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DOES THE ROUGHAGE SOURCES AFFECT DIGESTIBILITY, NITROGEN UTILIZATION AND SOME METABOLIC PARAMETERS IN RUMINANTS?

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SUMMARY

This experiment was carried out to study the effect of using different sources of roughage [berseem hay (BH), wheat straw (WS), rice straw (RS) and corn stalks (CS)] with concentrate feed mixture (CFM) on digestibility coefficient, nitrogen balance and some rumen liquor and blood serum parameters. Four digestibility and nitrogen balance trials were carried out using three Ossimi adult rams in each trial. Animals fed one of the following tested rations concretely to carry out the experiment:

R_1- 35% BH + 65% CFM R_2- 35% WS + 65% CFM

R_3- 35% RS + 65% CFM R_4- 35% CS + 65% CFM

The results showed that: all digestibility coefficients nutrients (except ADF and cellulose) and nutritive values (TDN and DCP) showed higher values ($P<0.05$) with the animals fed R_1 followed by R_2 (except CF and fiber fraction digestibility) than other rations (R_3 and R_4). Animals received high quality roughage (R_1) were showed higher ($P<0.05$) values of nitrogen balance than those received low quality roughages (R_2, R_3 and R_4). The obtained values of rumen liquor parameters tested (pH, total VFA's and ammonia-N) were within the normal range for normal rumen function with all tested rations. Values of serum total protein for R_1 and R_2 were higher ($P<0.05$) than values of other rations (R_3 and R_4). However there were no significant differences among rations for values of albumin, globulin, A/G ratio, urea and creatinine. Values of serum GOT and GPT enzymes were higher ($P<0.05$) for R_1 than that in other rations (R_2, R_3 and R_4). Results indicated that, use of four roughage sources as of 35% (especially BH or WS) in sheep rations is useful and does not cause any abnormal condition on digestibility, nutritive values, rumen activity, liver and kidney functions and animal performance as well.

Keywords: *Roughage source, berseem hay, wheat straw, rice straw, corn stalks, digestibility, N-balance, rumen liquor and blood serum parameters.*

INTRODUCTION

It is evident that the factor limiting animal production ability in Egypt and most of developing countries is the gap between the nutrients requirement of ruminants and the available amounts of feeds. It was estimated to be about 5

million tons of dry matter, which was equivalent to 3 million tons of TDN as reported by Abou Akkada (2000). This gap could be covered by the use of different sources of agricultural by-products such as roughage sources There is a considerable amount of roughages that can be used as feed resources which could make a major impact on ruminant livestock production, rather than helping to get rid of their environmental pollution hazardous. Another factor, including human population pressure on the land, scarcity and high cost of concentrate feeds, and the economic need to match ruminant livestock production system with available resources, justify increased use of these different roughage resources for ruminant animal feeding.

Roughage play a major role as feed for ruminants. Seasonal patterns affect the availability and quality of the roughages, particularly during the dry season (Wanapat, 1999). The low quality roughages are mainly characterized by high content of crude fiber and low nitrogen content and varying extents of minerals and vitamins. El-Ayouty (1991) reported that, the poor quality roughages are divided to cereal by products and legumes. The cereals by products were higher in energy especially with stalks than legumes. It is evident from the literature that forage or roughage alone cannot supply sufficient energy especially for high producing animals, therefore concentrate supplementation is always needed for maximizing intake and consequently improving overall performance of ruminant animal (Morita et al., 1996). The type of roughage represents one of the major dietary factors involved to influence feed intake which is reflected on rumen digesta kinetics and consequently rumen environment which is the resultant picture to feed utilization by ruminant farm animals. Ørskov (1992) reported that, better understanding of rumen environment, i. e. digestibility and fermentation parameters (such as rumen liquor parameters) are must for better utilization of feedstuffs and hence animal performance. The present research was conducted to study using different roughage types such as berseem hay, wheat straw, rice straw and corn stalks as sources of fibers in rations for sheep and their effects on digestibility and some rumen liquor and serum blood parameters.

MATERIALS AND METHODS

This study was carried out at the experimental station of Milk Replaces Research center, Faculty of Agriculture, Ain Shams University, Shoubra El Kheima, Kalubeya Province, Egypt.

Four digestibility and N-balance trials were conducted consequently using three adult Ossimi rams (an average live body weight of 49 kg) for each trial to evaluate the nutritive value of the tested rations. Four tested rations were formulated and each included following one of the sources of roughage {berseem hay (BH), wheat straw (WS), rice straw (RS) and corn stalks (CS)} along mixed with concentrate feed mixture (CFM) as 35% : 65% R : C ratio (as DM basis) as following:

R_1- 35% BH + 65% CFM

R_2- 35% WS + 65% CFM
R_3- 35% RS + 65% CFM
R_4- 35% CS + 65% CFM

The four tested roughages were chopped to 3 – 4 cm piece. The sheep were housed individually in metabolic cages to evaluate the tested rations nutritionally. Animals were fed to appetite (ad. Lib) from the tested rations which were offered several times daily. All sheep were given their daily feed in two equal meals at 8.0 a.m. and 3.0 p.m. Water was offered three times a day (at 8:30 a.m., 1:30 p.m. and 5:30 p.m.). The classical metabolism trial procedures were carried out on each ration as described by Schneider and Flatt (1975). Feces and urine were quantitatively collected. During the collection period, urine was collected daily in jars, each containing about 5 ml of concentrated H_2SO_4, to prevent any loss of ammonia from urine. Five percent of urinary volume excreted was taken in a bottle, for each animal, for urinary-nitrogen determination. Representative samples of feces (10%) were taken daily and added to 5 ml H_2SO_4 (10% concentration) and 5 ml of toluene solution (10% concentration) and were dried at 60 °C for 48 hrs.

Chemical composition of ingredients and feces were analyzed for DM, CP, EE, CF and ash content according to the A. O. A. C. (1990) and fiber fraction (NDF, ADF and ADL) according to Goering and Van Soest (1970) by using triplicates for each determination. Hemicellulose and cellulose were calculated as the differences between NDF and ADF, ADL orderly. Urinary –N content also was analyzed according to the A. O. A. C. (1990).

