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COMPARISON AMONG THE EFFECTS OF CLOVER HAY AND CORN SILAGES AS FEED INGREDIENTS ON THE NUTRITIVE VALUE, BACTERIAL STRAINS AND FERMENTATION IN THE RUMEN OF SHEEP

Eman H.M. Maklad[1] and Bahira K. Mohamed[2]

1- Animal Production Department, Faculty of Agriculture, Mansoura University, 2- Animal Production Research Institute, Agricultural Research Center, Dokki, Cairo, Egypt

SUMMARY

Three mature male ruminaly canulated sheep were fed at 90% of their *ad libitum* intake during successive metabolism trials. The three experimental rations were formulated to be similar in CP% (13-14%) as follows:

1- 48% clover hay (CH) + 14% bean straw (BS) + 38% concentrate feed mixture (CFM).
2- 25% corn silage with ears (CS) + 20% bean straw (BS) + 55% concentrate feed mixture (CFM).
3- 32% corn silage without ears (S) + 18% bean straw (BS) + 50% concentrate feed mixture (CFM).

The results showed that voluntary DM intake was not affected by dietary treatments. However, including (S) caused significant ($P<0.01$) decreases in the digestibilities of DM, OM, NFE, NDF and hemicellulose, N-balance, TDN, TDN intake and ME than when CH or CS were used. On the other hand, digestibilities of CF, ADF and cellulose of CS or S diets were significantly ($P<0.01$) lower than those of CH diet. Digestibility of EE of CS was higher ($P<0.05$) than that of CH, but there was no significant difference between CH or S. Feeding CS resulted in increasing ($P<0.05$) DCP of the ration than S, but there was no significant difference between CH and CS.

The *in situ* DM disappearance values of both CS and S were less ($P<0.01$) than that of CH, while NDF and ADF disappearance of CS and were much less as compared to CH. On the other hand, the potential degradability (a+b) of ADF of CH was higher ($P<0.01$) than CS or S and was higher ($P<0.01$) when feeding on S than CS (46.63, 41.31 and 32.76, respectively).

The mean rumen pH value was higher ($P<0.01$) when S was fed than CH or CS were offered (6.29, 4.83 and 5.68, respectively), while NH_3-N concentration decreased ($P<0.01$). The total volatile fatty acid (VFA) concentration was higher ($P<0.01$) when CH was fed than CS or S and was also higher ($P<0.01$) for CS than S was fed.

The results of bacterial strains isolated from rumen fluid showed that the percentage of isolation throughout a period of 8 hours of feeding was as follows:

Anaerovibrio lipolytica was higher when feeding CS or S than CH, *Bacteroids amylophilus* was higher with feeding on CS than S or CH, *R. Succinogenes* were higher when feeding on CH than CS or S, *R. Lactelytica* was higher when feeding on CS or S than CH, and *S. ruminantium* was higher when feeding CS than CH or S. The mean of total viable bacterial count (CFU/ml)x10^6 was higher when feeding on CS than CH or S.

In general, the data indicated that feeding on CH or CS resulted in similar effects on the TDN% and DCP% of the ration and were higher than feeding on S as a basal diet. This may refer to that CH and CS rations were suitable than S ration for normal ruminal function which may be reflected on animal health and productivity, since this function depends on qualitative (physical form) and quantitative (dietary concentration) aspects of dietary fiber.

***Keywords:** Sheep, clover hay, corn silage, in sacco and in vitro evaluation, bacterial strains*

INTRODUCTION

Formulation of the ruminant diets to attain a desired level of productivity can use numerous feed ingredients and methods of processing feedstuffs. Factors influencing choice and form of dietary feedstuffs include cost, availability, feeding system, animal management, efficacy in achieving a desire level of production, animal acceptability and animal health. Normal ruminal function is dependent on both qualitative (physical form) and quantitative (dietary concentration) aspects of dietary fiber (Woodford *et al.*, 1986). Formulation of the ruminant diets must take into account ruminal function and thus sources of dietary fiber that will optimize animal health and productivity.

The main objective of this project, therefore, was to compare among the effects of clover hay and corn silages as feed ingredients on the nutritive value, bacteria strains and fermentation in the rumen of sheep.

