers, 2005).

β-Hydroxy ethyl trimethyl ammonium hydroxide, so-called choline, is a main lipotropic agent and has an important role in fat metabolism by stimulating fat transmission and/or increasing the biodegradation of fatty acids to prevent the storage of fat in tissues (Artom, 1953). One of the important functions of choline is its critical role as a methyl donor (transmethylation). For this, choline must initially be oxidized to betaine (Olthof and Verhoef, 2005). Resulting betaine has two primary metabolic roles: it is a main methyl group donor and it is an osmolyte that assists in cellular water homeostasis (Petronini et al., 1992). It is well understood that choline may act as a methyl group donor but, in order to this function, it needs to be converted to betaine in the mitochondria (Molitoris and Baker, 1976). In the function as a methyl group donor, betaine, choline and methionine have the strong interrelationships.

Carnitine (γ-trimethyl-amino-β-hydroxybutyrate), another lipotropic agent, is also known for its potential to transport long chain fatty acids into the mitochondrial matrix for β-oxidation (Broquist, 1982). Although choline and carnitine have been known for their stimulatory effects on lipid turnover, however, there are contradictory results about the effects of dietary choline and carnitine on performance and health status of broiler chicks. As Waldroup et al. (2006) reported, using 1000 mg choline/kg of diet improved feed efficiency at 35 and 42 days of age in broilers. Abdominal fat percentage also decreased using 1000 mg/kg choline alone or in combination with betaine in broiler's diet (Jahanian and Rahmani, 2008). Also, Hamidi et al. (2010) showed that dietary betaine supplementation at the levels of 600 and 1200 mg/kg could improve BWG and feed conversion ratio (FCR) as well as increased serum and luminal (jejunum) IgA in coccidia-challenged broiler chicks. Latshaw and Jensen (1972) indicated that while choline deficiency caused excess liver fat in Japanese quails, introducing choline into the diet could significantly reduce liver fat. Contrary to these reports, Swain and Johri (2000) reported that supplemental levels of methionine or choline were ineffective in improvements of BWG, feed consumption and feed conversion efficiency in broilers.

According to Rabie and Szilagyi (1998) and Kita et al. (2002) dietary L-carnitine supplementation could improve BWG, feed consumption and FCR in broiler chicks. Deng et al. (2006) observed stimulatory effects of dietary L-carnitine on humoral immune responses of layer chicks. Also, Ghods-Alavi et al. (2010) reported that dietary supplementation with 100 mg/kg carnitine decreased abdominal fat pad in laying hens. In contrast, a lot of studies showed no significant effect due to supplementing carnitine into the broiler diets. In study by Lien and Horng (2001), no change in performance, abdominal fat and liver weight were observed by dietary supplementation of 160 mg/kg L-carnitine in broilers. Similarly, Xu et al. (2003) observed no effect on performance of male broiler chicks as a result of supplemental L-carnitine.

Because there are few research studies to examine the interactive effects of lipotropic factors (choline and carnitine) and high-energy diets, the present study was designed to investigate the effect of these lipotropic agents on performance, immune responses, liver health, thyroid activity, serum lipid metabolites and antioxidant status in broiler chicks fed on diets with incremental levels of metabolizable energy (ME).