Rumen liquor sampling and analysis:

Three rumen liquor samples were collected at the end of the collection period from each animal at three times, at the morning just before feeding (0 hr), 3 hrs and 6 hrs post feeding, using a rubber stomach tube. Rumen liquor was strained through 4 layers of cheese cloth for immediate determination of rumen pH using pH meter (EH-7010) and ammonia nitrogen according to Con-Way (1962). Then the liquor was stored in deep freezer at (-20°C) until chemically analyzed using dried glass bottles with adding 0.5 ml toluene and 1ml paraffin oil to each sample. Ruminal total volatile fatty acids (TVFA's) were determined in the strained rumen liquor according to Warner (1964).

Blood serum sampling and analysis:

Blood samples were taken from Jugular vein at the end of the collection period from each animal at morning (before feeding). Blood was left at room temperature for 45 – 60 min then centrifuged for 30 min. at 4000 r.p.m. Serum was separated into clean dried glass vials (5 – 7 ml) and stored frozen (-20°C) until analysis, total protein as described by Armstrong and Carr (1964) and albumin as described by Doumas *et al.* (1971) were analyzed. Globulin was determined by difference and albumin / globulin ratio (A/G ratio) was calculated. Serum urea, creatinine and transaminasis (GOT and GPT) were determined as described by Reitman and Frankel (1957).

Statistical analysis:

Statistical analysis for the obtained data was performed by the method of analysis of variance according to

Snedecor and Cochran (1980) using the general linear model procedures of SAS (1998). Comparison between means was carried out using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition:

The chemical composition of the rations ingredients, concentrate mixtures and the calculated composition of experimental rations are presented in Table (1). Berseem hay (as a high quality roughage sources) contained higher CP and EE and lower CF and ash, compared with other roughages. On the other hand, the chemical composition of the other roughages (low quality roughages: WS, RS and CS) varied slightly in their nutrients contents. Roughages appreciably varied in cell wall constituents. Rice straw contained the highest value of ADF, however BH contained the highest value of non fibrous carbohydrates (NFC) followed by WS.

Obviously, fiber fraction components varied widely among tested materials. The obtained values of fiber constituents of tested roughages are more close to those reported by El-Sadaney (1990) and Gaber and Ahmed (2003) with minor exceptions. Although all plant cell walls have a similar basic architecture, there are important differences among the major taxonomic group of forages in details of wall composition and structure (Jung and Allen, 1995).

Generally legumes such as berseem hay contain much less fiber constituents than do grasses or graminasae wastes (WS, RS and CS), but the reverse picture was true in the case of NFC content. The NFC contents include sugars, starch and pectin (Van Soest, 1982) and considered to be highly digestible and cell wall poorly so and their relative proportion have a strong influence on digestibility of straws to great extent (Jung and Allen, 1995).

The chemical composition of the tested rations in Table (1) cleared that the CP was higher ($P<0.05$) for R1than other rations (because it contained BH), however all rations were varied slightly in their gross energy (GE) content. The results revealed that the chemical composition values were within the normal ranges previously published in Egypt for both CFM and different roughage types (El-Deeb, 2001, El-Ashry et al., 2002, Gabr and Ahmed, 2003 and Aboul-Fotouh et al., 2005). There are many factors affect chemical composition of different feed stuffs such as plant age, soil type, fertilizations, ect.

Apparent digestibility coefficient and nutritive values:

Results of apparent digestibility coefficients and nutritive values of experimental rations are shown in Table (2). There were significant ($P<0.05$) differences in the digestibility coefficients of all nutrients among the four experimental rations. All digestibility coefficients (%) of nutrients (except ADF and cellulose) showed higher ($P<0.05$) digestibilities with the animals fed ration contained a high quality roughage [berseem hay (R_1)] as compared with other rations contained low quality roughages (R_2, R_3

Table (1): Chemical analysis of ingredients and calculated experimental rations (% DM basis)

Item	Ingredients					Experimental rations			
	*CFM	BH	WS	RS	CS	R_1	R_2	R_3	R_4
Proximate analysis									
DM	91.67	88.91	91.29	90.62	90.68	100.0	100.0	100.0	100.0
OM	90.89	89.89	88.16	84.81	87.83	90.54	89.93	88.76	89.81
CP	15.48	14.09	2.97	3.48	4.10	14.99	11.10	11.28	11.49
EE	3.32	2.94	0.98	1.53	1.13	3.19	2.50	2.69	2.55
CF	13.21	27.86	37.12	33.84	37.14	18.34	21.58	20.43	21.59
NFE	58.88	45.00	47.09	45.96	45.46	54.02	54.75	54.36	54.18
Ash	9.11	10.11	11.84	15.19	12.17	9.46	10.07	11.24	10.19
**GE	17.81	17.69	16.53	16.04	16.56	17.76	17.36	17.18	17.36
Fiber fractions									
NDF	41.12	57.12	70.41	72.31	74.02	46.72	51.37	52.03	52.63
ADF	19.02	30.08	48.31	50.11	47.13	22.88	29.26	29.89	28.85
ADL	6.47	13.36	7.96	12.21	12.92	8.87	6.98	8.47	8.72
Hemicel.	22.10	27.04	22.10	22.20	26.89	23.82	22.09	22.13	23.77
Cellulose	12.55	16.72	40.35	37.90	34.21	14.01	22.28	21.42	20.13
***NFC	29.20	15.74	13.80	07.49	08.58	25.64	24.96	22.76	23.14

*CFM consisted of 30% undecorticated cotton seed meal, 20% wheat bran, 38% yellow corn, 5% rice bran, 3%molasses, 2.5% limestone, 1%common salt and 0.5% minerals mixture.

**GE= Gross energy, calculated according to MAFF (1975) using the following equation GE (MJ/kg DM)= 0.0226 CP+ 0.0407 EE+ 0.0192 CF+ 0.0177 NFE.

***NFC= Non fibrous carbohydrates, calculated according to Calsamiglia *et al.* (1995) using the following equation: NFC= 100 – (CP + EE + Ash + NDF).

R1= 35% BH + 65% CFM R2= 35% WS + 65% CFM R3= 35% RS + 65% CFM R4= 35% CS + 65% CFM

Table (2): Effect of experimental rations containing different roughage sources on apparent digestibility coefficients, microbial protein (MP) and nutritive values.

