Dietary protein level and performance of growing Baladi kids

Abdelrahman, M. M.* **and Aljumaah, R. S.**

Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia

Correspondence: *M. M. Abdelrahman, Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia. E-mail: mutassimm@yahoo.com*

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Summary

A study was conducted to evaluate the effect of feeding different levels of protein to black Baladi breed kids. Weanling Baladi kids (n=18; 75 to 90 days old) were selected and individually housed at our experimental farm. Kids were divided randomly to one of the three treatments for 12 weeks. The three dietary treatments were: T1: control ration, formulated according to NRC to cover the protein (level 1) and other nutrients requirements. T2: ration formulated to cover only 75% of protein (level 2) recommended by NRC. T3: control diet + 2.4 g undegradable methionine (Smartamine®)/day/kid (level 3). Feed intake, initial and monthly body weights were recorded. Blood samples were collected monthly and analyzed for metabolites and Co, Zn and Cu levels. Decreasing the dietary level of protein (T2) negatively affected ($P<0.05$) the total live weight gain, average daily gain and feed conversion ratio when compared with the control and T3 groups. Moreover, treatment, time and time × treatment caused a significant change on Co concentration in blood serum with higher value at the end of the experiment. Treatments had a significant effect ($P<0.05$) on blood serum cholesterol and protein levels. Undegradable methionine supplementation (T3) significantly increased longissimus dorsi weight, fat thickness and omental fat%. In conclusion, feeding Baladi kids below the NRC requirements of protein negatively affect the growth performance and feed efficiency. The recommended protein level by NRC for growing kids cover the requirements of growing black Baladi kids for maximum growth and productivity.

Key words: Baladi kids, Metabolites, Minerals, NRC, Smartamine®

Introduction

Goats are widely distributed around the world with high demand for their meat in many developing and subtropical countries and arid regions (Casey *et al.*, 2003). In most of these countries, the productivity of goats is below their potential with inefficiency at primary production and post production system (Matossian de Pardos, 2000). The major advantage of goats meat (chevon) is the lower subcutaneous and intramuscular fat and higher muscle shear force (Sen *et al.*, 2004) compared with beef and mutton meat which make it attractive and healthier for human consumption (McMillin and Brock, 2005). The black Baladi goat is widely distributed in the Middle East as a major breed which represents more than 80% of the total goat population (MOA, 2001).

The protein requirements by animals depend on many factors such as species, breed, age, physiological status and environmental factors. The concept of by-pass or undegradable or protected protein/amino acid was well documented long ago. Since then, many experiments have been conducted and a significant retention of nitrogen was demonstrated, and consequently enhanced the animal productivity as a result of complete absorption of the amino acids in the small intestinal tract (Archibeque *et al.*, 2002). Nowadays, the protected amino acids, such as protected methionine as the first limiting amino acid was introduced to the market using very high technology to assure maximum absorption in the small intestinal tract (Shan *et al.*, 2007). Undegradable methionine (sulfur amino acid) may affect the bioavailability of other minerals. So, studying the negative or positive effects is necessary by measuring the accumulation of minerals in blood serum and tissues as a reliable indication (Underwood and Suttle, 2001).

Unfortunately, there is limited data regarding the protein requirements of Baladi kids and other breeds in our region. NRC (1981) identifies the nutrient requirements of the international temperate breeds which may not be applicable to our breeds, because of differences in growth potential and the environmental factors. Silva (2001) and many other researchers reported higher net protein requirements for raising lambs from one breed (Santa Ines lambs) to another (Ile de France lambs), and protein requirements levels were 20% higher than those recommended by ARC (1980). Therefore, this study was conducted to investigate the effect of feeding different levels of protein on general performance and trace minerals status of black Baladi kids by using undegradable methionine supplementation (Smartamine®) above NRC (1981) recommendations.

Materials and Methods

Weanling Baladi kids (n=18 for each), about 75 to 90 days old, were individually housed at our research station, Faculty of Agriculture, Mutah University, and injected sub-cutaneously with 2 ml enterotoxaemia vaccine. The experiment started in October and ended in December with maximum temperature ranging from 15-25ºC and annual rain fall from 150-200 mm. Kids were divided randomly to one of the three treatments. The 3 dietary treatments were 1: T1, control ration, formulated according to NRC (1981) to cover the protein (level 1) and other nutrients required. 2: T2, ration formulated to cover only 75% of protein (level 2) recommended by NRC. 3: T3, control diet + 2.4 g Smartamine®/kid/day (level 3) top dressing.

