

Effects of dietary vitamin B₆ and L-carnitine on growth performance and carcass characteristics of broilers reared under high temperature regime

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The objectives of the present study were to evaluate whether dietary supplemental vitamin B₆ and L-carnitine affect growth performance of broilers under high temperature regime. A two by two factorial arrangement was employed with two levels (0 or 3 mg/kg) of supplemental vitamin B₆ in feed and two levels (0 or 60 mg/kg) of supplemental L-carnitine in drinking water as main effects. 72, one-day-old broiler chicks were divided in four treatment groups (group 1: no supp., group 2: 3ppm vit B₆, group 3: 60 ppm L-carnitine, group 4: 3ppm vit B₆+60 ppm L-carnitine), comprising 18 bird each, in a complete randomized design. The birds were randomly allocated in individual cages under heat stress condition (34 to 36°C for 8 h and 20-22°C for 16 h per day) for a period of 42 days. Feed and water were provided *ad libitum* under 24 hours lighting regime. During the trial growth performance was evaluated by measuring feed intake, body weight gain and feed conversion efficiency weekly. At the end of the feeding period, the birds were slaughtered for carcass analyses. The data were analysed ANOVA procedure of SAS (1987). The threshold for significance was $P \leq 0.05$.

The results obtained at 42 days of age showed that body weight gain (2210 g, 2154 g, 2077 g and 2258 g in groups 1 to 4, respectively) and feed intake (3653 g, 3598g, 3464 g and 3762 g in groups 1 to 4, respectively) were significantly improved by vitamin B₆+L-carnitine supplementation at the end of the experiment. Supplemental vitamin B₆+L-carnitine significantly increased carcass weight (1645 g, 1618 g, 1553 g and 1698 g in groups 1 to 4, respectively). Additionally, vitamin B₆ x L-carnitine interactions were observed on body weight gain, feed intake and carcass weight, in which B₆ supplementation exhibited its positive effects on performance when used with L-carnitine, while having no positive effects when used alone. It was also observed that vitamin B₆ and/or L-carnitine had no significant effects on feed conversion efficiency, carcass yield, liver and abdominal fat weight of broilers under the present experimental condition.

It is concluded that dietary supplemental vitamin B₆+L-carnitine could have positive effects on body weight gain, feed intake and carcass weight growing in broilers.

Keywords: broiler; vitamin B₆; L-carnitine; growth performance; high temperature

Introduction

Vitamin B₆ is essential because of its participation in more than 100 enzymatic reactions, including protein metabolism, biosynthesis of carnitine, and the balance of sodium and potassium. In addition, vitamin B₆ facilitates the release of glycogen from the liver and skeletal muscles so that it can be used for energy (Kannan and Jain, 2004). Vitamin B₆ is known to be prerequisite for immunity to stimulate antibody production. Blalock et al. (1984) reported that pyridoxine deficiency causes significant reduction in antibody levels in broilers. Mahfouz and Kummerow (2004) indicated that vitamin B₆ supplementation prevented the oxidative stress and had an antioxidative effect in homocysteinemic rats. Kannan and Jain (2004) also showed that vitamin B₆ compounds inhibited the oxygen radical generation, reduced lipid peroxidation and damage to mitochondrial membrane.

Like vitamin B, carnitine is a vital micronutrient required for lipid metabolism and energy production for poultry. Carnitine is synthesized from methionine and lysine with magnesium-ATP,

vitamins C, B₆, niacin and iron, which are all necessary as catalysts (Bremer, 1983). These substances may alter carnitine metabolism and/or tissue distribution and must be available particularly under stressful conditions. Providing sufficient amount of L-carnitine to broilers resulted in more efficient utilisation of dietary energy and protein (Rabie and Szilágyi, 1998; Rabie et al., 1997). Harpaz et al. (1999) demonstrated that supplementation of L-carnitine to the diet resulted in better protection against cold stress. Dietary carnitine supplementation had also a significant effect on the response of chicks to the acute heat stress (Whitehead et al., 1997). Additionally, L-carnitine strengthened immune function by enhancing antibody responses in L-carnitine supplemented leghorn-type chickens (Deng et al., 2006).

Extensive studies have been carried out on the effect of carnitine supplementation in poultry. However, no study reported yet possible effect(s) of vitamin B₆, vitamin B₆ + L-carnitine on performance under stressful conditions. The aim of the present study was therefore to investigate whether dietary supplementation of vitamin B₆ and L-carnitine would have synergic effects on growth performance of broiler exposed to a high ambient temperature.

