PERFORMANCE OF CALVES FED RATION CONTAINING DL-METHIONINE HYDROXY ANALOG (HMB)

N. E. El-Bordeny[1] and A. A. Abedo[2]

[1]*Animal production Department, Faculty of Agriculture, Ain Shams University, 68 Hadayeq Shoubra, Cairo, Egypt.*

[2]*Animal Production Department, National Research Center, Dokki, Giza, Egypt.*

(Received 30/11/2010, Accepted 28/3/2011)

SUMMARY

Ruminal escape and absorbed methionine hydroxy analog (HMB) can be converted to Methionine in animal liver and enhance its productive performance. So this study was conducted to evaluate effect of HMB supplementation on growth performance of fattening calves. Thirty eight crossbred (Friesian X Balady) male calves with mean initial live body weight of 251.5 ±3.16 Kg were divided into two groups of 19 animals each. The animals were fed total mixed ration containing 28.17% corn silage, 32.32% yellow corn, 10.06% soybean meal, 10.77% wheat bran, 10.77% rice bran, 5.03% rice hulls, 1.44% limestone, 0.72% salt, 0.36% minerals and vitamins mixture and 0.36% buffering agent (on DM basis) without or with 10g HMB for G1 and G2, respectively. Insignificant differences ($P>0.05$) were observed in digestion coefficients of DM, OM, CP, CF, EE and NFE as well as feeding values as total digestible nutrients (TDN) and digestible crude protein (DCP) between the groups fed ration supplemented with HMB or not. Also insignificant differences were noticed in rumen liquor pH value, NH_3-N and TVFA's concentration between the two groups. Adding HMB to calves' ration increased both serum total protein ($P\leq0.025$) and albumin ($P\leq0.006$), while decreased ($P\leq0.032$) urea nitrogen concentration compared to the control group, while globulin and albumin: globulin ratio were not affected. Average body weight gain increased ($P\leq0.002$) for calves fed diet supplemented with HMB compared to calves fed control diet. Also, feed conversion as kg dry matter, TDN and DCP required for 1kg gain were ($P\leq0.002$) improved for calves fed HMB compared to calves fed the non-supplemented ration (control ration). It could be concluded that supplementation of calves' diet with DL- methionine hydroxy analog improved efficiency of protein utilization through protein metabolism process without any significant effect on rumen fermentation and nutrients digestibility; consequently body weight gain and feed conversion were improved.

Keywords: *methionine hydroxy analog, supplementation, nutrients digestibility, growth performance, and calves.*

INTRODUCTION

Proteins are the principle constituents of the animal body and are continuously needed in the feed for cell repairing and synthetic process. The transformation of feed protein into body protein is an important process of nutrition and metabolism. The strategy for meeting animal requirements from metabolizable protein is to first maximize microbial protein synthesis and flow, and then to meet any shortage in metabolizable protein with bypass sources of protein and amino acids. Amino acids that reach the small intestine depend on amino acids composition of the feed proteins and the proportional flow of ruminally undegraded feed and microbial protein. The response to use protected amino acids in feeding is variable and mainly depends on protein source and its level in the basal diet (Schwab *et al.*, 1992, Armentano *et al.*, 1997 and Rulquin *et al.*, 2001) . Results of estimating amino acids requirements (Komarek *et al.*, 1983), and nitrogen retention (Chalupa and Chandler, 1975, Richardson and Hatfield, 1978 and Ahmed, 1982) indicated that methionine and lysine are usually the first and second limiting amino acids for growing cattle. Rumen-protected amino acids and analogs can be incorporated into the diet to target these specific amino acid deficiencies without contributing additional amino-N beyond the animal's requirements, but the success of their use depends on the confidence and accuracy of the estimated amino acid delivery. The dry calcium salt of D, L-2-hydroxy-4-(methylthio)-butanoic acid (HMB) is more commonly known as methionine hydroxy analog (MHB), and has been extensively studied. The powder form of HMB (Alimet, Novus Int., Inc.; St. Louis, MO), which is more economical to produce, is used as a methionine source in mono gastric animal diets. It is also available for use in ruminant rations. The efficacy of the HMB to provide a source of methionine depends on its resistance to microbial degradation in the rumen, its rapid escape from the rumen with the liquid phase of digesta, and its subsequent absorption and metabolism to methionine within the tissues (Koenig *et al.*, 2002). Few studies have been conducted to evaluate performance of growing and fattening animals fed diets supplemented with HMB. So the objective of this study was to evaluate the effect of HMB supplementation on calves' performance.