Item	Experimental rations				± SE
	R_1	R_2	R_3	R_4	
Apparent digestibility coefficients (%)					
DM	71.42[a]	69.14[a]	64.44[b]	63.66[b]	0.31
OM	72.03[a]	71.09[a]	68.21[b]	67.82[b]	0.22
CP	73.11[a]	71.23[b]	63.82[c]	64.92[c]	2.24
CF	65.22[a]	52.12[c]	52.35[c]	53.77[b]	1.25
EE	78.23[a]	77.03[a]	72.63[b]	73.43[b]	4.21
NFE	77.31[a]	76.81[a]	73.14[b]	71.27[b]	0.33
Cell wall constituents (%):					
NDF	68.92[a]	53.33[c]	51.38[c]	58.21[b]	1.32
ADF	45.51[b]	48.75[a]	43.19[b]	50.07[a]	1.81
Hemicellulose	86.73[a]	68.21[c]	63.12[d]	78.39[b]	2.11
Cellulose	56.13[b]	52.75[c]	53.06[c]	64.61[a]	0.28
*MP (g/kg OMD)	86.89[a]	85.75[a]	82.28[b]	81.81[b]	1.27
Nutritive value (%)					
TDN	70.30[a]	65.54[b]	62.05[c]	61.89[c]	0.16
DCP	10.96[a]	7.91[b]	7.20[b]	7.46[b]	1.63

a, b, c and d: Means in the same raw with different superscripts are significant (P<0.05)
*MP= microbial protein, calculated according to Czerkawski (1986).
R1= 35% BH + 65% CFM R2= 35% WS + 65% CFM R3= 35% RS + 65% CFM R4= 35% CS + 65% CFM

Table (3): Effect of experimental rations containing different roughage sources on nitrogen balance (g).

Item	Experimental rations				± SE
	R_1	R_2	R_3	R_4	
No. of animals	3	3	3	3	
Nitrogen-intake	41.9[a]	31.1[b]	31.2[b]	31.4[b]	1.26
N-excretion					
Fecal	15.3[a]	11.5[b]	11.3[b]	11.9[b]	1.53
Urine	18.9[a]	13.9[b]	14.3[b]	14.0[b]	1.12
Total excretion	34.2[a]	25.4[b]	25.6[b]	25.9[b]	1.67
N-balance	7.7[a]	5.7[b]	5.6[b]	5.5[b]	0.06
N-balance % of N-intake	18.3[a]	18.3[a]	17.9[a]	17.5[a]	1.13

a and b: Means in the same raw with different superscripts are significant (P<0.05)
R1= 35% BH + 65% CFM R2= 35% WS + 65% CFM R3= 35% RS + 65% CFM R4= 35% CS + 65% CFM

and R_4). These results indicate that the improvement in nutrients digestibility for R1 may be due to the high content of crude protein (Table, 1) or the positive effect of BH on the microflora activity. El-Taweel (2000) reported that apparent total tract DM, OM, NDF and ADF digestibilities all increased linearly ($P<0.05$) with increasing crude protein level.

Ration contained wheat straw (R_2) was higher ($P<0.05$) in digestibilities values than that of R_3 and R_4 (except for digestibility values of CF and cell wall constituents). However, ration contained CS (R_4) showed higher ($P<0.05$) digestibilities of cell wall constituents than other rations (R_2 and R_3). These results were in agreement with those of Jung and Allen (1995), Valdes et al. (2000), El-Deeb (2001) and El-Fadaly et al. (2003).

Boxton and Redfearn (1997) showed that the energy availability from forage is limited by fiber concentration because fiber is slowly and incompletely digested, whereas, cell soluble is a major determinant of energy availability in forages. Grass normally has more fiber than legumes, especially in leaves (Table, 1).

Generally, decreasing values of CF digestibility of experimental rations might be due to increasing soluble carbohydrate with increasing concentrate protein in experimental rations, which may adversely affect rumen environment and reduce fiber digestion in the rumen (Talha, 1996). Ruminal pH has been proposed as major factor contributing to decrease fiber digestion when soluble carbohydrate is supplemented to ruminants consuming forage diet. Celluelytic bacteria are very sensitive to rumen pH less than 6.0 which seriously inhibit their growth (Hoover, 1986 and Soliman et al., 1997). Alternatively Van Soest (1982) and Taie et al. (1996) reported that the higher CF digestibility with high fiber rations might result from slower passage rate of fiber particles from the rumen.

Valdes et al. (2000) reported that, the digestibility of fiber in the total tract depends on the intrinsic characteristics of the ration, its passage rate and the microbial activity. On the contrary, Van Soest (1993) reported that hemicellulose is more closely associated with lignin than any other polysaccharide fraction and its digestion is negatively related to lignification. Also Church (1991) reported that as plant matures the protein and readily available carbohydrates contents decreases, while structural carbohydrates along with lignin increases and digestibility of protein and energy decreases.

The reported differences among the digestibilities and the feeding values of the tested rations (Table, 2) could be reflection of the variation in the concentration and nature of the cell wall fractions. Jung and Allen (1995) reported that as cell wall concentration of roughages decreases, the cell wall digestibility increases especially for those rich in NDF. However, Lesli and Fahey (1994) demonstrated that different rates and extents of cell wall fractions digestibilities could not account for the differences in the feeding values of different forages.

Mehrez and Ørskov (1977) reported that, it would be simpler to express microbial protein (MP) yield on the basis of organic matter fermented within the rumen. The values of microbial

protein, which predicted from organic matter digestibility (OMD), are presented in Table (2) and the values on average were ranged between 81.81 to 86.89 g/ kg OMD for R_4 and R_1, respectively. Values of MP for R_1 and R_2 showed the higher ($P<0.05$) than that of R_3 and R_4. It is worth noting that the same trend was observed for OM digestibility values of different rations (Table, 2). These results are in agreement with the results of El-Waziry et al. (2005) and Czerkawski (1986) who found that a highly significant correlation between microbial protein syntheses predicted from OMD in the rumen and that predicted from VFA production.

Regarding the nutritive values of the experimental rations (Table, 2), there were significant ($P<0.05$) differences among them in total digestible nutrients (TDN) and digestible crude protein (DCP). It is clear that BH ration (R_1) were superior ($P<0.05$) in TDN and DCP% followed by WS ration (R_2). However R_3 and R_4 showed lower values of TDN and DCP. The higher nutritive value of BH ration could be a reflection for its high content of digestible OM and NFE, and could be explained by increase in the favorable source for rumen microbes beside the reduced dietary energy escaping ruminal degradation. These results are in harmony with the findings of El-Fadaly et al. (2003).