MATERIALS AMD METHODS

The experimental work of the present study was conducted at the Agricultural Experimental Station, Faculty of Agriculture, Mansoura University.

Experimental rations and design

The experimental rations were formulated to provide adequate energy and N for maintenance. The average requirements per unit metabolic body size ($KgW^{0.75}$) were 24.8 TDN and 1.27 g DCP (Abou Raya *et al.*, 1971).

Ration 1: 48% clover hay (CH) + 14% bean straw (BS) + 38% concentrate feed mixture (CFM).

Ration 2: 25% corn silage with ears (CS)+ 20% bean straw (BS)+55% concentrate feed mixture (CFM).

Ration3: 32% corn silage without ears (S)+18% bean straw (BS)+50% (CFM).

The clover hay or corn silage was fed as it is without chopping, but bean straw was chopped to length of about 5 cm. The CFM contained about 18.87%CP. The daily feed was offered once daily at 800 hrs. The animals were kept in individual pens for the first 21 days. Each animal was then kept in a metabolic cage for another 21 days as a preliminary period.

Experimental animals and their management

Three digestibility and metabolism trials were carried out on sheep. Three healthy Rahmany rams were used. They were about 1.5 – 2.0 years old, with an average live body weight of 45 Kg. They were fitted with wide permanent rumen cannula (4 cm diameter).

Faeces and urine were collected separately and quantitatively for 7 days. Ruminal studies were carried out during the following 7 days.

The same three cannulated sheep were used for stuyding some rumen fluid parameters at different intervals after feeding and for determining the rate of DM and CF fractions disappearance in the rumen using the artificial fiber bag technique (Mehrez and Ørskov, 1977). These measurements were repeated twice during each experimental period.

Rumen fluid samples were collected through the cannula from different locations in the rumen. On each of the two sampling days, rumen fluid was collected just before offering the morning feed and at 2, 4 and 8 hrs post-morning feeding. The samples were filtered through two layers of surgical gauze and were used for determining pH, total volatile fatty acids (VFA), ammonia-N concentrations and bacteria strains.

Chemical analysis

The chemical analysis of tested materials, faeces and urinary nitrogen were determined according to the official methods of the A.O.A.C. (1984). The NDF, ADF and ADL were dtermined by the methods of Goering and Van Soest (1970), while cellulose and hemicelluolose were accordingly calculated.

In Situ disappearance

The artificial fiber technique developed by Mehrez and Ørskov (1977) was applied for measuring rate of DM disappearance in the rumen. On each of the sampling days, 5 weighed dacron bags were suspended in the rumen of each sheep (8, 16, 24, 36 and 48 hrs incubation interval). Each bag contained about 3 grams DM of the tested roughage (CH or CS or S) with their corresponding experimental ration. The data of disappearance were fitted by the exponential equation derived by Orskov and McDonald (1979) to describe the relation between disappearance and elapse of time of incubation and to predict the degradable portion of the tested material. In order to define and devided the portions of material which disappear from the bags during incubation in the rumen, they described the relationship between disappearance and elapse of time of incubation through an exponential equation :

$$P = a + b\,(1-e^{-ct}).$$

Where : a, represents the readily soluble fraction which disappears irrespective to fermentation (the intercept with Y axis), B, represents the fermentable fraction which disappears with the elapse of incubation interval.

In other words "a+b" represents the fermentable part of the material.

c, represents the undegradable fraction.

t, time (hr)

Effects of experimental diet on pH, NH_3 concentration and total VFA of rumen liquor at different times of sampling

The effects of roughage type on some rumen liquor parameters are presented in Table (4) and Figures (1, 2 and 3).

pH:

The pH value was higher ($P<0.01$) at 0 hrs, with feeding on S ration than CH or CS rations. The values tended to decrease ($P<0.01$) after feeding at 2 hrs and the decrease was ($P<0.01$) when feeding on CH than CS, and CS than S. The pH values decreased ($P<0.01$) also after 4 hrs of feeding CH, but there were no significant effect when feeding CS or S. The pH values tended to increase ($P<0.01$) with feeding CS or S and without significant effect when feeding CH at 8 hrs. The mean values decreased significantly ($P<0.01$), being 4.83, 5.68 when CH or CS were fed, respectively than feeding on S which recorded 6.29.