Kids were individually fed their respective diets *ad libitum*, as shown in Table 1, for 12 weeks and feed intake was recorded daily for each kid. The chemical composition of the control diet as fed was crude protein = 13%; metabolizable energy = 2.53 Mcal/kg; calcium = 4.79 g/kg; phosphorus = 4.45 g/kg, and dry matter = 89.23%. The diet 2 (75% of protein requirements) was crude protein = 10.1; metabolizable energy = 2.53 Mcal/kg; calcium = 4.64 g/kg; phosphorus = 4.28 g/kg, and dry matter = 89.11%. Initial and monthly body weights were also recorded. Blood samples from the jugular vein were collected monthly using non heparin vacutainer tubes and serum separated by centrifugation at 3000 rpm/15 min. At the end of the experiment, three animals from each treatment were slaughtered and kidney, liver and spleen were taken, weighted and samples collected for further analysis. The cross sections of the m. longissimus dorsi (LD) were collected from each slaughtered kid for meat quality evaluation. The dressing percentages of hot carcass were calculated for all slaughtered kids.

The biological samples were analyzed for the following: 1) Blood and tissues samples were prepared according to AOAC (1995) analysis for mineral concentrations using Atomic Absorption Spectro-photometer; 2) Blood glucose, triglyceride, total protein, cholesterol, and creatinine were measured by using different available commercial kits.

Data were analyzed using the General Linear Model (GLM) of statistical analysis system (SAS, 2002) as a complete randomized design (CRD) with repeated measurements. Protected LSD test was used to compare between means for significance at P<0.05 level.
The linear model was:

$$Yij = \mu + ti + Eij$$

Where,
Yij: Dependent variable
μ: Overall mean
ti: Effect of dietary treatments (protein levels)
Eij: Random error associated with observations

Results

Reducing the dietary protein level below the NRC recommendation (T1) caused a significant decrease in accumulated live weight gain (P<0.05), accumulated average daily gain (P<0.05) and increased the accumulated feed conversion ratio (P<0.01). There was no significant effect detected on final body weight, only numerical differences and total feed intake as a result of changing the protein levels (Table 2).

For carcass characteristics, crude protein had no significant effect on the dressing percentage, but affected omental fat% as hot carcass weight, LD weight (g) and LD average fat thickness. Undegradable methionine supplementation (T3) caused a significant increase

Table 1: Feed composition (as fed)

Ingredients (%)	Control (NRC, 1981 protein recommended)	Treatment (75% of protein recommended by NRC, 1981)
Corn	15.0	15.0
Barley	55.4	61.4
SBM	6.0	0.0
Tibin	10	10
Wheat bran	12.0	12.0
Salt	0.5	0.5
$CaCO_3$	1.0	1.0
Min. & Vit.	0.1	0.1
Total	100.0	100.0
Chemical composition (as fed)		
Dry matter%	89.23	89.11
Crude protein (g/kg)	129.95	101.45
Metabolizable energy (Mcal/kg)	2.53	2.53
Calcium (g/kg)	4.79	4.64
Phosphorus (g/kg)	4.45	4.28

1 Minivit-Forte, VAPCo, each 1 kg contains: Cu sulphate = 9.417 mg, Fe sulphate = 85 mg, Mg sulphate = 535 mg, Mn sulphate = 41.25 mg, Zn sulphate = 77.2 mg, Di-Ca phosphate = 145 mg, Vit A = 6250 IU, vit D3 = 1510 IU, vit E = 4.375 IU, Cobalt chloride = 1.933 mg, K iodide = 6.367 mg, and Na selenite = 0.274 mg

Table 2: The effect of treatment on the performance of black Baladi kids

Treatments	Initial BW		Final BW		AccGain[3]		AccADG[4]		AccFCR[5]		TFI[6]	
	X`	SD	X`	SD	X`	SD	X`	SD	X`	SD	X`	SD
Control (NRC)	16.9	1.1	27.0	1.1	10.1[b]	0.9	0.119[b]	0.01	6.8[b]	0.4	70.4	3.1
T1[1]	18.2	1.2	26.0	1.2	7.8[a]	1.0	0.083[a]	0.02	8.5[a]	0.4	64.6	3.3
T2[2]	16.2	1.2	26.8	1.2	10.6[b]	1.0	0.124[b]	0.01	6.5[b]	0.4	68.8	3.2
Significancy	NS		NS		*		*		**		NS	

