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Use of acetylsalicylic acid as an allostatic modulator in the diets of growing Japanese quails exposed to heat stress

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ABSTRACT

The purpose of this study was to investigate the effect of dietary acetylsalicylic acid (ASA) supplementation on performance, carcasses and some blood metabolites of growing quails exposed to heat stress. Three hundred sixty mix sexed Japanese quail chicks at 2 wk of age with average initial body weight of 77.4 g were randomly allotted to six dietary groups in a 3 × 2 factorial design with three dietary ASA doses (0, 0.5 and 1 g ASA/kg diet) and two ambient temperatures (one normal at 23 ± 2 °C and other high at 33 ± 2 °C). Body weight, daily body weight gain and feed consumption reduced in quails exposed to heat stress (33 °C) during 2–4 wk of age, but not during 4–6 wk of age and during total period (2–6 wk of age). Growth rate and feed utilization were not influenced by ASA supplementation or interaction between ASA supplementation and house temperature at all ages ($P > 0.05$). All carcass parameters were not affected ($P > 0.05$) by temperature or dietary ASA or their interactions except dressing percent was decreased ($P = 0.025$) by ASA. Plasma cholesterol and total lipid were affected by the interaction effect, which were elevated in birds exposed to high ambient temperature ($P = 0.004$ or 0.022) and ASA supplementation ($P = 0.041$ or $P = 0.003$). Glucose concentrations were also influenced by interaction effect, which increased due to ASA supplementation at normal temperature, but were not affected at high temperature. The effect of high ambient temperature or its interaction with ASA did not affect hepatic enzymes and thyroid hormones of growing quails. Diets supplemented with ASA (1000 mg/kg) decreased plasma contents of aspartate transaminase, triiodothyronine (T3) and thyroxin (T4) compared with the control. It is concluded that applications of ASA in quail diets are not suitable in mitigating the disturbances induced by heat stress in the most studied parameters.

1. Introduction

High environmental temperature incurs a great economic loss in poultry industries due to reduced growth rate and laying performance of birds including quails, and is also a concern with respect of welfare of poultry birds (El-Kholy et al., 2017). Heat-related stress has become a serious problem in poultry industry along with the global temperatures rise. High ambient temperature causes deleterious impacts on physiology and immunology resulting in abnormalities and impaired productivity of birds (Alagawany et al., 2017a). Heat stress may harm the function of intestinal barriers and suppress the immunity which facilitate gut luminal bacteria and endotoxin invasion, and also increase the serum levels of corticosterone, inflammatory cytokines, TNF-α and IL-2 in broiler birds (Alhanof et al., 2017). The adverse impacts of heat stress in poultry production can be alleviated through housing design, setting of cooling systems, changes in dietary constituents to account for reduced feed intake, requirements of various nutrients, and dietary supplementation of feed additives (Farghly et al., 2017, 2018). Housing design and cooling systems involve a great amount of cost in quail production. Since high ambient temperature in poultry house reduces the growth performance, feed intake and feed efficiency (El-Kholy et al., 2017), one of the effective ways to mitigate the undesirable impacts of high temperatures and heat stress on productivity and wellbeing of poultry is dietary manipulations including the use of antioxidants and probiotics. In this context, acetylsalicylic acid (ASA) has been suggested to add in feeds of animal and poultry as an allostatic modulator (Rokade et al., 2016).

Acetylsalicylic acid is a widely used antipyretic drug (Wu et al., 2016). Accordingly, it acts as hypothalamic thermostat (Truong et al., 2016) by inhibiting the biosynthesis of prostaglandins, which may be beneficial during heat stress. Supplementation of ASA to poultry diets resulted in improvement of the productive performance and

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physiological stress indicators under the heat stress (Wu et al., 2015), though there are some inconsistent reports (Mcdaniel et al., 1993; Mcdaniel and Parker, 2004; Alagawany et al., 2017b).

The feed additives including ASA are included both in feeds and the water (Brake et al., 1994; Naseem et al., 2005). The use of 2 g/kg of ASA in diets increased live body weight and mortality due to ascites in broiler chickens reared in high density (15 birds/m^2) pens (Al-Obaidi and Al-Shadeedi, 2010). Similarly, increased body weight of broiler chickens receiving 1 g/kg of aspirin was noted in another study (Al-Mashhadani et al., 1988). A study of Poźniak et al. (2013) showed that broiler chickens did not show side effects when fed diets with 100 and 200 mg/kg of ASA. Various hematological variables were not changed due to ASA supplementation, but concentrations of serum cholesterol and glucose lowered in the groups treated with 0.5–1.5 g/L of ASA in water (Mohammed, 2010). The information related to the use of ASA under heat stress conditions on carcass and hematological parameters of Japanese quails are limited and the earlier studies on the effects of ASA supplementation in poultry diets resulted in inconsistent conclusions. Therefore, this study was conducted to investigate the effects of dietary ASA on growth performance, carcass traits and some hemato-biochemical variables in growing Japanese quails under heat stress conditions.

