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Effects of Dietary Levels of Methionine on Broiler Performance and Carcass Characteristics

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Abstract: The present experiment was carried out to determine the effect of dietary methionine levels higher than NRC recommendation on broiler performance and carcass traits. Four dietary levels of methionine 0, 100, 120 and 130% of NRC recommendation were used. Dietary levels of methionine, expressed as percentage of NRC recommendations, significantly ($p \leq 0.05$) affected feed intake, Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER). Feed intake was numerically improved with 110 and 130% of NRC methionine, but was not improved by 120% NRC methionine. Body weight gain was significantly ($p \leq 0.05$) improved by 110 and 130% of NRC methionine compared to the control. The broiler chicks on methionine higher than NRC showed significant ($p \leq 0.05$) increase in absolute and relative weight of breast and significant ($p \leq 0.05$) decrease in abdominal fat.

Key words: Methionine, broilers, overall performance, carcass

INTRODUCTION

Methionine is an essential nutrient for poultry. In addition, this amino acid provides methyl groups, which are needed for several metabolic reactions such as the synthesis of carnithine and creatine (Schutte *et al*., 1997). Methionine is considered to be the first limiting amino acid in broilers fed practical corn-soybean meal diets. Adequate dietary level of this amino acid is needed to support optimum growth and carcass yield of fast-growing commercial broilers (Ojano-Dirain and Waldroup, 2002). Many poultry nutritionists use the levels recommended by the National Research Council (NRC, 1994) as a guideline in establishing their own amino acid requirements, regardless of location and environmental conditions. A limitation of using the NRC recommendations in warm weather feeding is that these levels are derived primarily from studies conducted in thermoneutral environments and do not indicate possible differences in amino acid needs due to environmental temperatures. Since very little information is available on the amino acid needs of broilers raised in warm environments, nutritionists confronted with warm weather feeding generally add margins of safety to the NRC levels (Ojano-Dirain and Waldroup, 2002). Although the NRC also suggests increasing the amino acid levels in warm environments to compensate for the expected reduction in feed intake, the NRC noted that this adjustment should be exercised with caution since some studies have indicated that minimizing excesses of dietary crude protein (Austic, 1985) and amino acids (Waldroup *et al*., 1976) with improved amino acid balance may be more beneficial for broilers raised in warm environments. In recent years, a number of studies have demonstrated that elevated environmental temperatures influence the amino acid needs of broilers, either as a function of reduced amino acid digestibility (Zuprizal *et al*., 1993; Hai *et al*., 2000) or as a result of decreased feed intake (Howlider and Rose, 1987). However, very few studies have been done to determine the amino acid needs of growing-finishing broilers raised under warm environments. In addition, previous studies on protein/amino acid nutrition of heat stressed broilers have shown conflicting results. Waldroup *et al*. (1976) showed that minimizing dietary amino acid excesses improved growth of broilers housed in hot temperatures. A series of studies conducted by Cheng *et al*. (1997) showed no advantage of increasing dietary amino acid levels of 3 to 7 week-old broilers when raised above 26.7^{o}C thus, they recommend feeding 90-100% of NRC suggested amino acid levels. Conversely, other researchers have reported that heat-stressed birds respond positively to increased amino acid consumption (e.g., Fuller and Mora, 1973; Dale and Fuller, 1980). On the other hand, the sensitivity of breast meat yield in broilers to dietary methionine has been demonstrated (Schutte and Pack, 1995a). Methionine may interact with the lipid metabolism by stimulating the oxidative catabolism of fatty acids via its role in carnithine synthesis, thus offering a potential for reduced carcass fatness in commercial production

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Table 1: Composition of experimental broiler starter diets containing graded levels of methionine