NH_3 concentration:

Table (4) and Fig. (2) show that for the NH_3 concentration, there was no significant effect at 0 hrs, but NH_3-N concentration increased ($P<0.05$) at 2 hr to 4 hr after feeding on CH or CS rations and there was no significant effect when fed on S rations. The NH_3-N tended to decrease ($P<0.05$) at 8 hrs of feeding on CH ration, but without significant effect when feeding on CS or S rations, The mean values were higher ($P<0.01$) when CH or CS rations were fed than when S ration was fed (17.78, 19.50 and 15.41 mg/100 ml RL, respectively).

Table 4. Effect of experimental diet on some rumen liquor parameters at different times of sampling

Items	Period (h)	48% CH+14% BS+38% CFM	25% CS+20% BS+55% CFM	32% S+18% BS+50% CFM	Mean
PH	0	6.03^{CD}	6.20^{BC}	6.73^{A}	6.32^{A}
	2	4.73^{G}	5.47^{EF}	5.93^{CD}	5.38^{BC}
	4	4.20^{H}	5.30^{F}	6.00^{CD}	5.17^{C}
	8	4.33^{GH}	5.73^{DE}	6.50^{AB}	5.52^{B}
Mean		4.83^{B}	5.68^{B}	6.29^{A}	
NH_3 mg/100 ml	0	13.85^{de}	13.16^{e}	14.69^{cde}	13.90^{B}
	2	22.46^{ab}	21.11^{ab}	16.58^{bcd}	20.72^{A}
	4	20.78^{ab}	24.32^{a}	15.03^{cde}	20.04^{A}
	8	14.02^{de}	19.42^{abc}	13.34^{e}	15.60^{B}
Mean		17.78^{A}	19.50^{A}	15.41^{B}	
VFA M eq/100 ml	0	4.18^{e}	3.14^{e}	3.60^{e}	3.64^{B}
	2	10.55^{ab}	9.20^{bc}	8.86^{cd}	9.54^{A}
	4	11.48^{a}	10.52^{ab}	8.54^{cd}	10.18^{A}
	8	11.48^{a}	9.92^{abc}	7.31^{d}	9.57^{A}
Mean		9.42^{A}	8.20^{B}	7.08^{C}	

Values without different superscripts significantly not differed.
Values with different small superscripts significantly differed at $P<0.05$.
Values with different capital superscripts significantly differed at $P<0.01$.

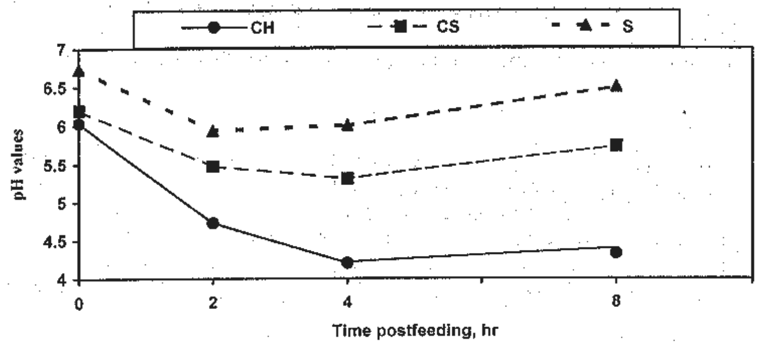

Figure 1. Effect of experimental diet on pH values of rumen liquor at different sampling times.