MATERIALS AND METHODS

The present study was conducted at a private farm (Amber Feed Lot Station, Ambr Company) located in El-Noubaria region, El-Behaira province, Egypt and the chemical and statistical analyses were completed at the laboratory of Animal Nutrition Research, Animal Production Department, Faculty of Agriculture, Ain Shams University as well as the Lab of Animal Nutrition, Animal Production Department, National Research Center.

DL- methionine hydroxy analog (HMB)

The methionine hydroxy analog that was used in this study is dry calcium salt of D, L-2-hydroxy-4-(methylthio)-butanoic acid (HMB) in powder form. Raw material of NOVUS®, Commercial name is IBEX-MET, containing 86% of DL-Methionine Hydroxy Analogue-Ca. Product of IBEX International, Giza province, Egypt.

Animals and feeding

Thirty eight male crossbred (Friesian x Balady) local calves with mean initial body weight of about 251.5 ±3.16 Kg were divided into two groups of 19 animals each, each group was assigned randomly to one of two dietary treatments, untreated (control, G1) or treated (G2). The animals were fed total mixed ration (TMR) at rate about 2.3 % of their live body weight in group feeding. The TMR containing 28.17% corn silage, 32.32% yellow corn, 10.06% soybean meal, 10.77% wheat bran, 10.77% rice bran, 5.03% rice hulls, 1.44% limestone, 0.72% salt, 0.36% minerals and vitamins mixture and 0.36% buffering agent on DM basis without or with 10 g HMB for G1 and G2, respectively. The TMR was balanced for minerals and vitamins and formulated to meet the nutrient requirements of calves according to NRC (2000) recommendations (Table 1). The diets were offered daily in two parts; at 8 a.m. and 4 p.m. and the animals had free excess to clean fresh water. The growth trial was conducted for a 132 day period during which individual body weights of calves were recorded and the feed intake was adjusted biweekly according to the changes in body weight.

Measurements of digestibility

At the end of the growth trial, six animals were randomly chosen from each group and subjected to grab sample method to determine nutrients digestibility, in which acid insoluble ash (AIA) was applied as an internal marker according to Ferret *et al.* (1999). Fecal samples (approximately 200 g wet weight) were collected from the rectum for three successive days (at 9.00 am and 5.00 pm) and composed for each calf and air dried at 55 C° for 48 h, and retained for chemical analysis. The digestion coefficients of certain nutrients were calculated according to the following formula (Ferret *et al.*, 1999):

$$\text{Digestibility} = 100 - \left(\frac{\%\ \text{indicator in feed}}{\%\ \text{indicator in feces}} \times \frac{\%\ \text{nutrient in feces}}{\%\ \text{nutrient in feed}} \times 100 \right)$$

Table (1): Ingredients and chemical composition of corn silage, total mixed ration and HMB.

Item	Corn silage	TMR	HMB
Ingredient (%)			
Corn silage		28.17	
yellow corn grain, ground		32.32	
soybean meal		10.06	
wheat bran		10.77	
rice bran		10.77	
rice hulls		5.03	
lime stone		1.44	
Salt		0.72	
Sodium bicarbonate		0.36	
minerals and vitamins mixture*		0.36	
Chemical composition, %			
Dry matter	21.05	61.65	98.51
Constituents, % on DM basis			
Organic matter	92.88	91.19	64.36
Crude protein	7.32	11.10	0.0
Crude fiber	30.67	19.05	0.0
Ether extract	3.39	5.16	1.03
Nitrogen free extract	51.50	55.88	63.33
Ash	7.12	8.81	35.64
Cell wall constituents, % on DM basis			
Neutral-detergent fiber	58.75	37.61	
Acid- detergent fiber	35.06	18.80	
A cid-detergent lignin	5.25	3.11	

Abbreviation is: DM = dry matter and HMB = methionine hydroxy analog.

** Minerals and vitamins mixture composition: Mg: 100, Mn: 125.8, Zn: 41.7, Fe: 166.7, Cu: 32, P: 100 (g/kg DM); I: 810, Se: 480, Co: 2000 (mg/kg DM); vitamin A: 20000000 (IU/kg DM), D: 2000000 and E: 10000 (IU/kg DM).*

Sampling procedure

Samples of corn silage were taken twice a week, before silage was subjected to TMR preparation, mixed and a representative sample was frozen. The TMR samples were also taken twice a week during offering the TMR to animals, mixed and a representative sample was frozen.