[1] 75% protein of NRC, [2] NRC protein level + 2.4 g protected methionine, [3] Accumulated gain, [4] Accumulated average daily gain, [5] Accumulated feed conversion ratio, and [6] Total feed intakes. * P<0.05, and ** P<0.01. NS: Not significant

(P<0.05) in the LD muscles weight, average fat thickness and omental fat% when compared with the control and T2 groups (Table 3).

Mineral concentrations (Zn, Fe, Cu and Mn) in kids' liver, kidney, spleen and meat were presented in Table 3. There were no significant differences in all minerals concentrations in tissues, except for liver. Zinc, Fe and Mn were significantly higher in liver of kids from control and T3 groups compared with the T2 group. The change in Co, Cu and Zn concentrations in blood serum throughout the experiment is presented in Table 4. Significant treatment (P<0.05) and time (P<0.001) effects were found on Co concentrations in blood serum with high concentration at the end of the experiment. Moreover, time and time x treatment caused significant effect (P<0.001) on Cu concentration, but Zn concentration was only affected by time (P<0.05).

Results of this experiment regarding the blood serum

Table 3: The effect of treatment on the black Baladi kids'; some carcass measurements, longissimus dorsi (LD) measurements and minerals concentrations in different tissues

Measurements	Control (NRC)	T2[1]	T3[2]	SE[3]	Significance
Carcass measurements					
Dressing percentage (hot carcass)	49.69	48.78	49.93	4.6	NS
Omental fat% (HCW)	3.12[a]	2.39b	4.71[c]	0.53	*
Longissimus dorsi measurements					
DM%	25.93	24.76	27.63	0.896	NS
Ash% ww	0.496	0.568	0.663	0.03	NS
Fat%	29.01	36.01	32.74	1.204	NS
LD[4] wt (g)	14.98[b]	17.61[a]	20.90[c]	2.8	*
LD fat wt (g)	5.76	2.45	4.97	0.97	NS
LD average fat thickness (mm)	3.00[a]	3.33[a]	5.222[b]	0.579	*
Minerals in tissues (µg/g wet weight)					
Spleen					
Zn	0.031	0.04	0.028	0.003	NS
Fe	0.153	0.412	0.162	0.02	NS
Mn	0.002	0.002	0.155	0.0002	NS
Cu	0.0035	0.005	0.0062	0.0001	NS
Meat					
Zn	0.0414	0.035	0.0467	0.005	NS
Fe	0.0234	0.0203	0.0263	0.001	NS
Mn	0.0002	0.0005	0.0006	0.0001	NS
Cu	0.00355	0.0044	0.00078	0.001	NS
Liver					
Zn	0.047[a]	0.037[b]	0.041[a]	0.004	*
Fe	0.06[a]	0.017[b]	0.08[a]	0.02	*
Mn	0.0231[a]	0.0045[b]	0.0272[a]	0.0004	*
Cu	0.0211	0.019	0.0124	0.003	NS
Kidney					
Zn	0.028	0.027	0.020	0.002	NS
Fe	0.08	0.122	0.042	0.02	NS
Mn	0.0015	0.0010	0.0005	0.0004	NS
Cu	0.0068	0.0059	0.00535	0.0001	NS

[1] 75% of protein requirements, [2] NRC + 2.4 g protected methionine, and [3] Standard error of means. * P<0.05. NS: Not significant

Table 4: The effect of treatments on the concentration of some metabolites and minerals concentrations (ppm) in blood serum of black Baladi kids

Minerals	Time				SE[3]	TRT[1]	Time[2]	TRT * Time
	1	2	3	4				
Blood serum minerals								
Co	0.34	0.43	0.36	0.46	0.08	*	***	NS
Cu	0.37	0.51	0.20	0.31	0.04	NS	***	*
Zn	0.29	0.53	1.66	2.56	0.03	NS	*	NS
Blood serum metabolites								
Cholesterol[4]	66.9	58.9	72.1	57.1	9.1	*	***	*
Albumin[5]	3.34	2.33	3.54	2.6	0.37	NS	*	NS
Protein[5]	6.17	5.84	6.4	6.5	0.34	*	*	NS
Creatinine[4]	1.46	1.36	1.46	1.36	0.17	NS	NS	NS
Glucose[4]	6.27	59.4	65.9	65.2	6.2	NS	NS	NS

