

## **STUDIES ON RUMEN METABOLISM II- EFFECT OF DIFFERENT DIETARY NITROGEN SOURCES ON RUMINAL FERMENTATION CHARACTERISTICS.**

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### **ABSTRACT**

Six complete rations based on bean straw and containing different dietary nitrogen sources were used to study their influences on rumen liquor characteristics. Soybean meal (SBM), corn gluten meal (CGM) and cottonseed meal (CSM) were used as the sole source of protein in the tested rations or in combination with 1%urea (U). Diets were formulated to be isonitrogenous and isocaloric (14%CP and 64% TDN). Thirty-six Finn-Ossimi crossbred male lambs (22kg average body weight and 4 months age) were used in a fattening trial for 106 days. The animals were divided into 6 similar groups. Each one was assigned to receive one of the following experimental rations: SBM, CGM, CSM, SBM+1%U, CGM+1%U and CSM+1%U. Rumen liquor was obtained from male lambs using a stomach tube at 0, 3 and 6 hours postfeeding.

#### **Results obtained could be summarized in the following:**

- 1- Dietary N source did not affect significantly the pH value, except SBM group which had higher ( $P<0.05$ ) pH value compared with the other groups.
- 2- Values of rumen pH increased 3hrs post feeding and then decreased 6hrs post feeding, where it lies between 6.22-6.51 on the average .
- 3- Urea supplementation decreased ruminal pH value, except CSM group.
- 4- Ruminal  $\text{NH}_3\text{-N}$  and VFA's concentration had, in general the normal distribution curve, since they increased 3hrs after feeding then decreased 3hrs later.
- 5- Dietary N sources affected ( $P<0.05$ )  $\text{NH}_3\text{-N}$  concentration in ruminal fluid, where natural proteins, in general had higher values compared with urea supplemented diets.
- 6- SBM had the highest ( $P<0.05$ )  $\text{NH}_3\text{-N}$  value (14.15mg/100ml), while CGM+1%U had the lowest ( $P<0.05$ ) value (10.73 mg/100ml).
- 7- Incorporation of U in the diets reduced ( $P<0.05$ )  $\text{NH}_3\text{-N}$  in rumen liquor.
- 8- Ruminal VFA's concentration for the experimental rations lies between 8.34 and 10.54m equiv/100ml, with SBM+1%U had ( $P<0.05$ ) the highest value (10.54m equiv/ 100ml) and CSM had ( $P<0.05$ ) the lowest value (8.34 m equiv /100ml).
- 9- Dietary N sources affected ( $P<0.05$ ) ruminal VFA's concentration. Moreover, U, supplementation increased ( $P<0.05$ ) VFA's concentration in rumen liquor.
- 10- Dietary N sources affected ( $P<0.05$ ) the molar proportion of VFA's.
- 11- Supplementing diets with urea increased ( $P<0.05$ ) the molar proportion of butyric acid, however it reduced ( $P<0.05$ ) the molar proportion of both acetate and the ratio of acetat/propionate.

**Keywords :** lambs - N sources - rumen fermentation .

### **INTRODUCTION**

Protein sources are degraded in the rumen by microbial activity and utilized as peptides and amino acids depending on needs of the microbial

population. Lack of N disturbs normal ruminal microbial growth and digestion ( *McAllan et al.*, 1988 ).

The extent of protein degradation in the rumen is an important parameter in determining the protein supply for the rumen microorganisms. A protein source that escapes ruminal degradation and that complements the amino acid profile of microbial protein should increase animal performance or decrease the amount of protein required for production (Owens and Bergen, 1983). These protein sources must, however, provide a minimal level of ammonia for the rumen microbes to prevent inefficient utilization of other dietary nutrients ( *Klopfenstein et al.*, 1982).

Soybean meal represents more than 92% of the total oil seed meal required for animal and poultry feeds. From an economical point of view, it is the most economical protein available for feed manufacturers. In addition, soybean meal is considered to be the standard of different protein sources used in the field of animal feeding ( Urbaniak, 1995). Soybean meal (SBM) is lower in fiber content than cottonseed meal (CSM), and also it is higher in digestible nutrients than CSM. Cottonseed meal is one of the important industrial by products used in animal feeding. However, CSM is less well like for poultry, nevertheless, it finds a widespread use in animal feeding, although its use is more limited due to various problems than that of SBM. Cottonseed cake, has a moderate amount of degradable protein in the rumen compared with corn gluten meal (CGM) which is naturally resistant to microbial degradation (McCollum and Gaylean, 1985; *Fleck et al 1988 and Khandaker et al, 1997*). On the other hand, urea (U) is completely degraded in the rumen, resulting in adequate amount of ammonia to be utilized by ruminal microorganisms, but not for maximum growth or lactation. Urea as non-proteinous nitrogen (NPN) is the least costly source of crude protein ( *McAllan et al, 1988; Milton and Brandt, 1994 and Shian et al., 1994*).

The aim of the present study was to evaluate the effect of some natural dietary protein sources, i.e. SBM, CGM and CSM with or without urea on ruminal fermentation characteristics.