At the end of the experiment, rumen fluid was withdrawn from six animals of each group by stomach tube before the morning feeding (zero time), then at 3 and 6 hours after feeding. Samples (50 ml/ calf) were immediately filtered by using 4 layers of cheesecloth and stored in deep freezer at -20° C for subsequent analysis.

Blood samples were withdrawn from jugular vein of six animals from each group at 3 hrs after morning feeding. The blood samples was centrifuged (4000 rpm for 15 min), then serum samples were transferred into clean dried glass vials and stored in deep freezer at -20° C for subsequent specific chemical analysis.

Analytical methods

Samples of corn silage, TMR and feces were taken and air dried at 55 C° for 48 hour in forced air oven (HERSON, Willow walk, S.E.1, London, UK) up to about 10 -12 % moisture, then kept for subsequent analysis. Dried samples were ground through a Wiley Mill fitted with a 1 mm screen (FZ102, Shanghai Hong Ji instrument Co., Ltd., Shanghai, China) ,and analyzed for DM (method 930.15), crude protein (method 954.01), crude fiber (method 962.09), crude fat (EE, method 920.39) and ash (method 942.05) of AOAC (1995) while NFE content was calculated by difference. Ruminal pH was immediately determined before rumen liquor was stored with a digital pH meter (pHep®, pocket-sized pH meter Hana instruments, Italy). Concentration of NH3-N was immediately determined using micro-diffusion method of Conway (1963). Frozen rumen liquor samples were analyzed for total volatile fatty acids (TVF's) by steam distillation according to Warner (1964). Neutral detergent fiber (NDF) was assayed with a heat stable amylase and expressed inclusive of residual ash, acid detergent fiber (ADF) expressed inclusive of residual ash, and acid detergent lignin ADL were determined according to Van Soest *et al.* (1991). Total protein of blood serum was determined as described by Armstrong and Carr (1964). Albumin (A) was determined as described by Doumas *et al.* (1971). Globulin (G) was calculated by subtracting albumin from total protein. The A G ratio was calculated by dividing the value of albumin on the value of globulin. Urea was determined by the method of Coulombe and Favrean (1963)

Statistical Analysis

Data were statistically analyzed using SAS (1999) for Windows, version 6, release 6.12 (SAS Institute Inc., Cary, NC, USA). Collected data for nutrient digestibility and blood constitutes were analyzed using one-way classification, ANOVA was applied (Tables 2 and 4). Data of rumen parameters over time were analyzed using two-way classification, repeated measures ANOVA was applied (Table 3). Data of growth performance and feed conversion was adjusted for initial body weight, ANACOVA was applied (Tables 5). Treatment differences (P<0.05) were assessed using Duncan's Multiple Range test (Duncan, 1955). The significance level of the test was (P<0.05).

RESULTS AND DISCUSSION

Nutrients digestibility, feeding values and rumen fermentation

Data of nutrients digestibility and feeding values presented in Table (2) showed that DM, OM, CP, CF, EE and NFE digestion coefficient and feeding values as TDN and DCP were insignificantly (P>0.05) affected by HMB supplementation. The insignificant effect noticed for nutrients digestibility may be attributed to that, about 50% of methionine hydroxy analog are escaping from degradation in the rumen and entering the abomasum and then became available for postruminal absorption (Koenig *et al.*, 1999). Therefore logically, the addition of HMB as well as protected methionine does not significantly affect the rumen fermentation parameters and nutrients digestibility in ruminants. Klemesrud *et al.* (2000) reported that digestibility of DM and CP for growing cattle were not affected by methionine and lysine supplementation. Also Löest *et al.* (2002) found that abomasal infusion of growing cattle with an amino acid mixture limiting in methionine, did not affect apparent total tract digestion of DM and OM. Also no changes in digestion of DM and OM in the fermenter effluent were noted between the control and HMB treatments (Wilson *et al.*, 2008). On the contrary, Schroeder *et al.* (2006) reported that infusions of 3 g methionine in abomasums of growing steers decreased apparent total tract digestion of OM, while NDF digestibility was not affected.

Table (2): Effect of feeding calves methionine hydroxy analog supplementation on nutrients digestibility and feeding value.

Item	G1	G2	s.e.	P
Animal No.	6	6		
Nutrients digestibility, %				
Dry matter	66.70	67.61	0.75	0.489
Organic matter	68.32	69.27	0.76	0.392
Crude protein	58.57	59.75	0.10	0.476
Crude fiber	66.80	67.59	1.00	0.588
Ether extract	73.07	72.54	0.31	0.253
Nitrogen free extract	69.90	70.96	0.63	0.268
Feeding value, %				
TDN	66.44	67.24	0.69	0.422
DCP	7.91	8.00	0.12	0.588

Abbreviation is: TDN = total digestible nutrients, DCP = digestible crude protein.