Materials and methods

Seventy-two, one-day-old male broiler chicks (Ross 308) obtained from a commercial hatchery were assigned to four dietary treatments with a similar mean weight (45.0 g; SE 3.50) comprising 18 birds each. Broiler starter (230 g/kg CP and 13.4 MJ/kg AME, from 1-3 weeks) and finisher (200 g/kg CP and 13.4 MJ/kg AME, from 4-6 weeks) diets were formulated (*Table 1*), with a similar nutrient profile of each. A two by two factorial arrangement was employed with two levels of vitamin B₆ (0 or 3 ppm) and two levels of L-carnitine (0 or 60 ppm) in the feed as main effects. According to the experimental design, four treatments group (group 1: no supp., group 2: 3 ppm vit B₆, group 3: 60 ppm L-carnitine, group 4: 3 ppm vit B₆+60 ppm L-carnitine) were obtained. The birds were randomly allocated in individual cages of three tiers battery blocks under heat stress condition (34 to 36°C with a relative humidity of 40 to 50% for 8 h and 20-22°C with a relative humidity of 60-70% for 16 h per day) for a period of 42 days. Feed and water were provided *ad libitum* under 24 hours lighting regime. Feed intake, body weight, feed conversion ratio (g feed:g gain) were calculated weekly. At the end of the experiment all birds were slaughtered, immediately plucked, eviscerated then weighed and then chilled overnight in a fridge in order to facilitate the removal of abdominal fat before estimation of cold carcass weight.

The data obtained in the experiment were analysed using the ANOVA procedure of SAS (1985) and treatment means were separated using Duncan's New Multiple Range Test.

Table 1 Composition and nutrients of basal diets

<i>Ingredients (g/kg)</i>	Starter (Week 1-3)	Finisher (Week 4-6)
Corn	471.5	549.1
Soyabean meal, (460 g/kg CP)	141.0	120.6
Corn gluten meal	99.9	50.5
Fullfat-soya	220	220.0
Vegetable fat	31.8	25.1
Dicalcium phosphate	17.6	16.6
Limestone	8.9	9.8
Lysine	0.2	-
Salt	2.5	2.5
Soda	1.6	1.5
Anticoccidial	1.5	0.8
Vitamin premix ¹	2.0	2.0
Mineral premix ²	1.5	1.5
TOTAL	1000.0	1000.0
<i>Analyses (g/kg)</i>		
Dry Matter	888.8	886.2
Crude Protein	230.0	200.0
Ether extract	93.6	87.0
Crude Fiber	35.7	36.4
Crude Ash	64.0	63.1
Lysine	11.0	10.0
Methionine+Cystine	9.1	7.4
Calcium	9.0	9.0
Available P	4.5	4.3
Sodium	1.6	1.6
AME (MJ/kg)**	13.4	13.4

*: AME (MJ/kg) was calculated using EC equation (Larbier and Leclercq, 1994, p. 71)

¹: each 2 kg of vitamin premix contain 12 000 000 IU Vitamin A, 3 500 000 IU Vitamin D₃, 100 g Vitamin E, 3 g Vitamin K₃, 2.5 g Vitamin B₁, 6 g Vitamin B₂, 25 g Niacin, 12 g Ca-D-Pantothenate, 15 mg Vitamin B₁₂, 1.5 g Folic Acid, 150 mg D-Biotin, 100 g Vitamin C, 450 g Choline Chloride,

²: each kg of mineral premix contain 100 mg Manganese, 25 g mg Iron, 65 g Zinc, 15 g Copper, 0.25 g Cobalt, 1 g Iodine, 0.2 g Selenium.

Results and discussion

The growth performance of the broilers fed the diet containing different levels vitamin B₆ and L-carnitine are summarized in Tables 2 (feed intake), 3 (body weight gain), 4 (feed conversion ratio) and 5 (carcass characteristics).

The broiler received vitamin B₆+L-carnitine (group 4) exhibited superior weight gain throughout the experiment except the second week. Body weight gain was significantly improved by vitamin B₆+L-carnitine supplementation especially during the last two weeks of the experiment ($P<0.05$). The improvements with vitamin B₆+L-carnitine under heat stress could be attributed to vitamin B₆ and L-carnitine's potential regulatory effects on energy metabolism and their potential role in modulating oxidative stress as antioxidants (Dayanandan et al., 2001, Derin et al., 2006) besides role of vitamin B₆ in gluconeogenesis and glycogenolysis (Okada et al., 1999). It is known that high temperature caused oxidative stress, increased lipid peroxidation, and disturbed some plasma parameters in broilers (e.g. Altan et al., 2003). Under these circumstances, vitamin B₆ and L-carnitine help to maintain physiological equilibrium of the body by improving fat utilization and energy expenditure (Çelik and Öztürkcan, 2003). It could be therefore speculated that vitamin B₆+L-carnitine could have potential to improve growth performance by increasing protein synthesis and improving fat utilisation.

Vitamin B₆+L-carnitine also affected feed consumption during the last two weeks of the experiment ($P<0.05$). However, feed conversion ratio was not affected ($P>0.05$) and all the birds utilized similar amount of feed for each kg of weigh gain during the experimental period (Table 4). However, data on the effects of dietary vitamin B₆ on performance of broilers are very limited. Comparable data could not be found in the literature on the effects of supplemental dietary vitamin

B₆+L-carnitine on performance of broilers exposed to heat stress. However, the improvements in feed intake with vitamin B₆ and L-carnitine in this experiment could be attributed to their role in prevention of oxidative stress and also improving energy utilisation, leading to increase in feed intake, especially during the later stages of growing period in which animals increase energy intake to maintain weigh gain.

