EFFECT OF FEEDING METHIONINE-SUPPLEMENTED RATION TO SHEEP: 2. RUMEN FERMENTATION, DIGESTION IN DIFFERENT SEGMENTS OF DIGESTIVE TRACT AND CARCASS CHARACTERISTICS

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تأثير اضافة المثيونين الى عليقة الأغنام
٢ ـ تخمرات الكرش ، الهضم فى الأجزاء المختلفة من القناة الهضمية وصفات الذبيحة

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ملخص البحث

استخدمت حملان الأغنام الأوسيمى النامية عند عمر ٨ شهور ومتوسط وزن ٣٧ كجم فى مجموعتين بكل ستة حملان لدراسة تأثير اضافة المثيونين الى العليقة على تخمرات الكرش ، الهضم فى الأجزاء المختلفة من القناة الهضمية وصفات الذبيحة · غذيت المجموعة الأولى على عليقة أساسية مكونة من علف مصنع ونخالة ودريس البرسيم ، بينما غذيت المجموعة الثانية على نفس العليقة مضافا اليها ٣,٣ جم مثيونين / كجم من العليقة الجافة ، وقد استمرت التجربة مدة ثلاثة شهور · وقد تم ذبح جميع الأغنام فى نهاية التجربة وسجلت بيانات الذبيحة ·

وقد دلت النتائج على أن أكثر من ٧٠٪ من هضم مكونات الغذاء تحدث داخل الكرش ، وأن أقل من ٣٠٪ يحدث بعد الكرش · زادت معاملات هضم المادة الجافة والمادة العضوية والبروتين الخام والكربوهيدرات الذائبة والألياف الخام فى الكرش نتيجة اضافة المثيونين · كما أدت اضافة المثيونين الى زيادة النشاط الميكروبى فى الكرش فقد ارتفع انتاج الأحماض الدهنية الطيارة معنويا من ٢٣,١١ الى ٢١,٩٥ ملمول / ١٠٠ مل من سائل الكرش ·· بينما زاد انتاج الأمونيا من ٣,٢٣ الى ٨,٣٢ ملجرام / ١٠٠ مل والبروتين الميكروبى من ٢٥,٤٤ الى ٥٢,٤٧ ملجرام / ١٠٠ مل ـ وقد كانت الزيادة فى الأمونيا والبروتين الميكروبى غير معنوية ·

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أدت التغذية على عليقة مضافا اليها المثيونين الى زيادة كل مـــــن وزن
الجسم عند الذبح ونسبة التصافى زيادة غير معنوية · لم تظهر أية فروق معنوية
بين المجموعتين فيما يختص بوزن ونسب كل من الرأس والفروة والأرجل والأعضاء
الداخلية · زادت مساحة العضلة العينية من ٩,١١ سم٢ فى المجموعة المقارنة
الى ١٤,٣ فى المجموعة المغذاه على عليقة مضافا اليها المثيونين · كما زادت
نسب كل من اللحم واللحم الى الدهن واللحم الى العظم وقلت نسبة الدهـــن
نتيجة اضافة المثيونين ومع ذلك فقد كانت هذه الفروق غير معنوية ·

ABSTRACT

Two groups, each of 6 growing male Ossimi lambs 8-month of age and average body weight 37 kg were used to study the effect of methionine supplementation on rumen fermentation, digestion in different segments of the digestive tract and carcass characteristics. The control group was fed a ration of co-op feed, wheat bran and clover hay. The treated group (MSR) was fed the same ration supplemented with 3.3 g methionine/kg DM. At the end of the experimental period, which lasted for 3 months, all animals were slaughtered. Weights of different carcass parts were recorded. Ribeye area and chemical analysis of the 9-10-11th ribs were determined. Acid insoluble ash was used as the reference marker for determination of the partial digestion in different segments of the digestive tract. Rumen samples were analyzed for volatile fatty acids (VFA), NH_3-N concentration and microbial protein synthesis (MCP-N).

Results revealed that more than 70% of the digestive events took place within the reticulo-rumen and no more than 30% occured post-ruminally. Digestibility of DM, OM, CP, NFE and CF within the rumen increased due to the methionine supplementation. Microbial activity was higher in the MSR group than in the control one; VFA increased from 11.23 to 21.95 mmol/100 ml., NH_3-N from 23.3 to 32.8 mg/100 ml and MCP-N from 44.25 to 47.52 mg/100 ml.

The slaughter body weight of sheep fed MSR was higher than those fed the control diet; dressing percentage followed the same trend, however, differences were not significant. No differences were found regarding weights and percentages of head, pelt, legs and the internal organs. Sheep fed MSR had larger-non-significant ribeye area (14.3 vs. 11.9 cm^2) than the control group. Lean percentage, lean/fat and lean/bone ratios followed the same trend; fat percentage was less in MSR group; differences were not significant.