Nitrogen balance:

Data in Table (3) revels the nitrogen balance of the experimental animals. Although there were significant differences in digested, fecal and urinary-N of animals received low quality roughage (R_2, R_3 and R_4), the nitrogen balance values were positive without significant differences in terms of nitrogen balance and N-balance % of N-intake. On the other hand animals received high quality roughage (R_1) were showed higher ($P<0.05$) value of nitrogen balance than those received low quality roughage (R_2, R_3 and R_4). The same trend was detected for nitrogen content (Table, 1), N-digested (Table, 2) and N-intake (Table, 3). However no significant differences between all tested rations for N-balance % of N-intake. These results came on line with those obtained by El-Deeb (2001), El-Fadaly et al. (2003) and Gharib et al. (2005).

Generally, the superiority in N-balance due to a ration than another is affected by several factors. From these, possible production of microbial protein synthesis or increased presence of fermentable energy, difference in availability of fermentable energy (Tagari et al., 1976), variability in nitrogen that might escape fermentation from the rumen or an increased utilization of ammonia in the rumen (Holzer et al., 1986), and the effect of free fats in protein synthesis (Sutton et al., 1983).

Rumen liquor parameters:

Rumen pH values and concentrations of ammonia-N and total VFA's that estimated over 0, 3 and 6 hrs post feeding are presented in Table (4). Values obtained of ruminal pH showed that there were significant ($P<0.05$) differences among the tested rations. Ruminal pH value was significantly higher ($P<0.05$) for R_4 followed by R_2 than those of other rations (R_1 and R_3). Campbell et al. (1988) found that change in rumen pH could be due to

Table (4): Effect of experimental rations containing different roughage sources on some rumen liquor parameters at different sampling time.

Item	Parameters		
	pH	TVFA's (m.eq/dl)	NH_3-N (mg/dl)
Experimental rations			
R_1	6.44^c	7.92^a	28.53^a
R_2	6.48^b	6.53^c	26.12^a
R_3	6.41^c	6.51^c	20.01^c
R_4	6.52^a	7.18^b	23.72^b
± SE	0.23	0.32	0.88
Sampling time			
Zero hr	$6.86^a \pm 0.07$	$07.31^c \pm 0.37$	$25.16^c \pm 0.87$
3 hrs	$6.12^c \pm 0.08$	$10.23^a \pm 0.45$	$29.82^a \pm 0.46$
6 hrs	$6.41^b \pm 0.04$	$08.89^b \pm 0.41$	$26.07^b \pm 0.91$

a, b and c: Means in the same column with different superscripts are significant (P<0.05)

R1= 35% BH + 65% CFM R2= 35% WS + 65% CFM R3= 35% RS + 65% CFM R4= 35% CS + 65% CFM

Table (5): Effect of experimental rations containing different roughage sources on some blood serum parameters.

Rations	Blood serum parameters							
	T.P. (g/dl)	Albu. (g/dl)	Globu. (g/dl)	A/G ratio	Urea (mg/dl)	Creati. (mg/dl)	GOT (u/l)	GPT (u/l)
R_1	7.3^a	3.9^a	3.4^a	1.14^a	46.1^a	0.98^a	37.2^a	18.40^a
R_2	7.2^a	3.9^a	3.3^a	1.18^a	44.3^a	0.93^a	30.8^c	17.70^a
R_3	6.9^b	3.8^a	3.1^a	1.22^a	43.9^a	0.87^a	32.6^b	16.40^b
R_4	6.8^b	3.6^a	3.2^a	1.12^a	45.1^a	0.91^a	30.5^c	17.60^a
± SE	0.43	0.21	0.27	0.14	1.21	0.08	1.62	2.15

a, b and c: Means in the same column with different superscripts are significant (P<0.05)

R1= 35% BH + 65% CFM R2= 35% WS + 65% CFM R3= 35% RS + 65% CFM R4= 35% CS + 65% CFM

plan of feeding and a reason to a change in fiber digestion. In this trial, there were significant ($P<0.05$) differences among CF and fiber fraction digestibilities among tested rations (Table, 2) which interpret the digestion of CF and fiber fractions as a reflection for changing rumen pH. Also, Fox et al. (2000) showed that, the one of the critical factors affecting microbial growth is rumen pH. They described physical characteristics of feed as related to their effectiveness in stimulating chewing, rumination and increased rumen motility based on total cell wall content and particle size within classes of feed (effective NDF).

It is interesting to record that mean pH values were always above 6.0. This would have an implication on celluloytic bacteria contents and activity (Hungate, 1966), and fiber fractions digestion (Mould and Ørskov, 1984).

There were also significant ($P<0.05$) differences among sampling time (Table, 4) where the highest value was recorded for zero hr while, the lowest value was recorded after 3 hrs post feeding. The values increased again after 6 hrs. The reduction in pH values with advancing sampling time post feeding was mainly due to increased fermentation after feeding. These results agree with those recorded by El-Sayed et al. (2002), El-Deeb (2003), El-Fadaly et al. (2003) and Khorshed et al. (2007).

Parasad et al. (1972) reported that rumen pH is one of the most important factor affecting the fermentation in the rumen and influences its functions. It varies in a regular manner depending on the nature of the diet and on the time that it is measured after feeding and reflects changes of organic acids qualities in the ingesta.

The differences in pH values as affected by the tested dietary and sampling times were mainly attributed to the production rate of VFA's via fermentation process of carbohydrates (Ahmed, 1996), which has changes as affected by feeding time (rate of fermentation) and type of feeding, so that affected the pH to some limit until they were proportionally and relatively absorbed from the rumen wall resulting in an increase in pH value (i.e. 6 hrs post feeding – Table, 4). This assumption is in agreement with the conclusion of Roddy and Roddy (1985) who stated to the pH values were inversely related to VFA concentration in the rumen.

Ruminal TVFA's values, obtained in this study, were within the normal levels (3.07 to 19.90 m.eq/dl of rumen liquor) reported by Kandil et al. (1996). There were significant ($P<0.05$) differences among rations TVFA's values (Table, 4). Total VFA's values for R_1 and R_4 were higher ($P<0.05$) than other rations (R_2 and R_3). However TVFA's values for R_1 was significantly ($P<0.05$) higher than that of R_4. The higher VFA's values in R_1 may be due to a higher microbial activity in the rumen of sheep fed this ration than those received the other tested rations. Meanwhile, it may be due to the differences among rations in digestibility of organic matter (Table, 2). These results could have also been affected by saliva contamination because sample were collected using a stomach tube.