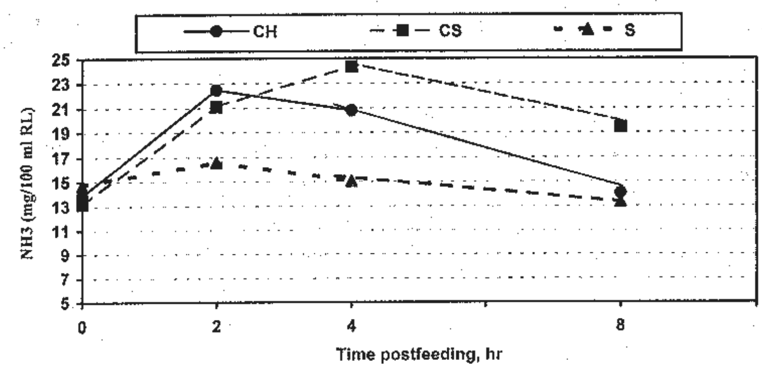

Figure 2. Effect of experimental diet on NH_3 concentration (mg/100 ml RL) at different sampling times

Total VFA

Table (4) and Fig. (3) show that the VFA concentration at 0 hrs was higher ($P<0.05$) when CH ration was fed than feeding on CS or S rations, but VFA values tended to increase ($P<0.05$) after feeding from 2 hrs up to 8 hrs, except when feeding CS or S rations. The VFA decreased at 8 hrs, but without significant difference. The means of VFA concentration values were higher ($P<0.01$) when feeding on CH ration than feeding on CS or S rations, and the production VFA was higher ($P<0.01$) when feeding on CS ration than feeding on S ration (9.42, 8.20 and 7.08 ml eq./100ml RL, respectively).

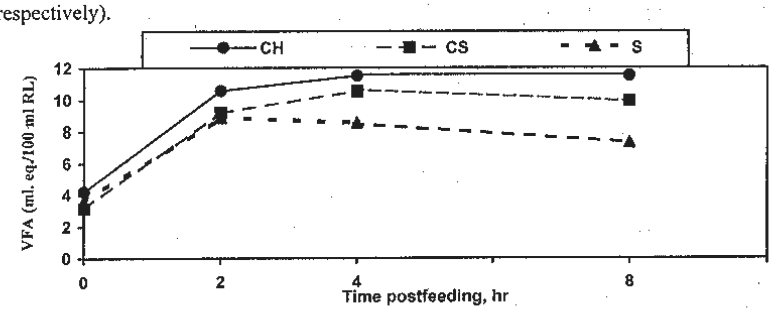

Figure 3. Effect of experimental diet on VFA (ml. Eq./100 ml RL) at different sampling times

Effect of experimental diet on DM, NDF and ADF disappearance in the rumen

Table (5) shows the effect of the experimental diet on the disappearance of DM (DMD), NDF (NDFD) and ADF (ADFD) of the three tested roughages.

The DMD of CH and S were higher ($P<0.01$) at 8 hrs. The DMD of CH increased ($P<0.01$) more than CS or S, but the increase was more higher ($P<0.01$) for S than CS at 16 hrs. The DMD of CH increased significantly ($P<0.01$) than CS and S from 24 hrs up to 36 hrs, but there were no significant difference between CS and S. Thee DMD of CH and CS were more than that of S at 48 hrs, but there was no significant difference between CS and S.

The NDFD of CH followed the same trend as DMD from 8 hrs up to 24 hrs, then there were no significant effect from 36 hrs up to 48 hrs between the three tested roughages.

The ADFD of the three tested roughages followed the same trend as DMD and NDFD from 8 up to 16 hrs. The ADFD of CH was higher ($P<0.01$) than CS or S at 24 hrs, but the increase in ADFD of S was more ($P<0.01$) than CS. The ADFD of CH increased ($P<0.01$) than CS and S, but there was no significant difference between CS and S at 36 hrs. The ADFD of CH at 48 hrs increased ($P<0.01$) than CS and S, and also ADFD of S was higher ($P<0.01$) than CS.