## **MATERIALS AND METHODS**

The present study was carried out in Al-Azhar experimental station Nasr-city, Cairo.

### **Animals:**

Thirty six Finn- Ossimi crossbred male lambs with an average age of 4 months and 22kg live body weight were randomly assigned to 6 nutritional groups. Each group of animals was allotted to receive one of the tested rations . Animals offered rations ad lib. and water was available all the time . At the end of the fattening trial, rumen liquor was obtained from the experimental animals (4 animals per each nutritional group) using a stomach tube at 0, 3 and 6 hours after feeding to estimate ruminal parameters.

**Diets:**

Six complete rations based on bean straw and containing different protein sources : soybean meal, corn gluten meal, cottonseed meal, soybean meal + 1% urea, corn gluten meal + 1% urea and cottonseed meal + 1% urea, were tested.

Diets were formulated to be isonitrogenous and isocaloric so as to provide 14%CP and 64%TDN according to (NRC recommendations, 1985). The composition and chemical analysis of the diets (according to A.O.A.C., 1980) are given in, Tables (1 and 2), respectively.

**Table (1) : Diets formulation.**

Treatments	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
Ingredient%	SBM	CGM	CSM	SBM +1%U	CGM +1%U	CSM +1%U
Bean straw	40	45	26	40	41	31
Wheat bran	5	5	5	5	5	5
Yellow corn	28	28	23	35	36	34
Soybean meal (44% CP)	18.7	----	----	10.7	----	----
Gluten (60% CP)	----	13.7	----	----	8.7	---
Cotton seed meal	----	----	37.7	----	----	20.7
Urea	----	----	----	1	1	1
Limestone	2	2	2	2	2	2
Molasses	5	5	5	5	5	5
Sodium chloride	1	1	1	1	1	1
Mineral premix	0.3	0.3	0.3	0.3	0.3	0.3
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

**Table (2) : Chemical composition of mixed diets containing different protein sources ( %, DM basis ).**

Item	Experimental diets (on DM basis)					
	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
DM	93.06	92.15	92.03	92.41	90.84	91.10
OM	90.77	87.25	89.16	90.98	88.75	90.77
CP	14.22	14.04	14.57	14.00	14.56	14.29
CF	16.92	16.22	16.97	15.25	16.14	17.92
EE	1.89	2.24	2.66	2.89	3.06	3.15
NFE	57.74	54.75	54.96	58.84	54.99	55.41
Ash	9.23	12.75	10.84	9.02	11.25	9.23

**Ruminal parameters:**

**1. Ruminal pH value:**

Rumen samples were withdrawn before feeding and 3 and 6 hours after feeding; strained through four layers of cheese cloth and assed immediately for pH, using a pH meter (EIL).

**2. Ammonia and volatile fatty acids concentrations:**

The zero rate of *in vitro* technique (Carrol and Hungate, 1954) was applied for measuring values of ammonia and volatile fatty acids (VFA) production. For incubation, rumen contents were collected from the male lambs using a stomach tube at 0, 3, and 6 hours after feeding in jars, (500 ml) immersed in large beaker containing warm water (39<sup>0</sup>c) .

Samples were flushed with CO<sub>2</sub> during the collection time, closed with a tightly fitting rubber with an outlet bunsen valve and incubated at 39°C in a thermostatically controlled water bath. Each sample, composed of two thirds fibrous material and one third liquid (El-Shazly and Hungate, 1965).

At zero time, two sub-samples were poured into another jars containing formalin (1ml/100gm rumen contents) and swirled vigorously to stop metabolic activity. One of these samples was used to estimate concentration of ammonia and VFA, while the other was used to determine the dry matter percentages in the rumen contents.

For estimation of ammonia and VFA production, rumen samples were strained through cheese cloth. One hundred ml aliquots of rumen liquor were deproteinized using sulfuric acid (100 ml 0.1 N) and volume was completed to 500 ml in a volumetric flask to be filtered. The supernatant was used for determination of ammonia nitrogen using MgO distillation method (Al-Rabbat et al., 1971). VFA's estimation was done by distillation as described by Warner (1964).

### 3. Ruminal individual VFA's:

The individual VFA's (acetic, propionic and butyric acids) were determined by Kanaur Higher Performance Liquid Chromatography (HPLC, pump 64, U.V. detector, Germany, Kanaur instrument).

#### Statistical analysis:

Statistical analysis was carried out using SAS program (SAS 1988). ANOVA of SAS followed by analysis of variance of repeated measurements and least square means were used to test the effect of time on ruminal fluid parameters.