INTRODUCTION

The use of methionine as a sulfur supplement has been investigated (Loosli and Harris, 1945; Albert et al., 1956; Lofgreen et al., 1947; Williams and Moir, 1951; Moir et al., 1967). It is perhaps significant that when comparisons have been made with other sulfur sources, or when methionine has been added to sulfur-adequate diets, no outstanding growth or production advantage has been obtained. Rendig and Weir (1957) found that the increase in urinary sulfate from lambs fed alfalfa and methionine equalled the methionine-sulfur added. Precise quantitative evidence of sulfur-amino acids metabolism particularly methionine metabolism in the rumen is still required. There is a need for a much more complete knowledge not only of its effect on digestion events and microbial activity in the rumen but also of its effect on carcass characteristics.

The present work was conducted to study the influence of inclusion of methionine into sheep diet on the rumen microbial activity, nutrient digestion in different segments of the digestive tract as well as carcass characteristics.

MATERIALS AND METHODS

The present experiment was carried out at the Animal Production Experimental Farm, Minufiya University, Shebin El-kom, Egypt. Twelve non-shorn Ossimi male lambs, 8-month of age were used. The animals were divided into two comparable groups. One group, served as control, was fed a ration consisted mainly of clover hay, co-op concentrates* and wheat bran. The other group fed the same ration

* Co-op feed containing: soybean meal, 28%; wheat bran, 44%; yellow maize, 19%; rice bran, 3%; molasses, 2%; limestone, 3%; salt, 1%; production of Tanta Co. for Oil and Soap.

supplemented with 3.3 g methionine per kg DM. Methionine was included in the diet by simple mixing with wheat bran. Animals were fed twice daily. Water was available all the time. At the end of the experiment which lasted for three months, all animals were slaughtered after being fasted for only 6 hrs, therefore, the digestion events would not be affected. Slaughtering followed according to Islamic rites. After complete bleeding and removal of the pelt, the offals and thoracic and abdominal organs were removed and weighed. The contents of the digestive tract were removed and their weights were subtracted from the slaughter live weight to obtain the empty body weight. The weights of each part as percentage of body weight were also calculated. A 9-10-11 rib section was removed from right side by making cuts in opposition to the anterior edges of ribs 9 and 12; they were stored in sealed polyetheline bags and chilled until analysis. Ribs were dissecated into lean, fat and bone. Chemical analysis of the boneless 9-10-11th ribs were carried out according to A.O.A.C. (1980) to determine the moisture, protein, fat and ash percentages. Area of ribeye was measured by means of a clean plastic grid placed over the cut surface as described by USDA (1968).

During slaughter procedure, grab samples of the contents of different segments of the digestive tract were collected in plastic containers. These segments were reticulo-rumen, omasum-abomasum, small intestine and large intestine. Samples of feeds, feces, contents of different segments of the digestive tract were oven-dried at 70°C for overnight and ground through a Wiley Mill (1 mm screen). The complete chemical composition of these samples were determined according to A.O.A.C. (1980). Nutrient digestion coefficients were calculated by the marker ratio technique (Schneider and Flatt, 1975). Acid-insoluble ash (AIA) was the reference marker. Feeds and feces as well as the contents of the digestive tract were analyzed by the 2N HCl AIA technique described by Van Keulen and Young (1977). Another sample of the rumen liqor was obtained from each animals for the determination of the microbial activity. Rumen fluid was strained through two layers of cheese-cloth into plastic containers. Samples were preserved by the addition of 0.1 ml of concentrated sulfuric acid to 5 ml of rumen fluid for late analysis of ammonia-N. Rumen fluid used for analysis of volatile fatty acids (VFA) was prepared by combining 5 ml of rumen fluid with 1 ml ortho-phosphoric acid according to Ahmed (1976). A composite rumen sample was used for determination of microbial protein-N (MCP-N) as a tungestic acid precipetate protein as shown by Ahmed (1976).

Statistical analysis was conducted according to Gill (1978).

RESULTS AND DISCUSSION

Data concerning the digestion coefficients of the nutrients in different segments of sheep digestive tract as affected by methionine supplementation are presented in Table (1). It is obvious that the majority of the digestion takes place in the reticulo-rumen. On the average more than 70% of the digestive events occure within the reticulo-rumen, while no more than 30% occure post-ruminally. Staples et al. (1984) came to the same conclusion with dairy steers that the fraction of total digestion occuring post-ruminally was less than 20%.

Methionine-supplementation significantly increased the digestibility of CP and NFE within the rumen. Digestibility of CP increased from 46.8 to 52.05% and NFE increased from 57.66 to 63.39%. There were also an increase in the digestibility of DM, OM and CF, however, differences were not significant.