Table (3): Effect of methionine hydroxy analog supplementation to calves diets on some rumen fermentation parameters.

Item	G1	G2	Mean ± s.e.	P
Animal No.	6	6		
pH value				
At zero time	6.63	6.56	6.595±0.052	0.398
After 3 hours	5.34	5.44	5.39±0.085	0.429
After 6 hours	5.88	5.8	5.84±0.048	0.485
NH_3- N concentration , mg/100 ml				
At zero time	14.12	13.96	14.04±1.018	0.258
After 3 hours	18.12	17.86	17.99±0.190	0.276
After 6 hours	14.89	14.76	14.83±0.404	0.422
TVFA,s concentration, meq/100ml				
At zero time	7.61	7.61	7.61±0.809	0.528
After 3 hours	10.71	11.27	10.99±0.585	0.427
After 6 hours	8.39	8.19	8.29±0.096	0.392

Also insignificant differences (P>0.05) between the two groups (without or with HMB) at different times, 0, 3 and 6 hrs post-feeding were noticed for pH value, NH_3-N and TVFA's concentrations in the rumen liquor, (Table 3). The values of pH started high then decreased at 3 hrs then tend to increase at 6 hrs after feeding, while NH_3-N and TVFA's concentration started low then increased at 3 hrs then tend to decrease at 6 hrs after feeding. An average ruminal NH3-N concentration were approximately 15.5 mg/dl and was well above the 5 mg /dl, which was sufficient to maximize microbial growth and rumen digestion (Satter and Slyter, 1974). These results indicate that any response to HMB supplementation was not due to provision of additional ammonia, but was specifically due to supplementation of HMB. The insignificant effect in rumen liquor ammonia nitrogen and TVFA's concentrations as well as pH value at different time and the mean value between the two groups may have been due to: **1)** the HMB compound (D,L-2-hydroxy-4-(methylthio)-butanoic acid) don't contain nitrogen atoms, consequently it did not have any effect on rumen nitrogen fraction, **2)** about 50% of HMB are escaping ruminal degradation and entering the abomasums (Koenig *et al.*, 1999), and some amount of this compound absorbed across ruminal and omasal epithelium (McCollum *et al.*, 2000). Similar results were obtained by Wilson *et al.* (2008) who reported no changes in microbial growth, pH, ammonia, VFA proportions, or concentrations of selected long-chain fatty acids in the fermenter effluent were noted between the control and HMB treatments.

Blood constituents

Data presented in Table (4) indicated that the calves received ration supplemented with HMB had higher total blood serum proteins (P= 0.025) and albumin (P≤ 0.006) concentration, while had lower (P=0.032) urea nitrogen concentration compared with calves fed the control diet (6.52 vs. 5.97g/dl, 3.34 vs. 2.97g/dl and 23.10 vs. 26.67mg/dl, respectively). On the other hand insignificant differences (P>0.05) were noticed for globulin concentration and albumin/globulin ratio between the groups fed rations without or with HMB supplementation.

The significant increase in total blood serum proteins and albumin concentrations can be attributed to that **1)** about 50% of HMB are escaping ruminal degradation, Koenig *et al.* (1999) and that, if absorbed, it can be converted to methionine (Belasco, 1972 and 1980; Papas *et al.*, 1974 and Wester *et al.*, 2000 a and b). **2)** The methionine is dietary essential amino acid that plays unique roles, both in protein structure (or biosynthesis) and in metabolism. Methionine serves as the initiating amino acid in eukaryotic protein synthesis (Brosnan *et al.* 2007). Gibb *et al.* (1992) and Schroeder *et al.*, (2006) observed that, plasma concentration of most essential amino acids especially methionine and lysine are responded (P<0.01) linearly and/ or quadratically to increased escape protein in growing calves diet.

The lower urea-N value in the present study may be due to high protein utilization by calves fed diet supplemented with HMB. Schroeder *et al.*, (2006) reported that growing steers which were abomasally-infused with 3g methionine decreased plasma urea concentration. While Overton *et al.* (1998) and Izumi *et al.* (2000) reported that plasma urea-N concentration was not affected by addition of protected methionine.

Table (4): Effect of feeding calves methionine hydroxy analog supplementation on some blood constituents of protein utilization.