## RESULTS

### 1. Rumen pH values :

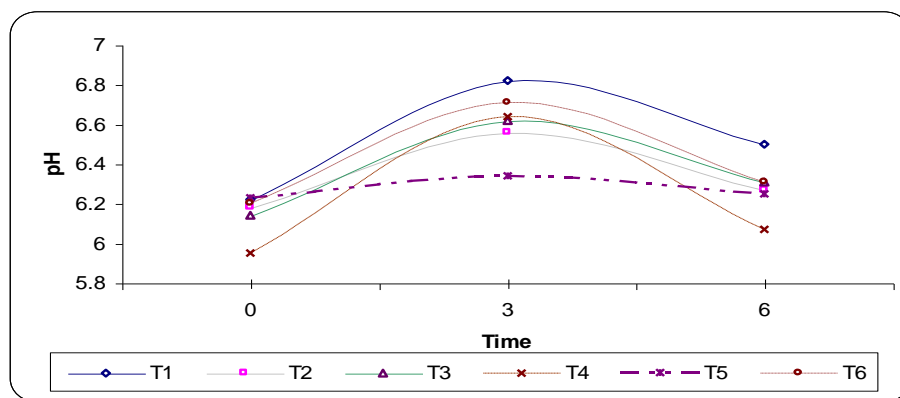
Generally, pH values were increased after 3hrs of feeding and then decreased at 6hrs post feeding for all experimental diets, (Table 3 and Fig.1).

Before feeding, ruminal pH values were not significantly different (P<0.05) among diets containing different protein sources without urea supplementation. The values were 6.22, 6.18 and 6.14 for soybean, gluten meal and cottonseed meal diets, respectively. All pH values were increased as a result of urea supplementation except for the diet contained soybean meal; it was significantly (P<0.05) decreased (from 6.22 to 5.95).

Table (3): Ruminal pH values for diets containing different protein sources fed to sheep (mean±SE).

Times	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
Before feeding	6.22 <sup>a</sup>	6.18 <sup>ab</sup>	6.14 <sup>ab</sup>	5.95 <sup>b</sup>	6.23 <sup>a</sup>	6.20 <sup>ab</sup>
	±0.09	±0.02	±0.04	±0.01	±0.12	±0.06
3 hr, after feeding	6.82 <sup>a</sup>	6.56 <sup>c</sup>	6.62 <sup>b</sup>	6.64 <sup>b</sup>	6.34 <sup>d</sup>	6.71 <sup>b</sup>
	±0.04	±0.08	±0.11	±0.02	±0.05	±0.05
6 hr, after feeding	6.50 <sup>a</sup>	6.27 <sup>b</sup>	6.31 <sup>b</sup>	6.07 <sup>c</sup>	6.25 <sup>b</sup>	6.31 <sup>b</sup>
	±0.01	±0.02	±0.15	±0.03	±0.16	±0.01
Overall mean	6.51 <sup>a</sup>	6.34 <sup>b</sup>	6.36 <sup>b</sup>	6.22 <sup>b</sup>	6.27 <sup>b</sup>	6.41 <sup>b</sup>
	±0.03	±0.04	±0.01	±0.11	±0.12	±0.04

a, b, c and d : Means in the same row with different superscripts are significantly different (P<0.05).



**Fig 1: Rumen pH values of sheep fed the experimental diets at different sampling times.**

Three hours post feeding, higher ruminal pH values were recorded for all experimental rations, i.e. with or without urea. However, urea supplementation reduced ( $P < 0.05$ ) ruminal pH values for both SBM and CGM groups, but it was not with CSM group, which was increased insignificantly ( $P > 0.05$ ) from 6.62 to 6.71. Six hours post feeding all experimental rations had lower pH values. Urea supplementation decreased, in general, ruminal pH values. Soybean meal diet showed a ( $P < 0.05$ ) decrease in rumen pH value especially with urea supplementation (from 6.50 to 6.07), while no significant differences were detected for gluten and cottonseed meal diets with urea supplementation (6.27 vs. 6.25 and 6.31 vs. 6.31, respectively).

The overall mean of rumen pH did not significantly differ ( $P > 0.05$ ) among all diets, except for SBM group which recorded the highest value ( $P < 0.05$ ). However, urea supplementation decreased the PH value. Milton and Brandt (1994) found a linear decrease in ruminal pH values as U level increased in the ration. Similarly, Bhattacharya and Pervez (1973) reported that rumen pH values decreased as U supplementation increased in the ration. On contrast, *Driedger et al. (1998)* reported that there were no differences in rumen pH values among steers fed either SBM or SBM (50%) + U (50%) as dietary protein sources. Also, *Shain et al. (1994)* concluded that increasing dietary urea level had no effect on ruminal pH values.