Table 5. Effect of experimental diet on DM disappearance of the three tested roughages

Items	48% CH+14% BS+38% CFM	25% CS+20% BS+55% CFM	32% S+18% BS+50% CFM
DMD (%)			
8 hrs	32.49^{H}	23.70^{I}	31.82^{H}
16 hrs	48.40^{CDE}	37.16^{G}	41.54^{F}
24 hrs	54.96^{AB}	45.25^{EF}	46.69^{DE}
36 hrs	58.38^{A}	52.03^{BC}	50.27^{CD}
48 hrs	59.32^{A}	55.59^{AB}	51.66^{BC}
NDFD (%)			
8 hrs	14.86^{E}	1.86^{F}	14.80^{E}
16 hrs	37.18^{BC}	19.87^{E}	26.85^{D}
24 hrs	42.67^{AB}	33.07^{C}	34.60^{C}
36 hrs	44.30^{A}	39.16^{ABC}	41.34^{AB}
48 hrs	44.52^{A}	41.76^{AB}	44.83^{A}
ADFD (%)			
8 hrs	12.84^{G}	-8.67^{I}	11.28^{G}
16 hrs	33.48^{DE}	3.50^{H}	24.22^{F}
24 hrs	41.44^{ABC}	23.94^{F}	31.56^{E}
36 hrs	45.31^{AB}	31.12^{E}	37.06^{CDE}
48 hrs	46.29^{A}	32.20^{E}	39.41^{BCD}

Values with different superscripts in the same row significantly differed at $P<0.01$.

Effect of experimental diet on the degradable (a+b) DM, NDF and ADF of CH, CS and S in the rumen

As shown in Table (6) and Fig. (4), there was no significant difference between the degradable (a+b) DM and NDF between CH or CS and S. The degradable (a+b) of ADF for CH was higher ($P<0.01$) than CS or S. The values were 46.63, 32.76 and 41.31% of CH, CS and S, respectively.

Table 6. Effect of experimental diet on the degradable (a+b) of DM, NDF and ADF of the three tested roughages

Items	48% CH+14% BS+38% CFM	25% CS+20% BS+55% CFM	32% S+18% BS+50% CFM
DM	60.92	61.36	52.55
NDF	44.56	45.43	48.59
ADF	46.63^{A}	32.76^{C}	41.31^{B}

Values with different superscripts in the same row significantly differed at $P<0.01$.

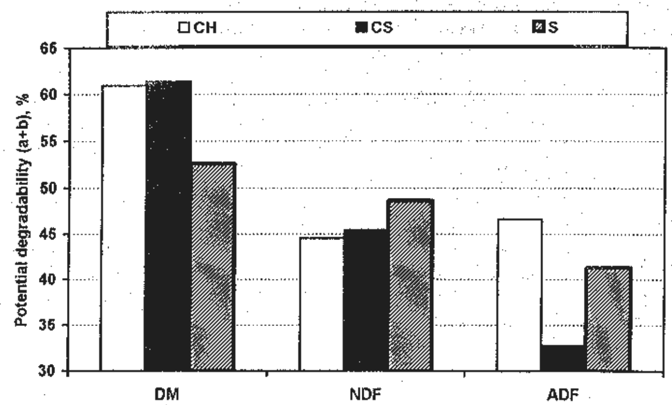

Figure 4. Effect of experimental diet on the degradability (a+b) of DM, NDF and ADF.

Effect of experimental diet on bacterial strains isolated from rumen fluid and their percentage throughout different times of sampling

As shown in Table (7) when feeding on CH ration *Anaerovibrio lipolytica* was not present at 0 hrs up to 2 hrs after feeding, then increased at 4 hrs after feeding, but tended to decrease at 8 hrs after feeding While when feeding on CS it was greatly increased at different times of sampling and when feeding on S ration it was isolated at 0 hrs up to 4 and increased greatly at 8 hrs. The mean percentages were 33, 100 and 75% when feeding on CH, CS and S rations, respectively.

Bacteroids amylophilus tended to disappear from 0 hrs up to 4 hrs of feeding on CH ration, but increased at 8 hrs of feeding, while when feeding on CS ration it disappeared at 0 hrs and increased greatly from 2 hrs up to 8 hrs, and when feeding on S ration it appeared from 0 hrs up to 4 hrs of feeding, but then disappeared at 8 hrs. The mean values were 17, 75 and 42% of CH, CS and S rations, respectively.

Bacteroides ruminicola sub sp. *ruminicola* showed great increases from 0 hrs up to 8 hrs after feeding on CH, CS and S rations, and the mean value for all rations was 100%.

