PRODUCTIVITY OF GROWING BALADI KIDS FED HIGH ENERGY AND PROTECTED METHIONINE

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ABSTRACT

This study investigated the effect of both high dietary energy, as dry fat (Magnapac™), and protected methionine (Smartamine™) on growth, feed intake, feed conversion efficiency, trace mineral concentrations in blood serum and some tissues of growing Baladi kids. Twenty Baladi kids (3 to 4 months old and 24.64±3.0 kg average body weight) were distributed equally into four treatment groups as follow: control group given the standard requirements of NRC (1981) and tested groups were given high energy (3.0 Mcal ME/kg DM) without (T1) or with 2.5 g methionine/head/day (T2) or 5.0 g methionine /head/day (T3) as Smartamine™. Results indicate that feeding Baladi kids high energy and protected methionine didn't lead to increase total weight gain, feed intake, and feed conversion efficiency. Treatments didn't cause any significant effect on dressing and organs percentage except the kidney. The omental fat percentage were significantly ($P<0.05$) increased with feeding high energy without or with 2.5 g/h/day protected methionine compared with the control, but intake of high protected methionine (5 g/h/day; T3) caused a significant reduction in omental fat compared with T1 and T2. Moreover, a significant effect of treatment on kidneys' cobalt, zinc and iron concentrations were found with variable changes for each mineral within groups. Copper concentration in blood serum showed significantly higher values for the final blood sampling of kids from T1 and T2 compared with the control and T3.

In conclusion, feeding Baladi kids high energy without or with methionine as Smartamine™ didn't cause any significant improve on their performance in term of growth and feed conversion, but affect the omental fat percentage and some trace minerals concentrations. Moreover, the recommended NRC requirements for goats of energy and protein cover Baladi kids requirements for maximum growth and productivity.

Key words: *Baladi kids, Productive performance, trace minerals, dry fat, methionine.*

INTRODUCTION

Goats are widely distributed around the world with high demand to their meat in many developing and subtropical countries and arid regions (**Casey *et al.*, 2003**). In most of these countries, the productivity of goats are below their potential with inefficiency at primary production and post production system **(Devendra, 1999; Matossian de Pardos, 2000).** The major advantage of goats meat (chevon) is the lower subcutaneous and intramuscular fat (**Smith *et al.*, 1978)** compared with beef and mutton meat which make it attractive and healthier for human consumption **(McMillin and Brock, 2005).**

In Jordan, the black Baladi goat is the major breed which represents about 80% of the total goat population **(MOA, 2001).** Feeding Baladi goats depends on natural range and crop residues for a very short period of the year (Feb. to March) and limited barley and wheat bran supplementation **(FAO, 1994).** A shortage in energy and protein is expected under grazing conditions which reflected on the productivity of goats. Therefore, there is an urgent need to cover nutrients requirements to increase goats' productivity, through intensive farming.

Using soap stock dry fat as a source of energy can be considered since it is available in the market in cheap price compared with oil. The problem with this product is their high contents of calcium and ash which may reduce or interfere the other dietary minerals. Moreover, the protected amino acids, such as protected methionine, as a first limiting amino acid (**Shan *et al.*, 2007)** can be used for goats to increase the dietary protein and consequently growth performance. Because of that, using dry fat (high calcium and ash percentages) and protected 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, 1999).**

Unfortunately, there is a limiting data regarding the energy and protein requirements of Baladi kids and other breeds in our region. **National Research Council (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. Because of that, there is a great need for requirements studies for our breeds to maximize their productivity with lower cost since Jordan mainly depends on imported animal feeds. Therefore, this study was conducted to investigate the effect of feeding high energy and protein on general performance and trace minerals status of Baladi kids by using dry fat (Magnapac ™) and protected methionine supplementation (Smartamine ™).