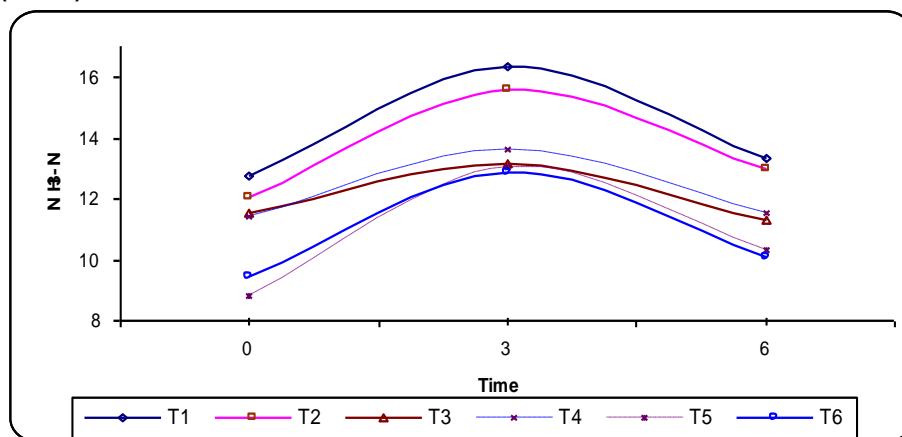
**2. Ammonia-N concentrations :**

No significant differences ( $P < 0.05$ ) were detected in ruminal  $NH_3-N$  concentration before feeding diets containing natural protein sources, although  $NH_3-N$  tended to be higher with SBM.

**Table (4) : Ruminal ammonia- N concentration (mg/100ml) of sheep fed mixed diets containing different protein sources(mean±SE).**

Times	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
<b>Before feeding</b>	12.78 <sup>a</sup>	12.08 <sup>a</sup>	11.52 <sup>a</sup>	11.41 <sup>a</sup>	8.82 <sup>b</sup>	9.46 <sup>b</sup>
	±0.61	±0.14	±0.61	±0.75	±0.35	±0.53
<b>3 hr, after feeding</b>	16.34 <sup>a</sup>	15.63 <sup>a</sup>	13.17 <sup>b</sup>	13.62 <sup>b</sup>	13.08 <sup>b</sup>	12.90 <sup>b</sup>
	±0.12	±0.13	±0.32	±0.54	±0.36	±0.21
<b>6hr, after feeding</b>	13.32 <sup>a</sup>	12.97 <sup>ab</sup>	11.29 <sup>c</sup>	11.54 <sup>c</sup>	10.30 <sup>d</sup>	10.08 <sup>d</sup>
	±0.15	±0.31	±0.25	±0.32	±0.15	±0.23
<b>Overall mean</b>	14.15 <sup>ab</sup>	13.56 <sup>a</sup>	11.99 <sup>c</sup>	12.19 <sup>c</sup>	10.73 <sup>d</sup>	10.81 <sup>d</sup>
	±0.23	±0.36	±0.51	±0.56	±0.25	±0.17

a, b, c and d : Means in the same row with different superscripts are significantly different (P<0.05).



**Fig 2: Ammonia-N concentrations in the rumen liquor of sheep fed the experimental diets at different sampling times.**

Adding urea to either gluten or CSM caused a reduction in rumen NH<sub>3</sub>-N (P<0.05) to a level of 8.82 and 9.46mg/100ml, respectively, although urea did not significantly change NH<sub>3</sub>-N when added to SBM, (Table 4 and Fig. 2).

Urbaniak (1995) showed that inclusion of SBM in diets resulted in an increase (P<0.05) of NH<sub>3</sub>-N concentration. Fleck *et al.* (1988) using cows, found an increase of rumen NH<sub>3</sub>-N when gluten meal feed was replaced by SBM. In a study with steers, Garrett *et al.*(1987) noticed lower (P<0.05) NH<sub>3</sub>-N concentration when animals were fed CGM than those fed SBM.

Three hours post feeding, higher NH<sub>3</sub>-N concentration was recorded for all experimental ration, i.e. with and without urea. However, rations supplemented with urea had, in general, lower NH<sub>3</sub>-N values compared with those containing true proteins, i.e. unsupplemented rations. The increase in NH<sub>3</sub>-N in diets with urea 3hrs post feeding was of lower magnitude. Yet, NH<sub>3</sub>-N concentration in diets containing CSM was comparatively lower than diets of SBM and corn gluten supplemented diets.

Six hours post feeding, a reduction occurred in  $\text{NH}_3\text{-N}$  concentration for all experimental rations, although this reduction was more pronounced with urea supplemented rations. Gluten meal and cottonseed meal containing diets with urea had the lowest ( $P<0.05$ )  $\text{NH}_3\text{-N}$  concentration (10.30 and 10.08 mg/100ml, respectively) than all other diets. The overall mean of  $\text{NH}_3\text{-N}$  concentration followed the same trend of 6 hours post feeding.  $\text{NH}_3\text{-N}$  concentration, in general, took the normal distribution curve where it increased after 3 hours and decreased after 6 hours of feeding. Contrary results were obtained by *Symonds et al. (1981)* who illustrated that  $\text{NH}_3\text{-N}$  was usually high with the addition of NPN source. Similar results were also reported by *Al-Kinani (1996)* with lambs fed 0, 1 or 2% U, partially replacing dietary SBM. *Windschitl and Stern (1988)* found that  $\text{NH}_3\text{-N}$  concentration was higher ( $P<0.05$ ) with U addition than with diets which had no U. Also, *Takahashi et al. (1995)* observed that  $\text{NH}_3\text{-N}$  concentration increased with U supplementation. *Lines and Weiss (1996)* showed that ruminal  $\text{NH}_3\text{-N}$  was higher for cows fed NPN than for those fed natural CP ( $P<0.06$ ) and was higher in cows fed U than in those fed natural CP ( $P<0.05$ ) and was also higher in cows fed U than those fed ammoniated alfalfa hay ( $P<0.05$ ).