The VFA's values were found to correlate significantly and negatively

with ruminal pH values (Muller, 1973). The pH value was the lowest and TVFA's was the highest for the BH ration (R_1), while the inverse trend was recorded for rations containing RS (R_3) and CS (R_4). Such result might be attributed to consequent slow down of the fermentation process in the rumen, which was resulted in higher pH and lower TVFA's production in the rumen media. These results are in agreement with Youssef et al. (2001), El-Sayed et al. (2002) and Mostafa et al. (2003).

Concerning the effect of sampling time, before feeding values were lower ($P<0.05$) in all rations than post feeding, such values increased ($P<0.05$) to reach higher levels than that of pre feeding (Table, 4). The same trend was observed by El-Fadaly et al. (2003).

Generally, the pattern of VFA's followed revealed that there was a close reverse relationship with pH values at all times and reflects the pattern of fermentation in the rumen (Mehrez, 1992).

It should be noted that, the VFA's concentration in rumen is governed by several factors such as DM digestibility, rate of absorption, rumen pH, transportation of the digesta from the rumen to other parts of the digestive tract and the microbial population in the rumen and their activities (Allam et al., 1984). One factor or more of these cases could change its pattern with proceeding time and might affect the total concentration of VFA's found in the rumen media.

Values of rumen liquor ammonia-N for rations R_1 and R_2 were higher ($P<0.05$) than values of other rations (R_3 and R_4). However, a value of rumen ammonia-N for R4 was significantly higher than of R_3. Improvement in ammonia-N and TVFA's in rumen liquor for R_1 ration (Table, 4) may be related to increased cellulose digestibility (Table, 2), crude protein content or digestible protein (Tables, 1 and 2). El-Taweel (2000) found a positive correlation between cellulose digestion coefficient and rumen ammonia-N or TVFA's concentration. In addition, Fahmy (1992) noticed that the dietary protein digestibility is a factor among those determing NH_3 concentration in the rumen. It is well recognized that ammonia-N found in the rumen at any given time represent the net concentration value of its production, utilization by rumen microbes, absorption across the rumen wall dilution by other factors and passage to the lower gut, differences in chemical composition of the rations, differences in the ration and consequently the availability of different components and recycled nitrogen via saliva which might have defected rumen microflora. It might be concluded that the increase in ruminal protein digestion (Table, 2) with ration containing berseem hay (R_1) is one of the reason to increasing the ruminal ammonia-N.

Values of rumen NH_3-N were at the minimum before feeding and increased ($P<0.05$) to its maximum level at 3 hrs after feeding. Then values tended to decrease gradually as the time passed up to 6 hrs after feeding (Table, 4). These results may be due to change in fermentation rate with advancing time after feeding. Ammonia-N value would satisfy microbial needs for N and hence maximize rate of fermentation of the experimental rations in the rumen. The

optimal ammonia-N concentration was recorded to be 23.5 mg/dl rumen liquor for concentrated rations (Mehrez et al., 1977) and 15 mg/dl rumen liquor for roughage rations (Krebs and Leng, 1984). However, it depends on the ratio between roughage and concentrate of the ration (Mehrez, 1992). Similar results have been obtained by El-Taweel (2000), Boraei et al. (2002) and Boraei (2003) who found that pH was decreased and ammonia-N and TVFA's concentrations in rumen liquor were increased significantly even at 3 hrs after feeding and continued to increase then decreased significantly.

In general, the fermentation process's parameters characteristics indicated quite clearly that the pattern of ammonia-N and TVFA's concentrations followed the reverse trend to that with obtained pH values at all sampling times and reflect the pattern of fermentation in the rumen as revealed by Shafie and Ashour (1997). Ruminal parameters results agreed with those of Kandil et al. (1996), Youssef et al. (2001), El-Sayed et al. (2002), El-Fadaly et al. (2003), Gharib et al.(2005) and Khorshed et al. (2007).

Blood serum parameters:

Blood serum parameters as affected by feeding sheep on different sources of roughages rations are shown in Table (5). Serum total protein and its fractions are considered a biological index reflecting health and performance of animal (O'Kelly, 1973). Values of serum total protein for rations R_1 and R_2 were higher ($P<0.05$) than values of other rations (R_3 and R_4). However there were no significant differences between rations for values of albumin, globulin and A/G ratio. This result came in line with values of CP content in tested roughage types (Table, 1) or with protein digestibility of the experimental rations (Table, 2). These results agree with the conclusion of Kumar et al. (1980) who reported positive correlation between dietary protein and serum protein concentration. Yousef and Zaki (2001) noticed that the increase in digestibility of CP may be the reason for the increase in each of serum total protein and albumin concentration. Values of serum protein fraction indicated better utilization of dietary protein and ruminal nitrogen through digestive tract.

The present estimates lie within the normal range. William (1997) reported that the normal level of total protein and albumin in blood of domestic animals has ranged between 6 to 8 and 3.5 to 4.0 g/dl serum respectively. Also, values of serum globulin concentration were within the normal values. It was ranged from 3.1 (R_3) to 3.4 (R_1). Data indicated the healthy status of the liver since the liver is the main organ of albumin synthesis.

The values of serum A/G ratio ranged from 1.12 (R_4) to 1.22 (R_3). It is important to note that, all values of A/G ratio were higher than 1.0, which indicates that animals did not suffer from any health problems that might affect the performance of the experimental animals. Our results are in harmony with El-Sayed et al. (2002), Borarei et al. (2003), Mostafa et al. (2003), Maged (2004) and Khorshed et al. (2007).

Regarding the effect of experimental rations on serum urea, is presented in Table (5). The results indicated that serum urea and creatinine

concentrations were not affected by type of roughage. Urea concentration for R_1 slightly higher ($P>0.05$) than other rations (R_2, R_3 and R_4). This result may be supported by the finding cited early, that rumen ammonia-N concentration were higher ($P<0.05$) for R_1 and R_2 as compared with R_3 and R_4 (Table, 4). Results are close to those obtained by El-Ayek et al. (2001), El-Sayed et al. (2002), Maged (2004) and Khorshed et al. (2005 and 2007).

According to Lewis et al. (1957), the measurement of blood urea was proposed as supplementary test for the efficiency of nitrogen utilization in ruminants. The apparently normal values obtained in the present study for blood serum urea-N and fluid ammonia suggests efficient utilization of nitrogen in the different experimental diets by rumen microorganisms.