[1] Treatment, [2] Time of taking blood samples (monthly), [3] Standard error of means, [4] mg/dl, and [5] g/dl. * P<0.05, ** P<0.01, and *** P<0.001. NS: Not significant

metabolites, time (P<0.05), treatment (P<0.001) and time × treatment showed a significant effect (P<0.05) on cholesterol level of the growing Baladi kids. Furthermore, this experiment showed a significant effect of time (P<0.05) on albumin and treatment and time (P<0.05) on total protein level in blood serum of the growing Baladi kids (Table 4).

Discussion

Sufficient supply of protein and well balanced amino acids, especially the most essential amino acids, methionine and lysine, is a very crucial factor for proper growth. The effect of protein levels on the performance of Baladi kids was reported in this study. Reducing the dietary protein level below the NRC recommendation (T2) caused a significant decrease in accumulated live weight gain (P<0.05), accumulated average daily gain (P<0.05) and increased the accumulated feed conversion ratio (P<0.01). The values for the control, T2 and T3 for the accumulated weight gain were 10.1, 7.8 and 10.6 kg, respectively. For accumulated average daily gain were 0.119, 0.083 and 0.124 kg, respectively. For the accumulative feed conversion it was 6.80, 8.50 and 6.50, respectively. Wiese *et al*. (2003) found that increasing the dietary level of methionine by using Smartamine to Merino lambs did not lead to any increase in growth rate, daily feed intake, feed conversion or final body weight which completely agreed with the findings of the present work. Atti *et al*. (2004) and Soto-Navarro *et al*. (2004) reported that the optimum crude protein level in growing goats' concentrate (DM = 89.8%) for maximum performance is approximately 130 g/kg BW and that any increase above this level did not improve performance. This level of feeding protected methionine to goats which was reported by Wiese *et al*. (2003) caused very little effect on the studied traits and their effect was reduced significantly with high dietary crude protein feeding which was consistent with the present findings. In a different study conducted by Shahjalal *et al*. (2000), studying effect of diets with 16.9 and 20.35 CP in black Bengal goats indicated a higher live body weight gain with increasing dietary protein (20.3%), which disagreed with our findings. This disagreement may result from breed, feed type, stage of growth and environmental factors (Negesse *et al*., 2001). For lambs, Zundt *et al*. (2002) indicated a linear effect of protein level (12, 16, 20 and 24%) on average daily gain which differs from our results. But Nuno *et al*. (2009) reported that the protein levels in the diet (14, 16 and 18%) had little or no effect on the performance of Dorper or Pelibuey lambs during fattening which is in agreement with our results. This disagreement with sheep may be mainly resulted from species differences in term of protein requirements. According to our findings, it is clear that feeding growing Baladi kids 14% crude protein as recommended by NRC (1981) is quite adequate to cover their protein requirements.

For the feed intake, the result was consistent with Prieto *et al*. (2000) and Chobtang *et al*. (2009) who found that there was no significant effect of different levels of protein in diet on the feed intake of Thai indigenous male goats, Spanish and Boer-Spanish crossbred kids. Moreover, Zundit *et al*. (2002) detected no significant effect of increasing dietary crude protein on dry matter intake by growing lambs which agreed with our results. In contrast, there was evidence that dry feed intake in Alpine and Nubian goats linearly increased as a result of increasing dietary crude protein levels (Lu and Potchoiba, 1990). Negesse *et al*. (2001) also confirmed the same trend in increasing feed intake with increasing dietary protein. It is possible that the difference in animal breed and feed ingredients composition and environmental factors are the reason for variation. On the other hand, the feed conversion ratios (FCR) showed a significant drop down in kids from T2 group (low protein) when compared with the control (NRC, 1981) and T3 with no differences between the control and T3. The obtained result was in agreement with the findings of Haddad *et al*. (2001) and disagreed with Shahrbabak *et al*. (2006).

According to previous studies, feeding high protein levels even in the form of undegradable protein did not cause any significant effect on dressing percentage (Shahjalal *et al*., 2000; Rocha *et al*., 2004; Choi *et al*., 2007). Moreover, Wiese *et al*. (2003) reported that feeding lambs protected methionine as Smartamine did not improve hot carcass weight and dressing percentage which agreed with the present findings.