### **3.Total VFA's concentration**

Lower VFA concentration was shown by soybean and cottonseed meal without urea supplementation at all sampling times, Table (5) and Fig. (3). Urea supplementation to soybean and CSM diets resulted in higher ( $P<0.05$ ) concentration of total VFA's before feeding (9.29 and 8.27 /100ml) than diet containing CGM (8.77m.Eq./100ml).

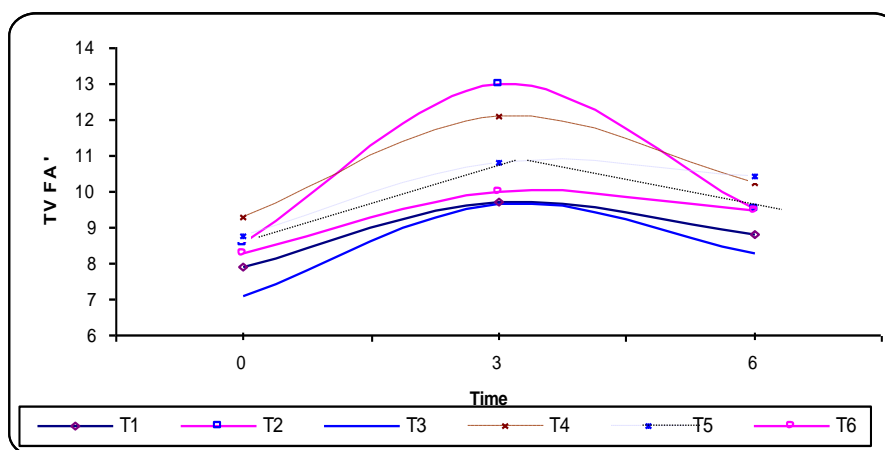
Three hours post feeding, higher ( $P<0.05$ ) VFA concentration was noticed with gluten meal diet without urea which had an obvious increase (13.02m.equiv/100ml) compared with the other tested rations. Nevertheless, U supplementation caused an increase in VFA concentration for all diets, except gluten meal diet. Higher ( $P<0.05$ ) VFA concentration with urea-supplemented diets was noticed for soybean (12.10 vs 9.73 m.equiv/100ml).

Six hours post feeding, a reduction was occurred in all experimental rations. Urea supplemented diets still had higher VFA concentration. It was also noticeable that cottonseed meal diet either with or without urea had always the lower VFA concentration compared to other protein sources at definite times of feeding. These results are in agreement with those obtained by *Khandaker et al. (1997)*, who found that VFA concentration was higher ( $P<0.01$ ) with sheep fed wheat straw supplemented with U than those fed on wheat straw alone. *Sharma et al. (1973)* studied the effect of feeding U and ammonium bicarbonate, each replacing 20 and 40% of ration N. Higher total VFA's concentration was obtained with feeding NPN sources. However, *Lines and Weiss (1996)* found that the total ruminal VFA concentration was not affected by diets that provided 26% of total CP from N added to hay by ammoniation, U, SBM or a commercial blend of animal protein meals. Also, *Milton et al. (1997)* found that total VFA concentrations were not affected by supplemental N source (U or SBM).

**Table (5) : Total VFA's concentration (m.Eq./100ml ) in the rumen liquor of sheep fed mixed diets containing different protein sources (mean±SE).**

Times	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
Before feeding	7.90 <sup>bc</sup>	8.58 <sup>b</sup>	7.08 <sup>c</sup>	9.29 <sup>a</sup>	8.77 <sup>ab</sup>	8.27 <sup>b</sup>
3 hr, after feeding	±0.20	±0.03	±0.21	±0.32	±0.30	±0.24
6hr, after feeding	9.73 <sup>cd</sup>	13.02 <sup>a</sup>	9.68 <sup>d</sup>	12.10 <sup>b</sup>	10.83 <sup>c</sup>	9.98 <sup>cd</sup>
	±0.23	±0.05	±0.31	±0.24	±0.23	±0.23
Overall mean	8.81 <sup>b</sup>	9.52 <sup>b</sup>	8.27 <sup>bc</sup>	10.24 <sup>ab</sup>	10.44 <sup>a</sup>	9.48 <sup>b</sup>
	±0.31	±0.04	±0.21	±0.26	±0.25	±0.41
	8.81 <sup>bc</sup>	10.37 <sup>a</sup>	8.34 <sup>d</sup>	10.54 <sup>a</sup>	10.01 <sup>a</sup>	9.24 <sup>b</sup>
	±0.26	±0.12	±0.25	±0.51	±0.21	±0.31

a, b, c and d: Means in the same row with different superscripts are significantly different (P<0.05).