Also, values of serum creatinine were not affected by the source of roughage (Table, 5). Generally, serum creatinine level is a useful indicator of glomerular filtration in kidney. From the previous data, it was found that the values of serum creatinine for sheep were within the normal levels. Regarding to the results of serum urea-N and serum creatinine concentrations, it is clear that tested animals were not in a catabolism situation and kidney function was not affected by the source of roughage. Consequently, the animals were in a good nutritional condition. Values of the present study are similar to those obtained by El-Sayed et al. (2002), Borarei et al. (2003), Maged (2004) and Khorshed et al. (2007).

There were significant ($P<0.05$) differences amog the overall means of serum transaminases GOT and GPT concentrations for different rations (Table, 5). Values of serum GOT and GPT for R_1 was higher than other rations. The increase in GPT for sheep fed on rations (R_1, R_2 and R_4) may be related to increase in fiber digestibility (Table, 2). Yousef and Zaki (2001) noticed that the higher CF digestibility may cause increase in the serum GPT to increase the source of energy for biosynthesis of protein. The present results are within the physiological range reported in lamb by Awad (1966). These results agreed with those reported by El-Sayed et al. (2002), Borarei et al. (2003), Maged (2004) and Khorshed et al. (2007).

The present values of GOT and GPT showed normal activity of the animal hepatic tissues and consequently, different sources of roughage applied in the present investigation could be used without any adverse effect on the liver functions.

CONCLUSION

From the obtained results, it could be concluded that feeding sheep rations contained 35% : 65% (R : C ratio) with including different tested roughage sources affect digestibility, feeding value, N-utilization and some rumen liquor and blood serum parameters. Since the best results obtained were by rations including BH and followed by WS.

REFERENCES

Abou Akkada, A.R. (2000). The use of agriculture by-products in ruminant

nutrition. ACSAD training program on the utilization of agricultural by-products in feeding farm livestock. Alexandria, Egypt. (In Arabic).

Aboul-Fotouh, G.E.; M.M.A. Abdou, Safa N. Abdel-Azeem and H.A.E. Ammar (2005). Effect of using lupin seed containing rations on sheep productive performance. Egypt. J. Nutr. and Feeds, 8 (1):25-32.

Ahmed, S.K.S. (1996). The use of different energy and nitrogen sources in complete rations. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo.

Allam, S.M.; A.K. Abu-Raya, E.A. Gihad and T.M. El-Bedawy (1984). Nutritional studies by sheep and goats fed NaOH treated straw. 1st Egyptian British Conf. on Animal and Poultry Production, Zagazig, 11-13 Sept. p. 53.

A.O.A.C. (1990). Association of Official Analytical Chemists: Official Methods of Analysis (13th Ed.) Washington, D.C., U.S.A.

Armstrong, W. D. and C. W. Carr (1964). Physiological chemistry: Laboratory Direction, 3 ded. P. 75, Burges publishing co. Minneapolis, Minnesots.

Awad, Y.J. (1966). Serum transaminases in Egypt farm animals. Proc. 7th Annual Arab Vet. PP.319. Cairo, Egypt.

Boraei, M.A. (2003). Utilization of deferent fiber sources in ruminant nutrition. Egyptian J. Nutr. and Feeds, 6(Special Issue):1267.

Boraei, M.A.; A.M. Kandil and A.A. Abou-El-Ella (2002). Effect of protein levels in rations on growth performance and rumen activity in buffalo calves. Al-Azhar J. Agric. Res. Vol., 35, pp.7-19.

Boxton, D.R. and D.D. Redfearn (1997). Plant limitation to fiber digestion and utilization. J. Nutr., 127 (5 suppl): 8145.

Calsamiglia, S.; M.D. Stern and J.L. Frinkins (1995). Effects of protein sources on nitrogen metabolism in continuous culture and intestinal digestion *in vitro*. J. Anim. Sci., 73: 1819.

Campbell, C.G.; L.J. Bush and G.D. Adams (1988). High wheat concentrate mixtures containing different sources of protein for lactating daring cows. Oklahoma Agric. Cxp. Station, Anim. Sci. Res. Report.

Church, D.D. (1991). Livestock feeds and feeding. 3rd Ed. Prentic Hall INC. Englewood Cliffs, New Jersy.

Con-Way, E.F. (1962). Modification analysis and volumetric error. Rev. Ed. Lock Wood, London, UK.

Czerkawski, J.W. (1986). An introduction to rumen studies. Pergamon Press. Oxford. New York.

Doumas, B.; W. Wabson and H. Biggs. (1971). Albumin standards and measurement of serum with bromochresol green. Clin. Chem. Acta., 31: 87.

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

El-Ashry, M.A.; H.M. El-Sayed, M. Fadel, H.M. Metwally and M.M. Khorshed (2002). Effect of chemical and biological treatments of some crop-residues on their nutritive value:2. Effect of biological treatments on chemical composition and *in vitro* disapperarnce. Egypt. J. Nutr. and Feeds, 5: 43-54.

El-Ayek, M.Y.; E.S. Soliman, A.Z. Mehrez, E.A. El-Ayouty and M.E. El- Kholany (2001). Influence of type of roughage on animal performance and carcass traits of growing lambs. Egyptian J. Nutr. and Feeds, 4 (Special Issue): 209.

El-Ayouty, S.A. (1991). Response of several legume and cereal roughages to NH_3 treatment. Egypt. J. Anim. Prod., 28:59.

El-Deeb, M.M. (2003). Evaluation of some feeds for ruminant animals. "Effect of roughage : concentrate ratio on feed utilization and some microbiological changes in the rumen of sheep". Ph.D. Thesis, Fac. Agric., Mansoura Univ., Mansoura, Egypt.

El-Fadaly, H.A.; H.M. El-Sjaborawy, M.M. El-Deeb and A.Z. Mehrez (2003). Effect of formaldehyde treatment of concentrate feed mixture and source of roughage on fermentation and some bacterial activities in the rumen of sheep. Egyptian J. Nutr. and Feeds, 6 (Special Issue): 1131.

El-Sadaney, H.H. (1990). Studies on the evaluation of some feedstuffs. M.Sc. Thesis, Fac. Agric. Mansoura Univ., Mansoura, Egypt.

El-Sayed, H.M.; M.A. El-Ashry, H.M. Metwally, M. Fadel and M.M. Khorshed (2002). Effect of chemical and biological treatments of some crop-residues on their nutritive value: 3- Digestion coefficient, rumen and blood serum parameters of goats. Egyptian J. Nutr. and Feeds, 5(1):55.