The increase in digestion coefficient within the reticulo-rumen is a good indicator that methionine is an essential factor for the

Table 1: Digestion coefficients of nutrients in different segments of the digestive tract of sheep fed methionine-supplemented ration (MSR)

Item		Reticulorumen		Omasum-abomasum		Small intestine		Large intestine	
		MSR	Control	MSR	Control	MSR	Control	MSR	control
		%							
DM		52.53	49.53	8.04	8.14	2.82	3.40	6.63	6.30
	%	75.02	73.52	11.48	12.08	4.02	5.05	9.47	9.35
OM		53.37	49.64	8.66	8.66	3.09	3.65	6.60	6.15
	%	74.41	72.89	12.07	12.72	4.30	5.36	9.20	9.03
CP		52.05[a]	46.86[b]	8.55	10.36	2.14	1.39	16.48	17.71
	%	65.70	61.40	10.79	13.57	2.70	1.82	20.80	23.20
EE		44.87	44.39	6.88	5.91	2.09	4.22	11.66	10.00
	%	68.50	68.80	10.50	9.16	3.19	6.54	17.80	15.50
NFE		63.39[a]	57.66[b]	8.50	8.02	2.94	3.58	6.86	5.53
	%	77.60	77.10	10.41	10.72	3.60	4.79	8.40	7.39
CF		39.37	37.12	4.68	4.88	0.42	0.99	8.13	9.00
	%	74.85	71.40	8.89	9.39	0.80	1.90	15.46	17.31

a,b Values not sharing the same superscript within each row are significantly different ($P < 0.05$).

microbial activity. Many investigators (Pittman and Bryant, 1964; Pittman et al., 1967; Moir, 1970) reported that methionine and cycteine are stimulatory or essential, to some rumen microorganisms. Methionine may be used directly by microorganisms (Nader and Walker, 1970). Microorganisms will attack NFE first (as an easily fermented soluble carbohydrate) making more ATP available for the proteolytic and cellulolitic bacteria which lead to an increase in the digestion of CP and CF in the rumen.

As it was shown in the previous work (Saddick and Ahmed, 1988) the methionine-supplemented ration had nitrogen:sulfur ratio near 10:1; this ratio is the favorite for microbial activity. Bray and Hemsley (1969) reported that rumen microbial activity and rate of cellulose digestion both increased with more favorable sulfur supply to narrow the N:S ratio to 9.7:1.

The digestion of dietary protein in the reticulo-rumen involves proteolysis by bacterial proteases, yielding amino aicds and other nitrogenous compounds. Depending upon conditions, a considerable proportion (63 to 82% of the amino acids and ammonia; Garrigus, 1970) thus produced is synthesized into microbial protein (MCP), which are then available to the host animals after hydrolysis post-ruminally. About 20% of the CP digestibility occured in the large intestine (Table 1). However, there is little absorption of amino acids from the hind gut (Henderickx et al., 1972).

Raminal microbial activity was measured using VFA production, NH_3-N level and MCP synthesis. These results are shown in Table (2). Again it is clear that microbial activity was significantly higher in the rumen of those animals fed the methionine-supplemented ration. Production of VFA increased from 11.23 to 21.95 mmol/100 ml (almost doubled) due to methionine supplementation. Whanger and Martone (1970) reported that the acetate plus propionate levels in

Table 2: Ruminal volatile fatty acids (VFA), ammonia-nitrogen (NH_3-N) and microbial protein-nitrogen (MCP-N) of Ossimi sheep fed methionine-supplemented ration (MSR). (Mean ± SE).

Item	MSR	Control
VFA, mmol/100 ml	$21.95^{a} \pm 1.56$	$11.23^{b} \pm 1.66$
NH_3-N, mg/100 ml	32.82 ± 7.81	23.30 ±4.25
MCP-N, mg/100 ml	47.52 ± 9.82	44.25 ±7.91

^{a,b}values not sharing the same supperscript within each row are significantly different ($P < 0.05$).

the rumen fluid did not differ significantly between the S-fed and S-deficient sheep, however, the concentration of butyric acid and higher acids was 2-3 times greater in the rumen fluid with the S-fed sheep than from S-deficient sheep. The total fatty acids concentration in the rumen fluid averaged 20% higher in the S-fed sheep. Ammonia-N also increased, however, difference was not significant. Microbial protein synthesis was more in the methionine-supplemented ration than in the control group. Whanger (1965) and Whanger and Matrone (1965) examined the rumen microorganisms and revealed that those from the S-supplemented sheep were predominatly gram positive whereas those from the S-deficient sheep were mostly gram negative. The bacterial population was greater in the rumen fluid from the S-fed animals. These observations are in agreement with Gall et al. (1951) who reported that a ration of urea plus sulfur supported a bacterial population about double that found in the rumen contents of animals fed the urea ration without added sulfur. As mentioned above, methionine is essential to rumen microorganisms, Hume (1970) found significant increases in the total MCP synthesis where some protein is added to urea-containing diets.