**Fig 3 : TVFA's concentration in the rumen liquor of sheep fed the experimental diets at different sampling times.**

**4. Molar proportion of VFA's :**

Table (6) shows that SBM and gluten diets supplemented with urea had lower (P<0.05) rumen acetic acid and acetic/propionic ratio (36.53, 35.59 and 1.27 and 1.21, respectively). Other diets had higher (P<0.05) acetic acid concentration and acetic to propionic ratio. Unsupplemented diets with different protein sources had lower (P<0.05) propionic concentration (28.42, 27.75 and 27.27 for soybean, gluten meal and cotton seed meal containing diets, respectively). Cottonseed meal diet supplemented with urea had higher (P<0.05) propionic acid concentration (30.0m.Eq./100ml) compared to CSM non-supplemented diet (27.27m.Eq./100ml). It was also higher than SBM and CGM supplemented diets but with non-significant difference (29.24 and 29.47, respectively).



**Table (6) : Effect of feeding diets containing defferent protein sources on molar prportion of individual VFA's and Acetic : Propionic ratio (mean±SE)**

	Diets	Tr <sub>1</sub>	Tr <sub>2</sub>	Tr <sub>3</sub>	Tr <sub>4</sub>	Tr <sub>5</sub>	Tr <sub>6</sub>
Acetic (Ac)	0	43.92 <sup>a</sup> ±2.15	43.30 <sup>ab</sup> ±1.55	42.67 <sup>ab</sup> ±0.46	39.97 <sup>b</sup> ±0.14	40.25 <sup>b</sup> ±0.78	42.35 <sup>ab</sup> ±0.23
	3	43.42 <sup>a</sup> ±1.02	43.52 <sup>a</sup> ±0.24	43.04 <sup>a</sup> ±1.02	35.07 <sup>b</sup> ±0.56	32.33 <sup>c</sup> ±0.25	44.43 <sup>a</sup> ±0.32
	6	44.35 <sup>a</sup> ±0.23	42.89 <sup>a</sup> ±0.24	43.82 <sup>a</sup> ±0.52	34.56 <sup>b</sup> ±0.24	34.18 <sup>b</sup> ±0.41	45.23 <sup>a</sup> ±0.34
	overall	43.90 <sup>a</sup> ±0.52	43.24 <sup>a</sup> ±0.25	43.18 <sup>a</sup> ±0.52	36.53 <sup>b</sup> ±0.51	35.59 <sup>b</sup> ±0.34	44.00 <sup>a</sup> ±0.41
	mean						
Propionic (Prop.)	0	28.58 <sup>b</sup> ±0.35	28.26 <sup>b</sup> ±0.59	26.82 <sup>bc</sup> ±0.41	26.19 <sup>c</sup> ±0.16	28.17 <sup>bc</sup> ±0.56	33.12 <sup>a</sup> ±0.23
	3	27.71 <sup>bc</sup> ±0.32	26.97 <sup>c</sup> ±0.23	27.62 <sup>bc</sup> ±0.35	30.23 <sup>a</sup> ±0.23	29.28 <sup>ab</sup> ±0.25	28.52 <sup>abc</sup> ±0.25
	6	28.96 <sup>abc</sup> ±0.52	28.03 <sup>c</sup> ±0.31	27.36 <sup>c</sup> ±0.52	31.31 <sup>a</sup> ±0.06	30.97 <sup>ab</sup> ±0.24	28.38 <sup>bc</sup> ±0.26
	overall	28.42 <sup>abc</sup> ±0.12	27.75 <sup>bc</sup> ±0.51	27.27 <sup>c</sup> ±0.31	29.24 <sup>ab</sup> ±0.41	29.47 <sup>a</sup> ±0.06	30.01 <sup>a</sup> ±0.23
	mean						
Butyric	0	22.37 ±0.68	20.90 ±0.73	24.89 0.05	28.57 ±0.30	28.22 ±0.23	23.02 ±0.26
	3	21.51 <sup>cd</sup> ±0.23	21.17 <sup>d</sup> ±0.21	24.92 <sup>bc</sup> ±0.52	28.53 <sup>a</sup> ±0.53	28.23 <sup>ab</sup> ±0.21	22.30 <sup>cd</sup> ±0.24
	6	19.73 <sup>cd</sup> ±0.36	19.06 <sup>d</sup> ±0.35	24.08 <sup>b</sup> ±0.23	30.01 <sup>a</sup> ±0.25	29.75 <sup>a</sup> ±0.26	22.14 <sup>bc</sup> ±0.12
	overall	21.37 <sup>cd</sup> ±0.21	20.37 <sup>d</sup> ±0.52	24.63 <sup>bc</sup> ±0.13	29.04 <sup>a</sup> ±0.61	25.84 <sup>ab</sup> ±0.34	22.49 <sup>bcd</sup> ±0.54
	mean						
Ac./Prop. ratio	0	1.53 ±0.09	1.53 0.07	1.59 ±0.01	1.53 ±0.07	1.43 ±0.04	1.56 ±0.02
	3	1.57 <sup>a</sup> ±0.03	1.62 <sup>a</sup> ±0.20	1.56 <sup>a</sup> ±0.05	1.16 <sup>b</sup> ±0.06	1.10 <sup>b</sup> ±0.04	1.56 <sup>a</sup> ±0.06
	6	1.53 <sup>a</sup> ±0.06	1.53 <sup>a</sup> ±0.04	1.65 <sup>a</sup> ±0.04	1.11 <sup>b</sup> ±0.06	1.10 <sup>b</sup> ±0.07	1.60 <sup>a</sup> ±0.08
	overall	1.54 <sup>a</sup> ±0.01	1.56 <sup>a</sup> ±0.02	1.60 <sup>a</sup> ±0.03	1.27 <sup>b</sup> ±0.01	1.21 <sup>b</sup> ±0.03	1.57 <sup>a</sup> ±0.01
	mean						