Feeding protected methionine, above NRC (1981) crude protein recommended level, to the growing Baladi kids caused a significant increase in omental fat percentage (HCW) and back fat thickness. Wiese *et al*. (2003) reported a reduction in back fat thickness (BFT) with feeding protected methionine as Smartamine, which is inconsistent with our findings. The reasons suggested by researchers for an increase in fat deposition when fed methionine is varied. McCarthy *et al*. (1968) reported a lesion in the lipoprotein synthesis which was prevented by methionine. Methionine may change the amount of chylomicron formation or affects the lipid metabolism by other biochemically pathways. On the other hand, methionine stimulates the lipid synthesis by rumen microorganism (Patton *et al*., 1968) as a result of increasing the number of rumen protozoa and consequently the protozoal phospholipids (Patton *et al*., 1970a, b). Thus, feeding by-pass methionine as a sulfur amino acid at high levels can cause a great effect on fat metabolism in terms of BFT and omental fat contents.

Trace mineral deficiencies may occur even if the dietary content of minerals seems to be adequate. Such conditioned deficiencies can be brought about in several ways. Nutritional minerals interaction is the main reason for conditional deficiencies. High intake of one mineral may interact with other minerals by sharing a common transport site or legend, leading to differences in absorption and bioavailability (Lucille *et al*., 1983). Mineral concentrations (Zn, Fe, Cu and Mn) in kids' liver, kidney, spleen and meat were presented in Table 3. There were no significant differences in all minerals concentrations in tissues, except for liver. Zinc, Fe and Mn were significantly higher in liver of kids from control and T3 groups compared with the T2 group. Significant treatment (P<0.05) and time (P<0.001) effects were found on Co concentrations in blood serum with high concentration at the end of the experiment (Table 4). Moreover, time and time × treatment caused significant effect (P<0.001) on Cu concentration, but Zn concentration was only affected by time (P<0.05).

Unfortunately, very little work has been carried out to study the negative (antagonistic) or positive effect (synergistic) of feeding undegradable methionine (sulfur amino acid) on trace minerals bioavailability in ruminants, especially related to Fe, Zn and Co. So, it is very difficult to explain by focusing only on the metabolic reasons without further research. Anyway, the results of this experiment showed significant change in terms of increasing and decreasing trace minerals concentrations in different tissues, but all values were within the normal levels according to Puls (1990).

Time (P<0.05), treatment (P<0.001) and time × treatment (P<0.05) significantly affect the cholesterol level in blood serum of the growing Baladi kids (Table 4). Unfortunately, there are no previous studies reported regarding the effect of dietary protein levels using undegradable methionine to growing black kids on blood total lipid profile. Thus, according to the findings of this experiment, feeding by-pass methionine as a sulfur amino acid at high levels can cause a great effect on fat metabolism in terms of total lipids profile in blood serum and others. A significantly higher total blood protein level and progress of experimental period were found for kids from the control and T3 compared with T2 (6.75, 6.23 and 5.84 g/dl). The improvement in the total protein values may be due to the increase of amino acid absorption from the dietary protein and undegradable methionine. Yousef and Zaki (2001), Shahen *et al*. (2004) and Abdel-Ghani *et al*. (2011) reported a positive correlation between dietary protein and serum total protein concentration in goats. This finding was in agreement with those reported by El-Shabrawy (2006). On the other hand, the findings reported by El-Reweny (2006) were inconsistent with ours.

The data from this experiment did not show any significant effect of protein levels, time and time by treatment effect on creatinine and glucose levels (Table 4). Abdel-Ghani *et al*. (2011) reported a significant reduction in creatinine and urea N levels in blood serum of lamb as a result of feeding protected protein which disagreed with our findings. They explained their finding assuming a higher utilization of dietary protein as a result of protection.

Feeding black Baladi kids below the NRC requirements of protein (75% of NRC recommendation) negatively affected the growth performance and feed efficiency of the growing Baladi kids. Undegradable methionine (Smartamine®) supplementation (2.4 g/day/kid) causes very minor improvement on kids' performance. So, the recommended NRC protein level for growing kids properly covers the requirements of the black Baladi kids for maximum growth and productivity.

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