MATERIALS AND METHODS

Feeding trial and sampling

Twenty growing Baladi black kids, 3-4 month old and 24.64±3.0 kg average body weight, were used in this trial. Kids were individually housed at Mu'tah University Research Station and injected sub-cutaneously with 2 ml enterotoxaemia vaccine. During the experiment period (90 days), kids were divided equally to four groups and each housed in an individual pen (0.8x 1.4 m) with separate feeder and drinker. The dietary treatments for each group were as follow: Control (NRC requirements); T1 (Control+High energy 3 Mcal ME / kg DM); T2 (Control+High energy 3 Mcal ME /kg DM and 2.5 methionine/ head/ day as Smartamine ™) and T3 (Control+High energy 3 Mcal ME/ kg DM and 5 g/ head/ day methionine as Smartamine ™). Animals fed basal concentrate diets according to NRC (1981) allowances plus dry fat (Magnapac ™) for increasing energy level to fit the treatments tested. The ingredients and chemical composition of diets fed to the growing Baladi kids were presented in Table 1. In order to increase the ME to 3.0 Mcal/ kg DM, dry fat (Magnapac ™) was added. On the other hand, protected methionine as Smartamine ™ was fed at two levels (2.5 and 5 gm/ head/day) as a source of by-pass methionine as essential amino acid for growth. It offered top- dressing on the daily morning concentrate meal to assure a complete consumption of the methionine. The nutritive value of Magnapac™ (Norvel- Misr- Egypt) is: 84% crude fat; 3.5% Moisture; 18% Ash; 0.5% acid insoluble ash and 9.0% Ca. Moreover, kids were fed the assigned diets which presented in table (1) for 3 months and data of feed intake was used for calculating the total feed intake (TFI) and total feed conversion (TFC). Kids' body weight were monthly recorded to calculate monthly and overall mean of weight gain (WG). Moreover, blood samples were collected at the beginning of the experiment and every month via needle injection in the jugular vein. Blood samples were centrifuged at 3000 rpm for 15 minutes and serum was separated **(AOAC, 1990)**. Serum samples were stored at – 20 ºC until analysis. Daily feed intake and monthly body weight were recorded. At the end of experiment, all kids were slaughtered and organs were separated (liver, kidney, spleen, testicles, lungs). Meat and omental fats were weighed and all samples taken for analysis. After slaughtering, weights of all hot carcasses were recorded to determine dressing percentage. The care and management of Baladi kids during the trial followed the regulation of Mu'tah University, Dean of Academic Research.

Blood serum and tissues (meat and kidney) samples were prepared according to **AOAC (1990)** and analyzed for mineral concentrations using Atomic Absorption Spectrophotometer **(AAS: Perkin- Elmer, 1981).**

Statistical Analysis

Data were analyzed using SPSS™ version (16.0) as a complete randomized design. The Protected least significant differences test (LSD) was used to determine differences among treatments means for significant dietary effect (Steel and Torrie, 1980), with $P<0.05$ considered statistically significant unless otherwise noted. The linear model was:

$$Y_{ij} = \mu + t_i + E_{ij}$$

Yij= dependent variable.

μ = overall mean.

ti= effect of dietary treatments (high energy without and with two levels of protected methionine).

Eij= random error associated with observations.