a,b,c,d and e : Mean in the same row with different superscripts are significantly different (P<0.05).

Dietary nitrogen sources had a significant (P<0.05) influence on butyric acid concentration. The highest value was obtained with SBM diet supplemented with urea (29.04m.Eq./100m), while CGM unsupplemented diet had the lowest value (20.37m.Eq./100m). Urea supplementation to natural protein sources increased (P<0.05) the butyric acid concentration in rumen liquor, except for cotton seed meal diet.

Molar concentrations of acetic and acetic to propionic ratio were not affected (P<0.05) by natural dietary protein sources; the case was opposite when diets were supplemented with urea. This observation is in agreement with *in vivo* results reported by *McCarthy et al., (1989)* using the same protein supplements. *Garrett et al. (1987)* found that the differences in molar

concentration of acetate and butyrate due to supplemented N source were small. The molar concentration of propionate was higher ( $P < 0.05$ ) for fermentors receiving SBM than for those receiving CGM, while those contained U and LSM were intermediate. *Calsamiglia et al. (1995)* reported that molar proportions of acetate, propionate and butyrate were not affected by supplemented N source. Milton and Brandt (1994) concluded that the acetate: propionate ratio was unaffected by supplemental N.

## **DISCUSSION**

The mean pH values of the diets were within the range of 6.22-6.51, which means that N source had little effect on ruminal pH, since the values were in the optimal range for proteolysis and deamination (Lewis and Emery, 1962). However, diets supplemented with urea had considerably more ruminal activity due to the increase of the levels of corn grain in their content (*Henning et al., 1980*).

Increases in ruminal  $\text{NH}_3\text{-N}$  concentration would result primarily from degradation of dietary protein to  $\text{NH}_3$ , SBM caused an increase in ruminal  $\text{NH}_3\text{-N}$  concentration, followed by CGM.

In all cases,  $\text{NH}_3$  availability should not have limited microbial activity (Satter and Slyter, 1974). *Garrett et al. (1987)* found that ruminal  $\text{NH}_3\text{-N}$  concentration was lower in steers fed CGM ( $P < 0.05$ ) than those fed SBM. However, the source of dietary protein and the extent of its degradation in the rumen influenced ( $P < 0.05$ )  $\text{NH}_3\text{-N}$  flow to the duodenum of lambs. The lowest rate of flow was observed in lambs fed blood meal (Urbaniak, 1995).

Supplementation with urea resulted in higher ( $P < 0.05$ ) total VFA concentration with SBM, while with CGM it resulted in insignificant ( $P > 0.05$ ) lower total VFA concentration. *Garrett et al. (1987)* found that supplementation with SBM resulted in lower VFA than supplementation with SBM+U. However, the relative concentration of VFA reflects the amounts of fermented carbohydrate,  $\text{CO}_2$ , methane and ATP production (Church, 1988).

Results obtained in Tables 4 and 5 showed lower ( $P < 0.05$ ) reduction in  $\text{NH}_3\text{-N}$  concentration due to supplementation of dietary protein sources with urea, while a reverse direction was obtained with TVFA's due to U supplementation. This result may be attributed to the higher carbohydrates (corn) in urea supplemented diets which resulted in a good fermentable activity, hence  $\text{NH}_3$  release was efficiently utilized by ruminal microorganisms indicating lower ( $P < 0.05$ ) ruminal  $\text{NH}_3\text{-N}$  concentration.

This result was obviously substantiated with TVFA's production results (Table 5), since supplementing natural dietary proteins with U increased ( $P < 0.05$ ) TVFA's production indicating a good ruminal activity. Moreover, supplementing CGM with U reduced insignificantly ruminal VFA's concentration due its lower degradability compared with both SBM and CSM which produced higher ( $P < 0.05$ ) TVFA's due to U supplementation, indicating efficient utilization of fermentable  $\text{NH}_3$ - released.