Item	G1	G2	s.e.	P
Animal No.	6	6		
Total protein, g/dl	5.97 ^{b}	6.52 ^{a}	0.15	0.025
Albumin, g/dl	2.97 ^{B}	3.34 ^{A}	0.08	0.006
Globulin, g/dl	3.01	3.02	0.22	0.966
A/G ratio	1.04	1.12	0.10	0.594
Urea nitrogen, mg/dl	26.67^a	23.09^b	1.02	0.032

a and b: Means of treatments within the same row with different superscript letters differ significantly (P< 0.05).
A and B: Means of treatments within the same row with different superscript letters are differ significantly (P< 0.01).

Table (5): Effect of methionine hydroxy analog supplementation on calves growth performance and feed efficiency.

Item	G1	G2	s.e.	P
Animal No.	19	19		
Feeding period, day	132	132		
Growth performance				
Initial body weight, kg	252.22	250.83	3.16	
Final body weight, kg	383.61 ^{B}	401.94 ^{A}	4.135	0.0017
Body weight gain, kg	131.39^B	151.11 ^{A}	4.33	0.0017
Average daily body weight gain, kg/h/d	0.995 ^{B}	1.145 ^{A}	0.03	0.0017
Feed intake, Kg/h/d				
Dry matter	7.47	7.47		
TDN	4.96	4.68		
DCP	0.59	0.59		
Feed conversion, kg /kg gain				
Dry matter	7.51^A	6.52^B	0.20	0.0019
TDN	4.99 ^{A}	4.39^B	0.17	0.0019
DCP	0.59 ^{A}	0.52^B	0.29	0.0019

Abbreviation is: TDN = total digestible nutrients, DCP = digestible crude protein.
A and B Means of treatments within the same row with different superscript letters differ significantly (P<0.01).

Growth performance and feed conversion

The calves received ration supplemented with HMB (G2) grew faster than those received control ration (G1); the total body weight gain and average weight gain were higher (P=0.0019) for calves of G2 by about 15%, compared to calves of G1 (Table 5). The increase in ADG and total gain presumably was due to additional metabolizable protein supplied by this source. This can occur through positive increase in metabolic processes to increase efficiency of protein utilization by, 1) increase anabolism processes as shown from increase total blood serum proteins and albumin concentration for G2 compared to G1 (Table 4), 2) decrease protein catabolism as shown from decrease blood plasma urea-N for G2 compared to G1 (Table 4); as it was mentioned above, methionine is a dietary essential amino acid that plays unique roles, both in protein structure and in metabolism (Ahmed and Bergen, 1983; Ahmed *et al.*, 1983; Brosnan *et al.*, 2007). The present results agree with Rodriguez *et al.* (2002) who noticed improved ADG compared with controls when growing cattle were fed Bermuda grass hay-based diets and supplemented with HMB at 5, 10, or 15 g/animal/d in a molasses-based supplement. Also Venable et al. (2005) reported a trend for linear effect of HMB on ADG for the first 30 d of an 85-d trial on heifers fed 0, 7.5, or 15 g/d of HMB. Also Ahmed and Bergen (1983) and Klemesrud *et al.* (2000) reported that the supplementation with ruminally protected methionine increased ($P \leq 0.05$) average body weight gain and maximize efficiency of protein utilization in steers. They also stated that addition of rumen protected amino acids to diets adequate in metabolizable protein can improve average daily gain of growing steers if that amino acid is deficient in the metabolizable protein presented postruminally and by meeting the animal's requirement for amino acids without over feeding them. Veira *et al.* (1991) and Van Amburgh *et al.* (1993) reported that ADG of Holstein steers was improved ($P<0.05$) by 16.3 -19% for the diet supplemented with ruminally protected lysine and methionine. In contrast to our findings, results with (steam-flaked) corn-based diets for finishing beef cattle indicated negative effect of HMB on ADG (Wilson *et al.*, 2008).