RESULT AND DISCUSSION

Growth and general performance of Baladi kids

The results of this experiment in term of growth performance, feed intake and efficiency of feed conversion, carcass and tissues percentage and trace minerals concentration in tissues and blood are presented in Tables 2 to 8. High energy intake with high level of methionine (T3) caused a significant ($P<0.05$) increase in body weight gain during the third month compared with other groups. There were no significant differences for treatments on the total weight gain during the whole period among all groups (Table 2). On the other hand, treatments didn't cause any significant effect on the total feed intake and feed conversion throughout the experiment (Table 3), but the total feed intake of alfalfa hay were significantly ($P<0.05$) increased with feeding high energy and methionine supplementation (Table 4). The average growth rate (AGR) and relative growth rate (RGR) values were significantly ($P<0.05$) affected by treatments but only during the first month with higher values for kids from T1 which received only high energy without methionine (Table 5). This finding disagreed with **Lu and Potchoiba (1990)** who reported that dry matter intake was influenced by dietary energy in a curvilinear fashion which considered the dominant factor. Moreover, **Khinizy *et al*, (2004)** found that feeding high levels of energy to weaned lambs increased the average daily gain and improved feed efficiency, but no effect of high protein intake on their general performance. **Haddad (2005)** reported an increase in average body gain, feed efficiency and carcass characteristics of Jordanian Baladi kids with increasing the dietary energy up to 2.9 Mcal ME/kg DM which also disagree with the present findings. The same trend was also reported by **Kioumarsi *et al.* (2008)** who found an improvement in performance of Taleshi lambs fed high energy. The explanations of this general trend is that high dietary energy help to produce more ME and fermentable products for microorganisms to increase synthesis of microbial protein as a supply of amino acids to the small intestinal tract and consequently improve growth performance **(Early *et al.*, 2001).** The offered high energy intake can be considered as a maximum requirement according to Baladi goat genetic potential where above it no significant effect was detected on animal performance. Hence, the energy intake of kids in the control group (2.82 Mcal ME/kg DM) that followed NRC can be considered adequate ME level for Baladi kids without negative effect on the performance in term of weight gain. This conclusion is supported also by **Mahgoub *et al.* (2005)** who reported an improvement in the growth rate of Omani goats with increasing dietary ME from 2.11 to 2.68 Mcal/kg DM which close to the level recommended by NRC.

Regarding the effect of protein level on performance, **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 findings of the present work. In addition, **Wright (1971)** reported that supplement of methionine to animals fed a low protein diet (8% CP) increased rate of gain and feed efficiency, but had no effect on those fed 12% CP diet. **Atti *et al.* (2004)** and **Soto-Navarro *et al.* (2004)** reported that the optimum crude protein level in growing goats' concentrate 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 cause very little effect on the studied traits and their effect was reduced significantly with high dietary crude protein feeding which consistent with the present findings. Accordingly, it is clear that feeding growing Baladi kids 14% crude protein as recommended by National Research council **(NRC, 1981)** is quite adequate to cover their requirements of protein . A significantly higher intake of alfalfa hay was recorded with Baladi kids fed high levels of energy and protected methionine (T3) when compared with kids in the other groups (Table 4). Moreover, Table 5. shows that treatment did not cause any significant effect on average and relative growth (AGR and RGR) except during the first month.

Dressing and tissues percentage of Baladi kids carcasses

Regarding hot carcass dressing percentage, there were no significant differences among all groups in term of hot carcass dressing percentage. **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. Similar trend was reported by **Shiran (1995)** for dressing percentage of lambs fed different levels of energy. Kidney weight was significantly increased in kids fed high energy (T1) and 2.5 g/h/day protected methionine (T2) compared with other groups (Table 6). Moreover, feeding high energy with or without 2.5 g/h/day protected methionine caused a significant increase ($P<0.05$) in the omental fat percentages compared with the control group. However, increasing protected methionine level to 5g/h/day caused a significant reduction in omental fat percentage compared with the kids of T1 and T2, but still higher than the control group. **Ebrahimi *et al.* (2007)** reported a trend of increasing fat deposition in the carcass and non carcass parts of Mehraban lambs with feeding high dietary energy density which agreed with the present findings. Furthermore, **Wiese *et al.* (2003)** reported a reduction in back fat thickness (BFT) with feeding protected methionine as Smartamine™. **Barry (1981)** reported a reduction in lamb's fat carcass as a result of abomasal infusion of casein and methionine which also supported the present findings. Thus, feeding by-pass methionine as a sulfur amino acid at high levels can cause a great effect on fat metabolism in term of BFT and omental fat contents. For comparison, these findings were also reported by other researchers on other species such as young chicks (**Boomgaardt and Baker, 1973)** and growing broiler **(Takahashi *et al.*, 1994; Bunchasak *et al.*, 1998).**