Bacteroides ruminicola sub sp. *succinogenes* increased greatly from 0 hrs up to 4 hrs then tended to disappear at 8 hrs after feeding on CH ration, while it was increased greatly at 0 hrs and tended to decrease from 2 hrs up to 8 hrs when feeding on CS ration, but while feeding on S ration it was lowest from 0 hrs up to 4 hrs and then increased greatly at 8 hrs after feeding. The mean values were 75, 58 and 50% of feeding on CH, CS and S rations, respectively.

Lachnospira multiporous disappeared at o hrs and increased greatly from 2 hrs up to 8 hrs after feeding on CH ration, while it was increased greatly at 0 hrs and then disappeared at 2 hrs up to 4 hrs, then increased greatly at 8 hrs when feeding on CS ration, while it was disappeared from 0 hrs up to 8 hrs when feeding on S ration. The mean values were 75, 100 and 0% when feeding on CH, CS and S rations, respectively.

Selenomonas ruminantium sub sp. *bryenti* showed that it was the lowest at 0 hrs and then increased greatly from 2 hrs up to 8 hrs when feeding on CH ration, while it was increased greatly from 0 hrs up to 8 hrs after feeding on CS or S rations. The mean values were 83, 100 and 100% of feeding on CH, CS and S rations, respectively.

Selenomonas ruminantium sub sp. *lactilytica* showed that it was the lowest at 0 hrs then increased greatly from 2 hrs up to 4 hrs, and then disappeared at 8 hrs after feeding on CH ration, while it was lowest at 0 hrs and then increased greatly from 2 hrs up to 8 hrs after feeding on CS ration, and the same trend was observed when feeding on S ration. The mean values were 58, 83 and 83% of feeding on CH, CS and S rations, respectively.

Selenomonas ruminantium sub sp. *ruminantium* showed that it was increased greatly from 0 hrs up to 4 hrs and then disappeared when feeding on CH ration, while it was increased greatly from 0 hrs up to 8 hrs after feeding on CS ration, but it was slowly increased when feeding on S ration. The mean values were 67, 92 and 33% of feeding on CH, CS and S rations, respectively.

Table 7. Bacterial strains isolated from rumen fluid of the three rams under investigation and percentage frequency of isolation throughout a period of 8 hours of feeding

Bacterial strain isolated	Hay					Corn silage					Silage				
	0h	2h	4h	8h	%	0h	2h	4h	8h	%	0h	2h	4h	8h	%
Anaerovibrio lypolytica	-	-	++	+	33	++	++	++	++	100	++	++	++	++	75
Bacteroides amylophilus	-	-	-	++	17	-	++	++	++	75	++	++	+	-	42
Bacteroides ruminicola	++	++	++	++	100	++	++	++	++	100	++	++	++	++	100
Bacteroides ruminicola	++	++	++	-	75	++	++	+	+	58	+	+	+	++	50
Lachnospira multisporus	-	++	++	++	75	++	-	-	++	50	-	-	-	-	0
Selenomonas ruminantium	+	++	++	++	83	++	++	++	++	100	++	++	++	++	100
Selenomonas ruminantium	+	++	++	-	58	+	++	++	++	83	++	++	++	++	83
Selenomonas ruminantium	++	++	++	-	67	++	++	++	++	92	+	+	+	+	33

- Not present. + Low density. ++ Medium density. +++ High density.

Mean bacterial density in rumen fluid when feeding on CH, CS and S rations at different times of sampling

The results presented in Table (8) showed that the bacterial density in rumen fluid appeared to increase with time from 0 hrs up to 4 hrs then tended to decrease at 8 hrs when CH ration was fed. While bacterial density appeared to increase from 0 hrs up to 8 hrs after feeding on CS or S rations. The mean values were 18.85, 29.30 and 17.09 x 10^6 CFU/ml of feeding on CH, CS and S rations, respectively.

Table 8. Mean bacterial density in rumen fluid collected at different times of sampling

Time of sampling (hrs)	Total viable bacterial count (CFU/ml) x 10^6		
	Hay	Corn silage	Silage
0	1.66	1.94	1.98
2	22.50	31.23	19.16
4	26.53	41.35	23.45
8	24.71	42.68	23.78
Mean	18.85	29.30	17.09

DISCUSSION

The summative analysis of the ingredients (Table 1) used to formulate the experimental rations were within the normal published ranges (Ead, 1982; El-Ayouty, 1991 and Kearl *et al.*, 1979).