Also, feed conversion as DM, TDN and DCP were improved ($P=0.0019$) for calves fed ration supplemented with HMB by 13.18, 17.87 and 11.86%, respectively compared with calves fed ration without HMB supplementation (Table 5). The significant improvement in feed conversion as kg DM, TDN and DCP /kg gain for calves fed ration supplemented with HMB compared with calves fed control ration, was mainly due to the increase in average daily gain. Beef steers fed ruminally protected lysine and methionine had 16.3% higher ($P \leq 0.05$) ADG and were 15.7% more efficient ($P \leq 0.05$) in feed conversion than the control Veira *et al.* (1991). Ahmed *et al.* (1983) and Veira *et al.* (1991) stated that the response to supplementation of ruminally protected amino acids may be depended on the level and source of dietary protein, whereas the positive productive responses and increased nitrogen retention were reported when lysine and or methionine were infused postruminally or fed to animal fed diets low in CP ($\leq$12% on DM basis) or based on ingredients that are low in ruminally undegraded fraction of feed protein. Also Hussein and Berger (1995) observed that supplementation of diet with 10 g/d rumen protected lysine and methionine improved gain/feed by 12% during the last 98 day of the trial.

CONCLUSION

From the present results it could be concluded that supplementation of calves diet with methionine hydroxy analog did not affect nutrient digestibility and rumen fermentation parameters. However, HMB supplementation increase protein anabolism and decrease protein catabolism. While it improved body weight gain, feed conversion and efficiency of protein utilization.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Late Prof. Dr M.A. El-Ashry (Animal Production Dept., Fac. of Agric. Ain Shams Univ., Egypt) for his assistance and helpful comments and advices throughout this work. Also the authors would like to thank Mr G. M. Hekal for his assistance and helpful effort during the feeding trails.

REFERENCES

Ahmed, B. M. (1982). Plasma amino acid studies in growing cattle. Ph.D. Dissertation. Michigan State Univ., East Lansing, MI 48824.

Ahmed, B. M. and W. G. Bergen (1983). Methionine-cycteine relationship in steers. J. Anim. Sci. 57 Suppl, 1. 110.

Ahmed, B. M.; W.G. Bergen and N. K. Ames (1983). Effect of nutritional state and insulin on hind-limb amino acid metabolism in steers. J. Nutr. 113: 1529-1543.

A.O.A.C. (1995). Association of Official Analytical Chemists. Official Methods of Analysis. 16[th] ed. Washington, D.C., USA.

Armentano, L.E; S. J. Bertics and G.A. Ducharme (1997). Response of lactating cows to methionine or methionine plus lysine added to high protein diets based on alfalfa and heated soybeans. J Dairy Sci., 80: 1194-1199.

Armstronge, W.D. and C.W. Carr (1964). Physiological Chemistry: Laboratory Directions, 3[rd] ed. Burges Publishing Co. Minneapolis, Minnesota, USA.

Belasco, I. J. (1972). Stability of methionine hydroxy analog in rumen fluid and its conversion *in vitro* to methionine by calf liver and kidney. J. Dairy Sci., 55: 353–357.

Belasco, I. J. (1980). Fate of carbon-14 labeled methionine hydroxyl analog and methionine in lactating dairy cows. J. Dairy Sci., 63: 775–784.

Brosnan, J.T.; M.E. Brosnan; R.F.P. Bertolo and J. A. Brunton (2007). Methionine; A metabolically unique amino acid. Livestock Sci., 112: 1-2: 2-7.

Chalupa, W and J. E. Chandler (1975). Methionine and lysine nutrition of growing cattle. J. Anim. Sci., 41:394.

Conway, E. F. (1963). Modification Analysis and Volumetric Error. Rev. ED. Look Wood. London.

Coulombe, J. J. and L. Favrean (1963). A new semi-micromethod for colorimetric determination of urea. Clinical Chemistry 9: 102.

Doumas, B.; W. Wabson and H. Biggs (1971). Albumin standards and measurement of serum with bromocresol green. Clinical Chemistry 31: 87.

Duncan, D.B. (1955). Multiple range and multiple F test. Biometrics. 11: 1-42.

Ferret, A.; J. Plaixats; G. CajaJ. Gasa and P. Prió (1999). Using markers to estimate apparent dry matter digestibility, faecal output and dry matter intake in dairy ewes fed Italian ryegrass hay or alfalfa hay. Small Ruminant Research 33: 145–152.

Gibb, D.J.; T. J. Klopfenstein; R. A. Britton and A. J. Lewis (1992). Plasma amino acid response to graded levels of escape protein. J. Anim. Sci., 70: 2885-2892.

Hussein, H.S. and L. L. Berger (1995). Feedlot performance and carcass characteristics of Holstein steers as affected by source of dietary protein and level of ruminally protected lysine and methionine. J. Anim. Sci., 73: 3503-3509.

Izumi, K.; C. Kikuchi and M. Okamoto (2000). Effect of rumen protected methionine on lactational performance of dairy cows. Asian-Aus. J. Anim. Sci., 13(9):1235-1238.