	Treatments			
Ingredients %	Control	110% NRC Methionine	120% NRC Methionine	130% NRC Methionine
Sorghum	57.60	57.60	57.60	57.60
Ground nut meal	16.00	16.00	16.00	16.00
Sesame meal	16.50	16.50	16.50	16.50
Wheat bran	0.50	0.50	0.50	0.50
Super concentrates*	5.00	5.00	5.00	5.00
Dicalcium phosphate	1.10	1.10	1.10	1.10
Oyster shell	0.30	0.30	0.30	0.30
NaCl	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.25
Methionine	0.00	0.05	0.10	0.15
Vitamin premix	0.25	0.25	0.25	0.25
Vegetable oil	2.10	2.25	2.20	2.15
Calculated analysis				
ME (kcal/kg)	3195.31	3190.91	3186.50	3182.10
CP %	23.54	23.54	23.54	23.54
Crude fiber %	4.47	4.47	4.47	4.47
Ca %	1.03	1.03	1.03	1.03
Available phosphorous %	0.45	0.55	0.45	0.45
Lysine %	1.15	1.15	1.15	1.15
Methionine %	0.50	0.55	0.60	0.65
Methionine + Cystine %	0.79	0.83	0.83	0.83
Determined analysis				
CP %	25.12	24.13	24.05	24.19
Crude fiber %	4.81	4.77	4.17	4.32
EE %	4.15	4.67	4.54	4.66
Ash %	7.12	7.15	7.23	7.31
Ca %	1.18	1.16	1.16	1.15
Total phosphorous %	1.62	1.63	1.59	1.59

*Cp 40%, ME 2000 kcal/kg, C. fiber 3%, EE 3%, Ash 34%, Ca 8%, Av. P 1.38%, Lysine 12%, Methionine 3%, Methionine + Cystine 3.5%. Vitamin A 250000 IU/kg, Vitamin D3 50000 IU/kg, Vitamin E 500 mg/kg, Vitamin K3 60 mg/kg, Vitamin B1/Thiamin 20 mg/kg, Vitamin B2/Riboflavin 100 mg/kg, Niacin Vitamin PP 600 mg/kg, Pantothenic acid/Vitamin B3 160 mg/kg, Vitamin B6/Pyridoxine 40 mg/kg, Vitamin B12 300 mcg/kg, Biotin/Vitamin H 2000 mcg/kg, Choline 10000 mg/kg, Vitamin C 4000 mg/kg, Folic Acid 30 mg/kg, Iron 800 mg/kg, Manganese 1400 mg/kg, Copper 120 mg/kg, Zinc 1000 mg/kg, Iodine 6 mg/kg, Cobalt 12 mg/kg, Selenium 3 mg/kg

(Schutte *et al.*, 1997). Ojano-Dirain and Waldroup (2002) found that methionine levels (0.38, 0.44 and 0.50%) affected both growth and carcass yield. However, for these different levels, mortality was low and was not significantly ($p \geq 0.05$). The objective of the present study was to investigate the impact of different levels of methionine higher than that recommended by NRC on various performance parameters and carcass characteristics in broilers.

MATERIALS AND METHODS

This experiment was initiated with 120 one-day-old unsexed broiler chicks (Hubbard) that obtained from Arab Poultry Breeders Company. The chicks were housed randomly in an open-sided poultry house at poultry unit, Faculty of Agricultural Technology and Fish Sciences, Alneelain University.

The chicks with average weight of 45.74±1.19 and 2.59% Coefficient of Variation (CV) were divided into four dietary treatments groups; each treatment was replicated in 3 floor pens (1 x 1 x 1 m) containing 10 chicks per pen. Vaccination for Marek's disease was done at the hatchery, while vaccination against Newcastle and infectious bronchitis disease was done at 5 and 27 day of age and vaccination for infectious bursal disease followed at 11 and 20 day of age. From 0-5 day of age, all birds were fed a pelleted prestarter diet (Table 1). Experimental diets were fed from second week to sixth week. Chicks had free access to feed and water and 24 h of light was provided.

Experimental starter and finisher diets were formulated to consist of different levels of methionine (100% of NRC, 110% of NRC, 120% of NRC and 130% of NRC (Table 2). Live body weight, feed intake and mortality were recorded weekly and body weight gain, feed conversion ratio FCR and protein efficiency ratio PER were calculated weekly.

Data were analyzed by ANOVA and means were compared using Duncan's multiple range test (Steel and Torrie, 1980) in SAS version 6.12 (SAS, 1985).

RESULTS AND DISCUSSION

Results for overall performance as affected by dietary levels of methionine are presented in Table 2 and Fig. 1. Dietary levels of methionine, expressed as percentage of NRC recommendations, significantly ($p \leq 0.05$) affected feed intake, FCR and PER. However, body weight gain is significantly ($p \leq 0.01$) affected by methionine levels. Feed intake was numerically improved with 110 and 130% of NRC methionine but was not improved by 120% NRC methionine. On the other hand, body weight gain was

Table 2: Composition of experimental broiler finishers diets containing graded levels of methionine