El-Taweel, M.A. (2000). Performance of buffalo calves given farm residual during growing period. Ph.D. Thesis, Fac. Of Agric. Al-Azhar Univ., Cairo, Egypt.

El-Waziry, A.M.; M.E.A. Nasser and S.M.A. Sallam (2005). Effect of soybean meal processing on gass production and rumen fermentation *In vitro*. Egyptian J. Nutr. and Feeds, 8(1) Special Issue: 647.

Fahmy, S.T.M. (1992). Protozoal counts, In sacco cellulose disappearance, volatile fatty acids and NH_3-N concentrations in rumen fluid as affected by dried poultry waste inclusion in the diet of sheep. Proceedings of international conf. on manipulation of rumen microorganisms to improve efficiency of fermentation and ruminant production. Alexandria, Egypt, 20-23 Sept.

Fox, D.G.; T.P. Tylutki, M.E. Van Amburgh, L.E. Chase, A.N. Pell, T.R. Overton, L.O. Tedeschi, C.N. Rasmussen and V.M. Durbal (2000). The net carbohydrate and protein system for evaluating herd nutrition and nutrient excretion. Anim. Sci. Mimeo 213, Department of animal science, Cornell Univ., 130 Morrison Hall, Ithaca, New York, 14853.

Gabr, A.A. and M.E. Ahmed (2003). Utilization of low quality agriculture by-products for making silage from 1-cut of berseem (*Trifolinm Alexandrinum*, L.) in a comparative study by sheep and goats. Egypt. J. Nutr. And Feeds, 6: 945.

Gharib, S.E.; B.E.A. Borhami, M.M. El-Fadaly, A.M. Allam, W.G. Fahmy and M.H. Yacout (2005). The use of the market-return of food products as ruminant feeds. Egyptian J. Nutr. and Feeds, 8(1):53.

Goering, H.K. and P.J. Van Soest (1970). Forage fiber analysis, apparatus, reagents, procedures and some applications on agriculture. Handbook No.379, USDAARS, Washington, P. 20402.

Holzer, Z.; D. Levy and V. Samule (1986). Interactions between supplementary nitrogen source and ration performance and nitrogen utilization in growing and fattening male cattle. Anim. Prod. P. 19,vol. 42.

Hoover, W.H. (1986). Chemical factors involved in ruminal fiber digestion. J. Dairy Sci., 69:2755.

Hungate, R.E. (1966). The rumen and its microbes. Academic Press, New York and London.

Jung, H.G. and M.S. Allen (1995). Characteristics of plant cell wall affecting intake and digestibility of forages by ruminants. J. Anim. Sci., 73: 2774.

Kandil, H.M.; H.M. El-Sayed and H.M. El-Shaer (1996). Atriplex Sp. in sheep and goats under desert conditions with using some rumen and blood metabolites as indices to predict digestible energy and protein. Egyptian J. Appl. Sci., 11(8).

Khorshed, M.M.; M.SH. Reiad and A.A. El-Houssini (2007). The nutritional evaluation of *Kochia indica* hay and it utilization in complete diets for ruminants. (under publication).

Krebs, G. and R.A. Leng (1984). The effect of supplementation with molasses-urea blocks on ruminal digestion. Anim. Prod. in Ausralia, 15:704.

Kumar, N.U.; B. Singh and D.N. Verma (1980). Effect of different levels of dietary protein and energy on growth of male buffalo calves. Ind. J. Anim. Sci. 51:513.

Leslie, D.M. and G.C. Jr. Fahey (1994). Ruminal digestion and glycosyl linkage patterns pf cell wall components from leaf and steam fractions of alfalfa, orchad grass and wheat straw. J. Anim. Sci., 72:1362.

Lewis, D.; K.J. Hill and E.F. Annison (1957). Studies on the portal blood of sheep absorption of ammonia from the rumen of the sheep Biochem. J. 66:587.

MAFF (1975). Ministry of Agriculture Fisheries and Food. Energy allowances feeding system for ruminants. Technical Bulletin, 33. H.M.S.O. London.

Maged, G.A. (2004). Nutritional studies on small ruminants. M.Sc. Thesis Fac. Agric. Mansoura Univ. Mansoura, Egypt.

Mehrez, A.Z. (1992). Influence of roughage : concentrate ratio on N requirements of rumen microbes for maximal rate of fermentation. Proc. of the Inter. Conf. Manipulation of rumen microorganisms to improve efficiency of fermentation and ruminant production. 20-23 Sept., Alex., Egypt. P.234.

Mehrez, A.Z. and E.R. Ørskov (1977). A study of the artificial fiber bag technique for determing the digestibility of feed in the rumen. J. Agric. Sci. (camb.), 88:645.

Mehrez, A.Z.; E.R. Ørskov and I. McDonald (1977). Rates of rumen fermentation in relation to ammonia concentration. Br. J. Nutr., 38:447.

Morita, S.; S. Devir, C.C.K. Lauwere, A.C. Smits, H. Hogeveen and J.H.M. Metz (1996). Effects of concentrate intake on subsequent roughage intake and eating behavior of cows in automatic milking system. J. Dairy Sci., 79:1572.

Mostafa, M.R.M.; R. Salama, M.E. Lashin and A.A. Abodu (2003). Utilization of olive cake in fattening rations of Rahmani lambs. Egyptian J. Nutr. and Feeds, 6 (Special Issue): 811.

Mould, F.L. and E.R. ørskov (1984). Manipulation of rumen fluid pH and its influence on cellulolysis in sacco, dry matter degradation and the rumen microflora of sheep offered either hay or concentrate. Anim. Feed Sci., and Tech., 10:1.

Muller, P.A. (1973). Rumen liquor pH, osmolality and volatile fatty acids changes in calves fed intensively on barley with ray. Brit. Vet. J. 129:267.

O'Kelly, J.C. (1973). Seasonal variation in the plasma lipids of genetically different types of cattle steers on different diets, Com. Biochem. Physical., 44:303.

Ørskov, E.R. (1992). Creating an optimal rumen environment. Proc. Of the Intern. Conf. on Manipulation of rumen microorganisms to improve efficiency of fermentation and ruminal production. Alex., Egypt, 20-23 Sept. P: 81.

Parasad, J.; S.S. Ahluwalia and B.P. Josh (1972). Climo biochemical studies in indigestion in cattle and buffaloes. Indian J. Anim. Sci., 42(11): 911.

Reitman, S. and S. Frankel. (1957). Calorimetric determination of pt activity according to the Reitman and Frankel Method. Am. J. Clim. Path. 28.