2. Materials and methods

2.1. Birds, treatments and diets

The experiment was conducted in a 3 × 2 factorial arrangement with three levels of ASA (0, 500 or 1000 mg ASA/kg diet) and two ambient temperatures (23 ± 2 °C and 33 ± 2 °C). Three hundred sixty unsexed Japanese quail chicks of 2-wk-old and an average initial body weight of 77.4 ± 0.33 g were randomly allocated to 6 groups of 60 chicks each with 4 replicates (15 chicks in each pen). Each pen had size of 90 × 40 × 40 cm. The control (basal) diet was prepared following the NRC (1994) to fulfill the nutrient requirements of growing quails throughout the period 2–6 wk of age (Table 1). The control diet was added with ASA at 500 or 1000 mg/kg diet for each level (23 ± 2 °C and 33 ± 2 °C) of ambient temperatures. During the first 2 wk of age, chicks were kept in brooders with wire floors and reared under the same hygienic and management conditions. During the experimental period of 2–6 wk of age, the ambient temperature was set at 33 ± 2 °C in heat stress groups, but the ambient temperature was set at 23 ± 2 °C in the thermoneutral groups. The lighting schedule was 23 h light with 1 h dark period. Water and feed were provided on ad-libitum during the experiment (2–6 wk-old). Acetylsalicylic acid was purchased from El-Gomhouria Company for Trading Chemicals and Medical, Zagazig, Egypt.

Table 1
Composition and calculated analysis of the basal diets.

Item	Basal diet
Ingredients (%)	
Yellow corn	56.71
Soybean meal (44%)	34.00
Corn gluten meal (60%)	6.30
Bone meal	2.35
Limestone	0.00
Premix[a]	0.25
NaCl	0.20
Dl- Methionine	0.06
L-Lysine Hcl	0.13
Cotton seed oil	0.00
Total	100
Calculated analysis[b]	
Crude protein %	24.05
ME (kcal/kg)	2901
Crude fiber %	3.81
Crude fat%	2.58
Calcium %	0.81
Available phosphorus %	0.45
Lysine %	1.33
Methionine + Cystine %	0.90

[a] Premix: Each 2.5 kg consists of: Vit. A 12,000 IU; Vit. D3, 2000 IU; Vit. E, 10 g; Vit k3, 2 g; Vit B1, 1000 mg; Vit B2, 4 g; Vit B6, 1.5 g; Vit B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g; Folic acid, 1000 mg; Biotin, 50 mg; Choline chloride, 500 g; Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn, 45 g.

[b] Calculated according to NRC (1994).

2.2. Growth performance

Quails were weighed individually at weekly intervals to determine body weight gain (BWG). Feed consumption (FC) and feed conversion ratio (FCR, g feed/g gain) were calculated by period as well as total. Feed losses were daily recorded to compute the feed consumption.

2.3. Carcass traits

Forty eight quails (eight in each group) at 6 wk of age were randomly selected, weighed and manually slaughtered for evaluation of carcass traits. The carcass parts (eviscerated carcass, liver, gizzard and heart) were weighed to express carcass traits as g/kg of slaughter body weight. Dressing percentage was calculated as follows: dressing percentage = carcass weight plus giblets (liver, gizzard and heart) weight*100/ pre-slaughter body weight.

2.4. Sampling of blood and laboratory analyses

At 6 wk of age, blood samples were collected randomly from four quails per group into heparinized tubes. Blood samples were centrifuged at 2147 g for 10 min and plasma samples were transferred to 2 ml tubes and kept at − 20 °C till analyses. Total plasma proteins (g/dl), albumin (g/dl), total lipids (mg/dl), AST (aspartate transaminase; U/l), ALT (alanine transaminase; U/l), cholesterol (mg/dl) and glucose (mg/dl) were analyzed using commercial kits described by the manufacturing companies (Spectrum Diagnostics Egyptian Company for Biotechnology, S.A.E.). Thyroid hormones i.e., T3(triiodothyronine; ng/ml) and T4 (thyroxin; ng/dl) were determined by RIA method (Akiba et al., 1982). Hemoglobin (Hb) was measured in the whole blood samples as per Dukes and Schwarte (1931). Packed cell volume (PCV) in blood was determined using microhematocrit tubes by centrifuging for 10 min at 2147 g (Schalm, 1961).

2.5. Statistical analyses

Performance, carcasses, and biochemical blood parameters data were analyzed using ANOVA in a 3 × 2 factorial arrangement. The statistical model included the effects of house temperature, ASA levels and their interaction:

$$Y_{ij} = \mu + A_i + E_j + AE_{ij} + e_{ij}$$

where, Y_{ij}: an observation, μ: the overall mean, A_i: the ASA effect (0, 500 or 1000 mg ASA /kg diet), E_j: the temperature effect (23 ± 2 °C and 33 ± 2 °C), AE_{ij}: the ASA × temperature interactions (= 1,2 … and 6), and e_{ij}: the random error. Differences among means were investigated by the post hoc Newman-Keuls test.

3. Results and discussion

3.1. Growth performance

The effects of temperature, dietary ASA supplementation, and their combinations on performance of growing quails during period 2–6 wk of age are shown in Figs. 1 and 2. Exposure to heat stress (33 ± 2 °C)