	Treatments			
Ingredients %	Control	110% NRC Methionine	120% NRC Methionine	130% NRC Methionine
Sorghum	60.00	60.00	60.00	60.00
Ground nut meal	19.00	19.00	19.00	19.00
Sesame meal	1.00	1.00	1.00	1.00
Wheat bran	10.20	10.20	10.20	10.20
Super concentrates*	5.00	5.00	5.00	5.00
Dicalcium phosphate	0.50	0.50	0.50	0.50
Oyster shell	0.90	0.90	0.90	0.90
NaCl	0.25	0.25	0.25	0.25
Lysine	0.00	0.00	0.00	0.00
Methionine	0.00	0.032	0.068	0.103
Vitamin premix	0.25	0.25	0.25	0.25
Vegetable oil	2.90	2.868	2.832	2.797
Calculated analysis				
ME (kcal/kg)	3165.69	3162.87	3159.71	3156.63
CP %	20.35	20.35	20.35	20.35
Crude fiber %	4.82	4.82	4.82	4.82
Ca %	0.85	0.85	0.85	0.85
Available phosphorous %	0.33	0.33	0.33	0.33
Lysine %	0.91	0.91	0.91	0.91
Methionine %	0.35	0.39	0.43	0.47
Methionine + Cystine %	0.58	0.59	0.59	0.59
Determined analysis				
CP %	4.92	5.02	4.71	4.62
Crude fiber %	4.81	4.77	4.17	4.32
EE %	4.07	4.15	4.21	4.58
Ca %	0.91	0.88	0.87	0.93
Total phosphorous %	1.03	1.24	1.11	1.26

*Cp 40%, ME 2000 kcal/kg, C. fiber 3%, EE 3%, Ash 34%, Ca 8%, Av. P 1.38%, Lysine 12%, Methionine 3%, Methionine + Cystine 3.5%. Vitamin A 250000 IU/kg, Vitamin D3 50000 IU/kg, Vitamin E 500 mg/kg, Vitamin K3 60 mg/kg, Vitamin B1/Thiamin 20 mg/kg, Vitamin B2/Riboflavin 100 mg/kg, Niacin Vitamin PP 600 mg/kg, Pantothenic acid/Vitamin B3 160 mg/kg, Vitamin B6/Pyridoxine 40 mg/kg, Vitamin B12 300 mcg/kg, Biotin/Vitamin H 2000 mcg/kg, Choline 10000 mg/kg, Vitamin C 4000 mg/kg, Folic Acid 30 mg/kg, Iron 800 mg/kg, Manganese 1400 mg/kg, Copper 120 mg/kg, Zinc 1000 mg/kg, Iodine 6 mg/kg, Cobalt 12 mg/kg, Selenium 3 mg/kg

Table 3: Effects of dietary levels of methionine on overall performance of broilers

	Treatments				
Parameters	Control	110% NRC Methionine	120% NRC Methionine	130% NRC Methionine	±SEM
Feed intake	3806.87^{ab}±67.71	3908.78^{a}±84.04	3700.30^{b}±24.58	3827.89^{ab}±69.71	37.76
Body weight gain	2097.20^{c}±85.82	2302.39^{ab}±96.41	2214.89^{bc}±1.96	2381.00^{a}±53.31	40.32
Feed conversion ratio	1.82^{a}±0.09	1.70^{ab}±0.05	1.67^{b}±0.05	1.61^{b}±0.06	0.04
Protein efficiency ratio	2.73^{b}±0.09	2.86^{ab}±0.07	2.92^{a}±0.07	3.00^{a}±0.11	0.05
Mortality	0.00±0.0	0.58±0.0	0.00±0.0	0.00±0.0	0.17

Values are means of 3 replicates per treatment.

^{abc}Means with different superscripts in the same row were significantly different ($p \leq 0.05$).

SEM: Standard error of the means from ANOVA d.f 8

significantly ($p \leq 0.05$) improved by 110 and 130% of NRC methionine compared to the control. These results agreed with findings of Pillai *et al.* (2006) who reported that feed intake, weight gain and feed efficiency were significantly maximized with addition of methionine. On the other hand results obtained for feed intake are in disagreement with those of Saki *et al.* (2007) who found no significant differences.

Supplementation of 120 and 130% of NRC methionine significantly ($p \leq 0.05$) improved FCR and PER. This result is in agreement with the findings of Saki *et al.* (2007) and Kidd *et al.* (1997) who owed this improvement to decrease of bacteria with supplemental methionine.

These conflicting results may due to the interaction between amino acids imbalance and high temperature (Brake *et al.*, 1998).