The effect of feeding ration containing methionine to sheep on their carcass characteristics are presented in Table (3). The slaughter body weight of sheep fed methionine-supplemented diet was heavier than those fed the control diet. However, differences did not reach the level of significancy. No significant differences were detected between both groups regarding the weights of head, pelt, legs and the internal organs. However, weights of almost all these organs (except the separable fat) were greater in the methionine-supplemented ration group than the control one.

Data in Table (4) shows that dressing percentages followed the same trend of the slaughter body weight. Values of dressing percentage relative to live body weight or empty body weight in

Table 3: Slaughter data of sheep fed methionine-supplemented ration (MSR)

Item	MSR	Control
No. of sheep	6	6
Live body weight at slaughter, kg	52.50	50.33
Empty body weight, kg	46.99	44.79
Tailless hot carcass weight, kg	22.64	21.25
Head, kg	3.90	3.67
Legs, kg	1.24	1.20
Pelt, kg	6.15	5.94
Heart, kg	0.26	0.25
Lungs and trachea, kg	0.58	0.56
Liver, kg	0.92	0.88
Kidneys, kg	0.17	0.16
Spleen, kg	0.08	0.07
Fat tail, kg	4.23	4.51
Empty digestive tract, kg	4.01	3.76
Tests, kg	0.38	0.32
Separable fat*, kg	4.73	4.94

*Separable fat included: omentum, kidney fat and fat tail.

Table 4: Dressing percentages and relative weights of different organs to live body weight of sheep fed methionine-suplemented ration (MSR).

Item	MSR	Control
	%	
Dressing, (1)	43.12	42.22
Dressing, (2)	48.18	47.44
Head	7.43	7.29
Legs	2.36	2.39
Pelt	11.72	11.79
Heart	0.50	0.49
Lungs and trachea	1.11	1.11
Liver	1.76	1.75
Kidneys	0.32	0.31
Spleen	0.15	0.13
Fat tail	8.05	8.95
Empty digestive tract	7.64	7.48
Tests	0.72	0.64
Separable fat (3)	9.00	9.82

1, Base on live body weight.

2, Based on empty body weight.

3, Separable fat included: omentum, kidney fat and fat tail.

treated group (43.12 and 48.18%) were higher than those in control one (42.22 and 47.44%); differences, however, were not significant. Adding the weight of the tail to the tailless carcass weight, the dressing percentages based on live body weight and empty body weight would be 51.17 and 57.19% for the treated group and 51.16 and 57.49% for the control group.

When weights of the different organs were related to body weight (Table 4), no significant differences were obtained between the two groups. The relative weight of tail, although not significant, appears to be higher in the control group than those in sheep fed methionine supplementation. Sheep recieved methionine deposited less fat than did the control sheep, since the relative separable fat (omental, kidney and tail fat) was found to be 9.00% for the methionine-fed group vs. 9.82% for the control.

Table (5) shows the physical and chemical composition of the 9-10-11th rib section of sheep fed methionine- or control diets. However not significant, sheep fed methionine-diet had more ribeye area (14.3 vs. 11.9 cm^2) than the control group. Lean percentage, lean/fat and lean/bone ratios followed the same trend. Fat percentage of the treated group was less than the control group being 25.85 vs. 28.38%.

Regarding the chemical analysis it was obvious that the methionine-fed sheep had more protein (62.29 vs. 60.54%) and less ether extract (34.03 vs. 35.95%). These are in agreement with results reported by Ahmed (1982) who pointed out that methionine is a limiting amino acid for muscle protein synthesis.

The increase in the size of the ribeye muscle and carcass weight along with the decrease in the separable fat indicate the increase in the yield grade. Accordingly it could be concluded from the

Table 5: Means and standard errors of chemical and physical characters of the 9-10-11 th ribs of sheep fed methionine-supplemented ration (MSR).

Item	MSR	Control
Physical characters:		
Ribeye area, cm^2	14.30±2.24	11.94±1.22
Lean (L), %	57.05±3.16	54.15±3.15
Fat (F), %	25.85±2.21	28.38±5.44
Bone (B), %	17.10±4.04	17.46±2.36
L/F ratio	2.23±0.23	2.01±0.54
L/B ratio	3.64±1.31	3.14±0.27
Chemical analysis of boneless 9-10-11 th ribs:		
Moisture, %	71.22±2.37	70.50±1.70
Protein, %	62.29±3.55	60.54±3.04
Fat, %	34.03±3.69	35.95±3.07
Ash, %	3.68±0.39	3.14±0.27

results obtained in the present study that sheep slightly respond to methionine supplementation regarding carcass characteristics.

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