With the objective to compare between feeding clover hay or silages from corn as a basal diet on the site, extent of digestion and bacterial strains in the rumen of sheep. The three rations were formulated at the commonly practiced ratios as shown in Table 2.They were formulated to be slightly over the 12% CP necessary for optimal utilization and fermentation of roughage in the rumen Orskov *et al.*, 1972). The target of 13% CP in the experimental ration was achieved since the ingredients were analysed before formulating the experimental diets. It should be pointed out that roughage : concentrate ratio in the tested diets would create possibilities of associative effects (Ead, 1982). Accordingly, chemical composition including fiber fractions and their fermentability in the rumen, depending primarily on the predominant type of microorganism along with fermentation indices were studied together with *in vivo* digestion and values of the tested rations were evaluated for proper interpreting the results and in order to achieve conclusions based on strong scientific basis.

Van Soest (1982) has heavily criticized the CF definition and its determination. He developed a new system by which he defined and differentiated between the cell contents and cell wall contents through their solubilities either in neutral or acid detergents. Such system allows the prediction of cellulose, hemicellulose and lignin. Several investigations applying these procedures were able to correlate the contents of the fiber fractions with digestibility and feeding values of roughage especially with ADF. On the other hand, Staples *et al.* (1984) reported that a more rapid rate of cellulose disappearance and a slow rate of passage of particulate matter through the rumen and total digestion tract with decreasing feed intake were key factors responsible for bringing about changes of digestion coefficients.

It was clear that the CH ration was higher in ADF%, cellulose % and lignin % and lower in hemicellulose % as compared to CS or S rations which were higher in hemicellulose % and lower in ADF, cellulose % and lignin % (Table 2). These differences were related to the chemical composition of each type of the roughage (Table 1), and to the percentage of each roughage in the ration. On the other hand, the rations were similar in NDF% and NFC% of diet DM

In mature grasses, the cell wall and fiber (NDF) concentration of forage are very similar, whereas for legumes the fiber (NDF) estimates are routinely lower than the cell wall concentration (Theander and Aman, 1980). This disparity stems primarily from the solubility in neutral detergent solution of pectins which are present in high concentrations in the cell walls of legumes (Van Soest, 1982). On the other hand, Broderick (1995) reported that condensed tannins found in legumes are known to decrease protein degradation either by altering the forage proteins or by inhibiting microbial proteases. The nature of the basal diet can have a major impact on efficiency of protein utilization, the quality of microbial protein synthesis is influenced by the amount of substrate fermented in the rumen (Cecava *et al.*, 1988).

Patton (1994) showed that lignin is negatively correlated with the amount of fiber that can be fermented, while hemicellulose is negatively correlated with the rate at which fiber is digested. Alfalfa is high in lignin (16% of the NDF which is 47% of the plant), but low in hemicellulose. This means that alfalfa fiber digestion will be limited. The maize stalks like many other high lignin quality by-products has low digestibility. The high lignin inhibits microbial digestion of cellulose and hemicellulose (Said and Wanyolike, 1987).

In general, cellulose, hemicellulose and lignin are present in plants in conjugated forms varying in complexity according to plant type, plant part and stage of maturity.

These proportions were chosen to achieve isonitrogenous diets, 13.85, 14.94 and 13.97% CP for CH, CS and S rations, respectively. Because ruminal NH_3 concentration was lower and N excretion was reduced with diets containing corn silage, so corn silage should constitute one-third to two-thirds of dietary forage DM when fed with alfalfa silage to derive maximal benefit (Dhiman and Satter, 1997). On the other hand, the total moisture contents of CS and S were about 74 and 62%, respectively, so Lahr *et al.* (1984) showed that the substitution of dry hay for alfalfa silage increased DMI, and they concluded that the DM of diets not less than 60-65%. It appears that the quality of ruminally available protein needed to optimize microbial growth may under some conditions be as high as 14 to 15% of diet DM (Hoover and Stokes, 1991). On the other hand, Willms *et al.* (1991) studied the effect of increasing CP level with SBM on nitrogen retention in lambs fed diets based on alkaline hydrogen peroxide treated wheat straw. These data are interpreted to indicate that maximal nitrogen retention and fiber digestibility in diets are obtained at least 12% CP.