Copper, Zn, Mg, Co and Fe concentrations in blood serum and tissues

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 that produce conditional deficiencies. High intake of one mineral may interact with other minerals by sharing a common transport site or legend lead to differences in absorption and bioavailability **(Lucille *et al.*, 1983)**. Mineral concentrations in blood serum are frequently used in assessment of their status because they are significantly correlated to their nutritional status **(Mills, 1987).** Liver, kidney, meat….etc are other tissues which are very sensitive to change in dietary minerals, but were also affected with other factors **(Underwood and Suttle, 1999).** In this study, trace mineral concentration in blood serum, kidney and meat were measured to evaluate the effect of feeding the dry fat (containing high calcium) and protected methionine (sulfur amino acid) on the bioavailability of magnesium (Mg), copper (Cu), cobalt (Co), zinc (Zn), and iron (Fe) which can be reflected on their concentrations in tissues.

Table (7) shows the effect of treatment on the concentration of trace mineral in blood serum of kids at the beginning and the end of experiment. Treatment didn't cause any significant effect on Mg, Zn and Co in both sampling times, but the final Cu concentration were significantly affected with higher levels for kids of T1 and T2 compared with the control and T3 groups. Generally, copper absorption in ruminant is comparatively low due to complex interactions that occur in the rumen environment. It is well documented that Cu requirements vary greatly in ruminants depends on concentration of other dietary components, especially sulfur and molybdenum **(McDowell, 1992; Kincaid, 1999; Spears, 2003).** This may partially explain the change in Cu concentrations in blood serum of kids in treated group with an increase for kids fed dry fat (1.09 ug/ml; T1) and decreased for kids fed dry fat and 2.5 and 5 g methionine/h/d (0.89 and 0.57 ug/ml; for T2 and T3 respectively) compared with the control (0.67 ug/ml).

Treatments caused a significant changes ($P<0.001$) in inorganic matter percentages in meat with the higher levels for kids from the control and T2 compared with other groups. Moreover, Mg concentration was also affected by treatments with significantly lower values for kids of T2 compared with other groups (Table 8). Treatments caused a significant effect on kidneys' Co, Zn and Fe concentrations, but no effect on concentrations of other minerals (Table 8). Cobalt concentration were significantly higher in kid's kidneys of T2 and T3 and the lowest for kids of T1, but Zn concentration were higher in kidneys of kids fed high energy and 2.5 g/h/d protected methionine (T2) and the lowest for the control group compared with other groups. Furthermore, Fe concentrations were significantly higher in kid's kidneys of the control group, followed by T1 and T3 kids and the lowest concentration for kids of T2 group (Table 8).

Unfortunately, very little work has been carried out to study the negative or positive effect of feeding dry fat (high calcium content) and protected methionine (sulfur amino acid) on trace minerals bioavailability in ruminants. Few studies only focus on increasing the dietary Ca relative to P above 7:1 or decreasing below 1:1. Some researchers reported an increase in fecal excretion of Mn and Zn in sheep with increasing Ca% from 1% to 2%. Thus, high dietary calcium may be responsible of reducing availability of Cu, Mn, and Zn which influence availability of Mg **(Verdaris and Evans, 1975).** The results of this experiment showed significant change in term of increasing and decreasing trace minerals concentrations in different tissues, but all values were within the normal levels according to **Puls (1990).** Accordingly, the magnitude of feeding 3% dietary dry fat (Magnapac™) and 2.5 and 5 g/h/d protected methionine (Smartamine™) on Mg, Co, Cu, Zn and Fe in different tissues is relatively small and no negative effect on health and performance was recognized.

CONCLUSION

The energy and protein levels that recommended by **NRC (1981)** are sufficient for maximum growth and productivity of growing Baladi kids under the Jordanian environment. Feeding growing Baladi kids high energy with or without methionine as a Smartamine™ did not cause any significant effect on their performance in term of growth rate and feed efficiency, but increased the consumption of alfalfa hay and some trace minerals concentration in tissues.