The present results on carcass characteristics are shown in Table 4. The broiler chicks consuming diets with methionine higher than NRC showed significant ($p \leq 0.05$) increase in absolute and relative weight of breast and significant ($p \leq 0.05$) decrease in abdominal

Table 4: Effects of dietary levels of methionine (expressed as percentage of NRC recommendation) on carcass characteristic

Parameters	Treatments: Control	110% NRC Methionine	120% NRC Methionine	130% NRC Methionine	±SEM
Dressing out %	75.23±0.39	76.27±2.28	77.17±1.56	78.25±1.46	0.91
Absolute breast weight	224.07^{b}±3.80	300.80^{a}±45.45	301.23^{a}±37.91	295.97^{a}±18.53	17.94
Relative breast weight	9.08^{b}±0.82	11.83^{a}±1.48	12.87^{a}±1.39	11.73^{a}±1.04	0.70
Absolute breast meat weight	195.60^{b}±7.26	252.90^{a}±41.79	247.63^{a}±13.58	245.33^{a}±10.00	13.18
Relative breast meat weight	7.92^{b}±0.04	9.93^{a}±1.11	10.60^{a}±0.70	9.72^{a}±0.53	0.42
Absolute breast bones weight	11.87^{b}±0.58	20.70^{ab}±5.48	28.20^{a}±11.04	26.63^{a}±1.89	3.60
Relative breast bones weight	0.48^{b}±0.03	0.80^{ab}±0.27	1.18^{a}±0.38	1.05^{a}±0.04	0.14
Absolute thigh weight	135.97±16.68	137.07±22.07	132.87±28.22	145.47±8.95	11.70
Relative thigh weight	5.47±0.26	5.37±0.55	5.65±0.74	5.78±0.69	0.34
Absolute liver weight	45.63±8.52	46.10±9.11	40.20±4.93	47.53±5.96	4.24
Relative liver weight	1.83±0.21	1.81±0.33	1.72±0.13	1.87±0.13	0.12
Absolute heart weight	12.20±0.85	11.57±2.39	10.80±2.85	12.27±2.23	1.27
Relative heart weight	0.50±0.08	0.45±0.07	0.46±0.05	0.48±0.07	0.04
Absolute gizzard weight	33.76±2.93	32.27±1.96	32.70±4.01	36.70±3.95	1.92
Relative gizzard weight	1.36±0.06	1.27±0.11	1.41±0.19	1.45±0.07	0.07
Absolute fat weight	19.63^{a}±2.10	13.43^{b}±2.22	15.10^{b}±1.82	11.47^{b}±1.17	1.08
Relative fat weight	0.80^{a}±0.17	0.53^{b}±0.06	0.66^{ab}±0.17	0.46^{b}±0.07	0.08
Absolute shanks weight	126.50±25.35	116.53±11.68	121.10±14.37	136.20±16.55	10.25
Relative shanks weight	5.06±0.55	4.58±0.14	5.18±0.25	5.37±0.37	0.21
Absolute wings weight	95.47±17.00	97.47±10.17	96.97±14.21	96.63±10.94	7.71
Relative wings weight	3.82±0.32	3.83±0.20	4.14±0.22	3.82±0.32	0.16

Values are means of 3 replicates per treatment.

^{abc}Means with different superscripts in the same row were significantly different ($p \leq 0.05$).

SEM: Standard error of the means from ANOVA d.f 8

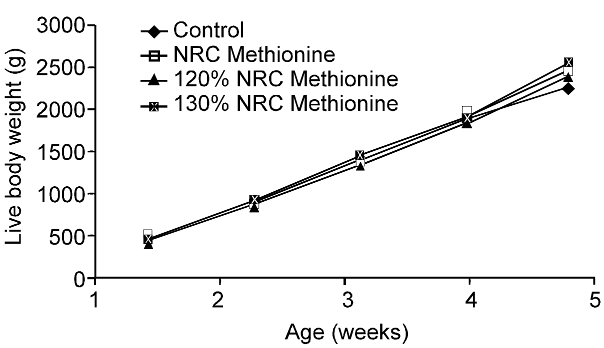

Fig. 1: Growth curve of broiler chicks fed dietary methionine expressed as percentage of NRC recommendation

fat. These results are in coincided with the observations of Schutte and Pack (1995b). However, no responses were shown in relative and absolute of thigh, liver, heart and gizzard to dietary levels of methionine. This results agreed with the observations of Saki *et al.* (2007). This may relate to independent effects on these organs by methionine supplementation.

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