Roddy, K.J. and M.R. Roddy (1985). Effect of feeding complete feeds on various nitrogen fraction and total VFA concentrations in the rumen flouid of sheep. Indian J. Anim. Sci. 55(9): 819.

S.A.S. (1998). Statistical Analysis System. SAS User's Guide: Statistics. SAS Institute Inc. Editors, Cary, NC.

Schneider, B.H. and W.P. Flatt (1975). The evaluation of feeds through digestibility experiments. The Univ. Georgia Press. Athens.

Shafie, M.M. and G. Ashour (1997). Anticeptazole of the rumen in

complementary adaptation to environment.Egyptian J. Nutr. and feeds, 1:21.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods 7th ed. Allied Pacific. Bombay, India.

Soliman H.S.; S.A. Ibrahim, Salwa M. Hamdy and M.H.Talha (1997). Use of agro industrial by-product in feeding ruminants fed diets based on berseem. 3- Effect of supplementing rams' rations with different levels of potato processing by-product on in-situ dry matter disappearance and feed intake. J. Agric. Sci. Mansoura Univ., 22:4271.

Sutton, J.D.; R. Knight, A.B. Mc. Allan and R.H. Smith (1983). Digestion and synthesis in the rumen of sheep given diets supplemented with free and protected oils. Brit. J. Nut., 49: 419.

Tagari, H.; D. Lery, Z.H. Oizer and D. Jlan (1976). Poultry litter for intensive beef production. Anim. Pro. 23: 317.

Taie, H.T.; B.M. Ahmed and K.M. Kewan (1996). Rumen activity and microbial protein synthesis as affected dietary protein and fiber levels. Egyptian J. Anim. Prod., 33:207.

Talha M.H. (1996). Nutritional studies on green forage. Ph.D. Thesis, Fac. Agric. Ain Shams University, Cairo, Egypt.

Valdes, C.; M.D. Carro, M.J. Ranilla and J.S. Gonzalez (2000). Effect of forage to concentrate ratio in complete diets offered to sheep on voluntary feed intake and some digestive parameters. J. Ainm. Sci., 70:119.

Van Soest, P.J. (1982). Nutritional ecology of the ruminant. O. & B. Books Inc., Coravallis, Oregon, USA.

Van Soest, P.J. (1993). Cell wall matrix interaction. Session in Synopsis. In: Jung, H.G.; D.R. Buxton, R.D. Halfield, J. Ralph (Ed.). Forage cell wall structure and digestibility. P. 377. ASA-CSSA-SSSA, Madison, W.I.

Wanapat, M. (1999). The ruminants in the tropics based on local feed resources. Khon Kaen Publishing Comp. Ltd., Khon Kaen, Thailand, P. 236.

Warner, A.C.J. (1964). Production of volatile fatty acids in the rumen. Methods of measurements. Nut. Abst. and Rev. 34:339.

William, O.R. (1997). Physiology of domestic animals. 2nd Ed. Iowa state Univ., USA.

Yousef, H.M. and A.A. Zaki (2001). Effect of barley radical feeding on body weight gain and some physiological parameters of growing Friesian crossbred calves. Egyptian J. Nutr. and Feeds, 4 (Special Issue): 465.

Youssef, K.M.; Afaf M. Fayed and H.S. Khamis (2001). Productive and reproductive performance of ewes and does fed non-conventional diets based on olive pulp in Sinai. Egyptian J. Nutr. and Feeds, 4 (Special Issue): 591.

هل لمصدر العلف الخشن تأثير على الهضم والاستفادة من النيتروجين وبعض قياسات التمثيل الغذائى في المجترات ؟

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أجريت هذه التجربة لدراسة تأثير التغذية على علائق تحتوي على أنواع مختلفة من الأعلاف الخشنة (دريس البرسيم – تبن القمح – قش الأرز – حطب الذرة) بالإضافة إلى مخلوط العلف المركز على معاملات الهضم والاستفادة من النيتروجين وبعض قياسات سائل الكرش وسيرم الدم. تم أجراء أربعة تجارب هضم وميزان أزوت واستخدم في كل تجربة ثلاث كباش أوسيمي ناضجة غذيت على أحدى العلائق محل الدراسة الآتية:-

العليقة الأولى (R_1) تتكون من 35 % دريس برسيم + 65 % مخلوط العلف المركز.

العليقة الثانية (R_2) تتكون من 35 % تبن القمح + 65 % مخلوط العلف المركز.

العليقة الثالثة (R_3) تتكون من 35 % قش الأرز + 65 % مخلوط العلف المركز.

العليقة الرابعة (R_4) تتكون من 35 % حطب الذرة + 65 % مخلوط العلف المركز.

أوضحت النتائج ارتفاع كل من معاملات الهضم للمركبات الغذائية (عدا الـ ADF والسليلوز) والقيمة الغذائية (في صورة مجموع المركبات الغذائية الكلية المهضومة والبروتين الخام المهضوم) للحيوانات المغذاة على العليقة الأولى (R_1) تليها العليقة الثانية (عدا معامل هضم الألياف الخام ومكونات الألياف) مقارنة بالعلائق الأخرى (R_3 و R_4). كما أظهرت الحيوانات المغذاة على مادة العلف الخشنة عالية القيمة الغذائية (R_1) ارتفاعاً معنويا لقيمة ميزان الأزوت عن الحيوانات المغذاة على أعلاف خشنة منخفضة القيمة الغذائية. بينما لم توجد فروق معنوية بين العلائق المختلفة في نسبة ميزان الأزوت بالنسبة للنيتروجين المأكول.

كانت قيم قياسات سائل الكرش {قيم درجة الحموضة (pH) ومجموع الأحماض الدهنية الطيارة والأمونيا} في المستوى الطبيعي والتي تدل على قيام الكرش بوظيفته الطبيعية مع كل العلائق المختبرة . وكانت قيم البروتين الكلي لسيرم الدم مرتفعة معنويا للعلائق R_1 وR_2 مقارنة بقيمته للعلائق R_3 وR_4 بينما لا توجد فروق معنوية بين العلائق المختلفة بالنسبة لقيمة كل من الألبيومين والجلوبيولين والنسبة بينهما واليوريا والكرياتينين وكانت قيم أنزيمات الكبد (GOT وGPT) مرتفعة معنويا في الحيوانات التي تغذت على العليقة الأولى مقارنة بالعلائق الأخرى (R_2 و R_3 و R_4).