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Table 1. Ingredients composition of diets (%) (As fed)

Ingredient	Control (NRC, 1981 recommended ME energy)	Treatment (High ME energy diet)
Corn	10.0	5.0
Barley	61.4	62.4
Soybean meal	0.0	1.0
Wheat bran	12.0	12.0
Alfalfa hay	15.0	15.0
Dry fat (Magnapac)	0.0	3.0
CaCO3	1.0	1.0
Salt	0.5	0.5
Mineral & vitamins premix[1]	0.1	0.1
Chemical composition		
Crude protein (g/ Kg DM)	141.54	141.90
Metabolizable energy (Mcal/ kg DM)	2.82	3.00
Calcium (g/ kg DM)	8.11	9.60
Phosphorus (g/ kg DM)	4.90	4.83

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

Table 2. Effect of treatments on monthly and total weight gain (Kg) of growing Baladi kids during the three months of experimentation.

Treatment	M1[4] WG[5]	M2 WG	M3 WG	Total WG
Control	4.91[ab]	3.53	2.89[a]	11.32
T1[1]	5.59 [a]	3.84	2.01[b]	11.20
T2[2]	4.34 [ab]	4.07	2.31[b]	10.00
T3[3]	4.39 [b]	3.18	3.34[c]	10.69
SEM	0.39	0.41	0.38	0.78
Significancy	NS	NS	*	NS

Table 3. Effect of treatments on the monthly and total feed intake (Kg) and feed conversion of growing Baladi kids.

Treatment	M1 FI [4]	M2 FI	M3 FI	Total FI	TFC[5]
Control	35.27	26.9	24.92	84.85	8.44
T1[1]	34.71	28.3	28.45	83.65	9.97
T2[2]	33.74	28.75	27.84	94.60	9.27
T3[3]	33.40	27.23	27.32	85.60	9.01
SEM	0.59	1.36	1.11	2.37	0.64
Significancy	NS	NS	NS	NS	NS

Table 4. Effect of treatments on the concentrate and alfalfa hay intake (Kg) by growing Baladi kids during the experiment

Measurement	Control	T1[1]	T2[2]	T3[3]	SEM	Significance
Concentrate (Kg)	71.62	75.5	74.5	69.2	2.46	NS
Alfalfa hay (Kg)	15.72[a]	15.97[ab]	15.90[ab]	16.41[b]	0.106	*

(Tables 2, 3 & 4 symbols ID)

Means bearing different superscripts in the same column are significantly different (P<0.05).

Control: NRC requirements
[1] High energy diet
[2] high energy+ 2.5g/d/head Smartamine.
[3] High energy+5.0g/d/head Smartamine.

SEM= standard error of means
NS = not significant
* P <0.05

Table 5. Average (AGR[1]) and relative growth rate (RGR[2]) of growing Baladi kids during the experiment.

Measurement	Month 1	Month 2	Month 3	Overall
AGR (Kg) :				
Control	0.173[ab]	0.126	0.02	0.1005
T1[3]	0.212[a]	0.138	0.140	0.1325
T2[4]	0.154[ab]	0.146	0.160	0.122
T3[5]	0.121 [b]	0.114	0.130	0.115
SEM	0.012	0.015	0.030	0.015
Significancy	*	NS	NS	NS
RGR:				
Control	0.207[ab]	0.112	0.01	0.325
T1[3]	0.301[a]	0.120	0.05	0.550
T2[4]	0.177[b]	0.1225	0.054	0.41
T3[5]	0.138[b]	0.103	0.098	0.39
SEM	0.022	0.0122	0.03	0.041
Significancy	*	NS	NS	NS

Means bearing different superscripts in the same column are significantly different ($P<0.05$).

[1] AGR= Final monthly weight (kg)- initial weight (kg)/ period (days)

[2] RGR= Final monthly weight (kg)- initial weight (kg)/ initial weight (kg).