The change in the molar concentration of acetate and butyrate due to N source were small. The molar concentration of propionate was greater ( $P < 0.05$ ) for urea-supplemented diets. This could be due to those diets, which

contained higher amounts of soluble carbohydrates (Church, 1988) than in unsupplemented diets. On the other hand, unsupplemented diets had greater ( $P<0.05$ ) acetate values, which indicate cellulolytic degradation (Birkelo *et al.*, 1986). Molar concentration of butyrate was greater ( $P<0.05$ ) with SBM+U followed by CGM+U, indicating a higher energy diet (Pritchard and Males, 1985). Ruminal butyrate production may enhance the passage of urea through rumen wall by influencing the activity of wall attached microbes or cell division of the ruminal epithelial cells (Visek, 1984). However, absorption of VFA is dependent on ruminal pH and the length of chain of the presented acids (Church, 1988) and butyric being more preferred over acetic for growing animals.

## CONCLUSION

In the light of the present results, it could be concluded that dietary nitrogen sources (nature and degradability) affected significantly ( $P<0.05$ ) the ruminal fermentation characteristics; and since the animal performance is a mirror which reflects the ruminal fermentation activity; thus dietary N source, level, nature and degradability must be considered in formulating animal feed, besides the other dietary factors to attain more efficient utilization of the feedstuffs .

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### دراسات على التمثيل الغذائي في الكرش

#### ٢ - تأثير مصدر نيتروجين الغذاء على بعض خصائص التخمر في الكرش

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إستخدم في هذه الدراسة ست علائق مخلوطة على صورة مكعبات تعتمد في تركيبها على تبن الفول كمادة أساسية ، وهي وإن تساوت في محتواها من البروتين الخام والطاقة ( ١٤% بروتين خام ، ٦٤% مركبات مهضومة كلية ) فإنها قد تباينت في مصدر النيتروجين الغذائي بها - حيث إستخدم في تركيب المخاليط ثلاثة مصادر بروتين طبيعية تتفاوت في درجة ذوبانها وتكسرها في الكرش ألا وهي كسب فول الصويا - كسب جلوتين الذرة ، وكسب القطن غير المقشور ، وقد استبدل ١% من مصادر البروتين الحقيقية في الثلاث علائق الأخرى باليوربا ( كمصدر نيتروجيني سريع التخمر والذوبان. )

وقد استهدفت هذه الدراسة تقييم الخصائص المختلفة لعملية التخمر داخل الكرش كنتيجة لاستخدام مصادر نيتروجينية في الغذاء تتفاوت في درجة تحللها وذوبانها داخل الكرش.

أجريت هذه الدراسة على حملان خليطة فلندى أوسيمي ذكور في تجربة تسمين استمرت لمدة ١٠٦ يوم.

- أخذت سحباً من سائل الكرش للحملان المعاملة - حيث تم فيها قياس درجة الأس الأيدروجيني - درجة تركيز الأمونيا ، كمية الأحماض الدهنية الطيارة ونسبتها الى بعضها البعض. وقد أظهرت النتائج المتحصل عليها مايلي:
- ١- كان لمصدر نيتروجين الغذاء تأثير معنوي على درجة الأس الأيدروجيني لسائل الكرش - فقد سجلت العليقة المحتوية على كسب فول الصويا أعلى درجة حموضة مقارنةً بباقي العلائق.
  - ٢- كانت درجة الحموضة في الحدود الطبيعية لها ( ٦,٢٢ - ٦,٥١ ) كمتوسط عام وقد تزايد تركيزها بعد ٣ ساعات ثم انخفض بعد ٦ ساعات من عملية التغذية.
  - ٣- أدت إضافة اليوريا للعلائق الى خفض في درجة تركيز الأس الهيدروجيني - فيما عدا العليقة المحتوية على كسب القطن فقد زاد بصورة غير معنوية.
  - ٤- كان لمصدر نيتروجين الغذاء تأثير معنوي على مستوى تركيز الأمونيا في سائل الكرش - وسجلت العلائق المحتوية على مصادر بروتين طبيعية نسبة أمونيا أعلى معنوية من تلك المدعمة باليوريا.
  - ٥- سجلت العليقة المحتوية على كسب فول الصويا أعلى معدل لانتاج الأمونيا (١٤,١٥ مليجرام / ١٠٠ ملل ) بينما سجلت العليقة المحتوية على جلوتين الذرة + اليوريا أقل تركيز للأمونيا (١٠,٧٣ مليجرام / ١٠٠ ملل )
  - ٦- كان لمصدر نيتروجين الغذاء تأثيراً معنوياً ( ٥% ) على كمية الأحماض الدهنية الطيارة داخل الكرش - وقد أدت إضافة اليوريا للعلائق الى زيادة معنوية في نسبة حمض البيوتيريك على حساب نسبة حمض الخليك ونسبة حمض الخليك إلى البريونيك.
  - ٧- أدت إضافة اليوريا الى مصادر البروتين الحقيقي للعلائق الى زيادة معنوية في كمية الأحماض الدهنية الطيارة في سائل الكرش وعلى النقيض من ذلك فإن إضافتها قد أدت الى خفض معنوي في درجة تركيز الأمونيا بسائل الكرش