Klemesrude, M. J.; T. J. Klopfenstein and A. J. Lewis (2000). Metabolizable methionine and lysine requirements of growing cattle. J. Anim. Sci., 78: 199-206.

Koenig, K. M.; L. M. Rode; C. D. Knight and P. R. McCullough (1999). Ruminal escape, gastrointestinal absorption, and response of serum methionine to supplementation of liquid hydroxy analog in dairy cows. J. Dairy Sci., 82: 355–361.

Koenig, K.M.; L.M. Rode; C.D. Knight and M. Vázquez-Añón (2002). Rumen degradation and availability of various amounts of liquid methionine hydroxy analog in lactating dairy cows. J. Dairy Sci., 85: 930–938.

Komarek, R.J.; R. A. Jandzinski and S. R. Awes (1983). Effect of diet upon the postruminal supplies of amino acids in the steer. J. Anim. Sci., 57 (suppl.1): 447.

Löest, C. A.; E.C. Titgemeyer; G. St-Jean; D.C. Van Metre and J.S. Smith (2002). Methionine as a methyl group donor in growing cattle. J. Anim. Sci. 80:2197–2206.

McCollum, M.Q.; M. Vázquez-Añón; J. J. Dibner and K. E. Webb (2000). Absorption of 2-hydroxy-4-(methylthio) butanoic acid by isolated sheep ruminal and omasal epithelia. J. Anim. Sci., 78: 1078-1083.

NRC (2000). National Research Council. Nutrient Requirements of Beef cattle. Seventh Revised Edition: Update 2000. National Academic of Science, Washington, D.C. USA.

Overton, T.R.; L.S. Emmert and J. H. Clark (1998). Effects of source of carbohydrate, protein and rumen protected methionine on performance of cows. J. Dairy Sci., 81: 221-228.

Papas, A.; G.A. Hall; E.E. Hatfield and F.N. Owens (1974). Response of lambs to oral and abomasal supplementation of methionine hydroxy analog or methionine. J. Nutr., 104: 653-659.

Richardsem, C. R. and E.E. Hatfield (1978). The limiting amino acids in growing cattle. J. Anim. Sci. 46, 740.

Rodriguez, E. R.; W. E. Kunkle and M. Vázquez-Añón (2002). Effects of Alimet on performance of growing cattle fed forage diets and molasses based liquid supplements. J. Ani. Sci., 80 (Suppl. 1): 238 (Abstract).

Rulquin, H.; R. Verite; J. Guinard-Flament and P.M. Pisulewski (2001). Amino acids digestibl. in the small intestine. Factors of variation in ruminats and consequences on milk protein secretion. INRA productions Animals. 14: 201-210.

SAS (1999). Statistical Analysis System. SAS User's Guide Statistics. SAS Institute Inc., Cary, NC, USA.

Satter, L.D. and L. L. Slyter (1974). Effect of ruminal ammonia concentration on nitrogen utilization by steers. British Journal of Nutrition 32: 199–208.

Schroeder, G.F.; Titgemeyer E.C.; M.S. Awawdeh; J.S. Smith and D.P. Gnad (2006). Effects of energy level on methionine utilization by growing steers. J. Anim. Sci., 84: 1497-1504.

Schwab, C.G.; C.K. Bozak; N.L. Whitehouse and M.M.A. Mesbah (1992). Amino acid limitation and flow to duodenum at four stages of lactation. 1- Sequence of lysine and methionine limitation. J. Dairy Sci., 75:3486-3502.

Van Amburgh, M.T.; P.D. Fox and G. Ducharme (1993). Growth response of Holstein steers supplemented with rumen protected lysine and methionine. J. Anim. Sci. 71 (1), 260 (Abstract).

Van Soest, P.J.; J.B. Robertson and B.A. Lewis (1991). Methods for dietary fiber, neutral detergent fiber and non –starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.

Veira, D.M.; J.R. Seoane and J.G. Proulx (1991). Utilization of grass silage by growing cattle: Effect of a supplement containing ruminally amino acids. J. Anim. Sci., 69: 4703.

Venable, E.; M. Kerley; B. Miller and M. Vázquez-Añón (2005). Potential of Alimet supplementation to improve growth and reproduction of beef heifers fed a forage diet. J. Anim. Sci., 83 (Suppl. 2):89 (Abstr).

Warner, A.C.I. (1964). Production of volatile fatty acids in the rumen methods of measurements. Nutrition Abstract and Review 34: 339.