Control: NRC requirements

[3] High energy diet

[4] high energy+ 2.5g/d/head Smartamine.

[5] High energy+5.0g/d/head Smartamine.

SEM= standard error of means

NS = not significant

* $P <0.05$

Table 6. Dressing and different tissues percentages (of hot carcass weight) of slaughtered Baladi kids.

Measurement	Control	T1[1]	T2[2]	T3[3]	SEM	Significance
Dressing[4]	49.73	48.97	49.23	50.80	0.36	NS
Liver	3.76	4.01	4.10	3.32	0145	NS
Kidney	0.65[b]	0.703[b]	0.883[a]	0.687[b]	0.017	*
Spleen	0.49	0.35	0.393	0.453	0.03	NS
Heart	1.46	1.27	1.33	1.41	0.057	NS
Lungs	2.43	2.82	2.59	3.07	0.115	NS
Testicals	1.68	1.68	1.76	1.68	0.06	NS
Omental fat	2.92 [c]	4.71[a]	4.29[a]	3.72[b]	0.23	*

Table 7. The effect of high energy intake and methionine supplementation on trace mineral concentrations (ug/ml) in blood serum of growing Baladi kids.

Treatment	Control	T1[1]	T2[2]	T3[3]	SEM	Significance
Mg concentration ug/ml						
Intial	32.56	32.99	31.86	32.37	2.48	NS
Final	32.73	31.92	32.03	31.92	1.02	NS
Cu concentration ug/ml						
Intial	0.79	0.99	0.91	1.07	0.06	NS
Final	0.67[b]	1.09[a]	0.89[a]	O.57[b]	0.06	*
Zn concentration ug/ml						
Intial	1.92	2.01	1.93	1.87	0.12	NS
Final	1.52	1.64	1.86	1.70	0.11	NS
Co concentration ug/ml						
Intial	0.18.	0.13	0.14	0.14	0.01	NS
Final	0.16	0.18	0.16	0.20	0.01	NS

Means bearing different superscripts in the same column are significantly different (P<0.05).

Control: NRC requirements

[1] High energy diet
[2] high energy+ 2.5g/d/head Smartamine.
[3] High energy+5.0g/d/head Smartamine.

[4] Dressing%= (Hot carcass wt./ Live wt.) x 100%
SEM= standard error of means
NS = not significant
* P <0.05

Table 8. The effect of treatment on the mineral concentrations (ug/g dry matter basis) in Baladi kids meat and kidney.

Minerals	Control	T1[1]	T2[2]	T3[3]	SEM	Significance
Meat:						
Mg	31.48[a]	39.86[a]	22.72[b]	39.54[a]	3.21	*
Co	6.66	5.78	6.22	8.23	1.28	NS
Cu	9.68	46.43	16.10	24.21	3.4	NS
Zn	143.13	185.20	149.97	209.97	16.21	NS
Fe	44.74	190.9	33.84	37.56	7.33	NS
Dry matter%	26.41	25.19	26.65	24.46	1.02	NS
Inorganic%	0.95[a]	0.814[b]	0.94[a]	0.740[b]	0.03	***
Kidney:						
Mg	50.67	44.98	39.76	42.84	4.69	NS
Co	11.76[b]	5.00[c]	16.05[a]	19.33[a]	2.00	*
Cu	24.68	21.92	33.92	25.05	2.74	NS
Zn	85.08	106.16	152.10	101.01	11.67	*
Fe	175.57[a]	143.27[b]	107.02[c]	152.59[b]	11.15	*
Dry matter%	18.449	18.11	18.98	18.025	0.43	NS
Inorganic%	1.13	1.07	1.10	0.973	0.032	NS

Means bearing different superscripts in the same column are significantly different ($P<0.05$).

Control: NRC requirements

[1] High energy diet

[2] high energy+ 2.5g/d/head Smartamine.

[3] High energy+5.0g/d/head Smartamine.

SEM= standard error of means

NS = not significant

* $P <0.05$