As it can be seen from Table 5, broiler fed on vitamin B₆+L-carnitine (1698 g in group 4) supplemented diet had a higher carcass weight than the other groups (1645 g, 1618 g and 1553 g in groups 1 to 3, respectively). The effects of vitamin B₆+L-carnitine on carcass weight found to be similar to body weigh gain. However, there were no significant differences in carcass yield, liver weight, abdominal fat weight or relative abdominal fat weight among broilers fed any of the dietary treatments.

Table 2 Effect of dietary vitamin B₆ and L-carnitine on cumulative feed intake (g/bird) of broiler chicks exposed to a high ambient temperature

LC (mg/kg)	0		60		Main Effects			SED	
	VitB ₆ (mg/kg)		LC		VitB ₆	LCxVitB ₆			
	0	3	0	3	LC	VitB ₆	LCxVitB ₆		
Weeks	1	103.56	103.00	105.60	113.25	NS	NS	NS	3.13
	2	373.25	359.00	363.53	383.17	NS	NS	NS	7.53
	3	829.44	794.14	793.80	852.00	NS	NS	NS	15.91
	4	1535.25	1497.93	1450.60	1606.25	NS	NS	NS	26.14
	5	2404.63ab	2361.57ab	2291.60b	2523.33a	NS	NS	*	34.37
	6	3652.69ab	3597.50ab	3463.47b	3761.50a	NS	NS	*	47.06

SED : Standard error of difference between means

NS : Not significant (P>0.05)

* : P<0.05

Table 3 Effect of dietary vitamin B₆ and L-carnitine on body weight gain (g/bird) of broiler chicks exposed to a high ambient temperature

LC (mg/kg)	0		60		Main Effects			SED	
	VitB ₆ (mg/kg)		LC		VitB ₆	LCxVitB ₆			
	0	3	0	3	LC	VitB ₆	LCxVitB ₆		
Weeks	0	44.49	44.16	44.19	45.40	NS	NS	NS	0.43
	1	79.70	78.63	80.88	81.27	NS	NS	NS	2.33
	2	281.76	268.34	273.28	281.43	NS	NS	NS	6.20
	3	596.45	563.34	571.35	604.60	NS	NS	NS	12.20
	4	1034.08	1003.06	965.28	1068.85	NS	NS	NS	17.62
	5	1534.01	1487.27	1450.61	1580.68	NS	NS	*	21.42
6	2209.58	2154.41	2077.41	2258.35	NS	NS	*	27.93	

SED : Standard error of difference between means

NS : Not significant (P>0.05)

* : P<0.05

Table 4 Effect of dietary vitamin B₆ and L-carnitine on feed conversion ratio (g feed/g gain) of broiler chicks exposed to a high ambient temperature

LC (mg/kg)	0		60		Main Effects			SED	
	VitB ₆ (mg/kg)		LC		VitB ₆	LCxVitB ₆			
	0	3	0	3	LC	VitB ₆	LCxVitB ₆		
Weeks	1	1.31	1.33	1.31	1.40	NS	NS	NS	0.022
	2	1.33	1.35	1.34	1.36	NS	NS	NS	0.000
	3	1.40	1.41	1.39	1.41	NS	NS	NS	0.009
	4	1.49	1.49	1.51	1.50	NS	NS	NS	0.008
	5	1.57	1.59	1.58	1.60	NS	NS	NS	0.009
	6	1.65	1.67	1.67	1.67	NS	NS	NS	0.011

SED : Standard error of difference between means

NS : Not significant (P>0.05)

* : P<0.05

Table 5 Effect of dietary vitamin B₆ and L-carnitine on carcass parameters of broiler chicks exposed to a high ambient temperature

LC (mg/kg) VitB ₆ (mg/kg)	0		60		Main Effects			SED
	0	3	0	3	LC	VitB ₆	LCxVitB ₆	
Carcass weight (CW, g/bird)	1645ab	1618ab	1553b	1698a	NS	NS	*	23.07
Carcass yield (% of BW at 42 d old)	72.96	73.54	73.08	73.71	NS	NS	NS	0.29
Liver weight (g/bird)	46.98	43.50	43.07	44.30	NS	NS	NS	1.27
Abdominal fat weight (g/bird)	31.61	29.53	30.63	30.88	NS	NS	NS	1.40
Relative abdominal fat weight (% of CW)	1.91	1.82	1.92	1.82	NS	NS	NS	0.08

CW : Carcass weight

BW : Body weight

SED : Standard error of difference between means

NS : Not significant (P>0.05)

* : P<0.05

Conclusion

In conclusion, the present study showed that dietary supplemental vitamin B₆+L-carnitine resulted in a maximal benefit in performance of broiler chicks exposed to a high ambient temperature.

Acknowledgements

The author is grateful to Çukurova University Research Fund and Lohmann Animal Health, Cuxhaven, Germany for their supports.

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