Wester, T.J.; M. Vázquez-Añón; D. Parker; J. Dibner; A.G. Calder and G.E. Lobley (2000a). Metabolism of 2-hydroxy-4-methylthio butanoic acid (HMB) in growing lambs. J. Dairy Sci., 83 (1):268-269.

Wester T.J.; M. Vázquez-Añón; D. Parker; J. Dibner; A.G. Calder and G.E. Lobley (2000b). Synthesis of methionine (Met) from 2- hydroxy-4-methylthio butanoic acid (HMB) in growing lambs. J. Dairy Sci., 83(1): 269.

Wilson, K.R.: C.S. Abney: J.T. Vasconcelos; M. Vázquez-Añón; J.P. McMeniman and M.L. Galyean (2008). Effects of 2-hydroxy-4-(methylthio)-butanoic acid on performance and carcass characteristics of finishing beef cattle and on fermentation in continuous culture. J. Anim. Sci., 86:1951-1962.

الأداء الإنتاجي للعجول المغذاة على علائق مدعمة بالمثيونين هيدروكسي أنالوج

نصر السيد البرديني[1] و عبدالمجيد أحمد عبيدو[2]

[1]قسم الإنتاج الحيواني- كلية الزراعة- جامعة عين شمس- حدائق شبرا- القليوبية- مصر.

[2]قسم الإنتاج الحيواني- المركز القومي للبحوث- الدقي- الجيزة- مصر.

أجريت هذه التجربة بهدف دراسة تأثير إضافة المثيونين هيدروكسي انالوج الى علائق العجول النامية على معدل النمو، كفاءة تحويل الغذاء والكفاءة الاقتصادية. استخدم فى هذه الدراسة عدد 38 عجل بقرى خليط بمتوسط وزن 251.52 ±3.16 كجم قسمت الى مجموعتين متساويتين فى العدد، غذيت المجموعة الأولى على عليقة مكونة من 28.17% سيلاج ذرة، 32.32% ذرة صفراء، 10.06% كسب فول صويا، 10.77% نخالة قمح، 10.77% نخالة ارز، 5.03% رجيع كون، 1.44% حجر جيرى، 0.72% ملح طعام، 0.36% مخلوط أملاح معدنية وفيتامينات، 0.36% منظم حموضة بدون إضافة مثيونين هيدروكسي انالوج، وغذيت المجموعة الثانية على نفس العليقة السابقة مع إضافة 10 جم مثيونين هيدروكسي انالوج /رأس/يوم. استمرت تجربة التغذية لمدة 132 يوم تم خلالها تسجيل وزن الجسم والغذاء المأكول وتقدير معاملات الهضم والقيمة الغذائية للعلائق. وقد أظهرت النتائج ما يلي:

معاملات هضم كل من المادة الجافة، المادة العضوية، البروتين الخام، الألياف الخام، الدهن الخام والكربوهيدرات لم تتأثر معنويا بإضافة المثيونين هيدروكسي انالوج. كما لم يختلف معنويا كل من المركبات الكلية المهضومة والبروتين الخام المهضوم.

كذلك لم يلاحظ وجود اختلافات معنوية فى قيم درجة pH ، تركيز كل من الامونيا والاحماض الدهنية الطيارة الكلية لسائل الكرش بإضافة المثيونين.

اضافة المثيونين أدى الى زيادة معنوية في قيمة البروتين الكلى والالبيومين بينما أدى الى تقليل نيتروجين اليوريا فى سيرم دم العجول بالمقارنة مع العجول المغذاة على عليقة المقارنة، إلا أن قيمة الجلوبيولين ونسبة الالبيومين: الجلوبيولين لم تتأثر معنويا.

أدت إضافة المثيونين الى زيادة معنوية في معدل النمو اليومى (1.145كجم) مقارنة مع 0.996 كجم/رأس/يوم للعجول المغذاة بدون إضافة. كما أدت الإضافة الى تحسن كفاءة تحويل الغذاء معنويا في صورة كجم مادة جافة، مركبات كلية مهضومة، وبروتين خام مهضوم/ كجم نمو (6.52، 4.09، 0.52) مقابل 7.51، 4.98، 0.59 كجم/كجم نمو للعليقة بدون إضافة.

نستخلص من هذه الدراسة أن إضافة المثيونين هيدروكسي انالوج الى علائق العجول النامية بمعدل 10 جم/رأس/يوم أدت الى زيادة معدل الاستفادة من بروتين العليقة، معدل النمو، وكفاءة تحويل الغذاء.