The results of the present study showed that the digestibility of NDF was significantly ($P<0.01$) higher of CH and CS rations than S ration. The digestibility of ADF of CH ration was significantly ($P<0.01$) higher than CS or S rations, and it was also significantly ($P<0.01$) higher of CS ration than S ration, and the same trend was observed on the digestibility of cellulose. The hemicellulose digestibility was higher ($P<0.01$) with feeding on CH and CS rations than feeding on S ration. On the other hand, the digestibility of NFC was higher ($P<0.01$) when feeding on CS ration than feeding on CH and S rations, but it was higher ($P<0.01$) when feeding on S ration than feeding on CH ration. Ruiz *et al.* (1995) reported that dietary NDF concentration, digestibility of dietary fiber influence DMI and milk production. On the other hand, Valadares *et al.* (2000) showed that there was a linear decrease in NDF digestibility with increasing dietary NFC, and found that the optimum concentrate for cows fed high moisture ear corn plus alfalfa silage as the only forage was equivalent to 37 to 38% dietary NFC. The concentration of total digestible nutrients (TDN) tended to be higher for diets with high oil silage (71.6 *Vs.* 69.9%) and tended to be higher for processed silage than unprocessed silage (71.7 *Vs.* 69.8%) "Weiss and Wyatt, 2000).

In general, Valadares *et al.* (2000) formulated diets from alfalfa silage plus a concentrate mixture based on ground high moisture ear corn and found that 20% concentrate (43% NFC), 80% alfalfa silage was higher in the feed efficiency (milk/DM intake) with a minimum at 27% dietary NFC. Whereas, Weiss *et al.* (1989) showed that the digestibility of hemicellulose was higher and cellulose and ADF digestibilities were lower by cows fed alfalfa-barley diet at 50:50 than cows fed 70% alfalfa silage : 30% corn grain. These data show that forage : concentrate ratio and source of starch must be considered prior to recommending that diets be balanced for NDF. The same trend was recorded by Ead (1982) who found that there was negative associative effect on fiber digestion of clover hay when the diet contains more than 25% barley, since the CF digestibility was 58.44% in the diet of 25% barley *vs.* 52.15% in the diet of 50% barley. On the other hand, Reid *et al.* (1987) reported that a small negative associative effect for mixtures of grasses and legumes compared with pure species.

Another attempt was made by measuring the disappearance % and the rate of disappearance of ADF of the CH, CS and S in the tested rations in the rumen through the *in sacco* artificial fiber bag technique. The results were as follows:

Period (hrs)	CH		CS		S	
	%	% / h	%	% / h	%	% / h
8	12.84	1.61	-8.67	-1.08	11.28	1.41
16	33.48	2.09	3.50	0.22	24.22	1.51
24	41.44	1.72	23.94	1.00	31.56	1.32
36	45.31	1.25	31.12	0.86	37.06	1.02
48	46.29	0.96	32.20	0.67	39.41	0.82
Mean	35.87	1.53	16.42	0.33	28.71	1.21

The disappearance of legumes were higher and more rapid from 8 hrs up to 24 hrs of ruminal fermentation than cereal by-products which did not approach complete until 72 hrs of fermentation (Leslie and Fahey, 1994). The results also showed that the disappearance % of S was higher than CS as the effect of dietary concentrate which has more influence on passage of low quality-forage than on passage rate of grain or high-quality forage (Poore *et al.*, 1990).

When the data of disappearance in the present study was fitted according to the exponential equation of Ørskov and McDonald (1979), it was clear that the degradability (a+b) of NDF of CH, CS and S were similar, but the degradability (a+b) of ADF of CH was significantly increased ($P<0.01$) than CS or S (Table 5). Jung and Varel (1988) found that animals fed alfalfa degraded the fiber fractions of all substrate forages best than smooth bromegrass hays. These observations would explain the reason of lower digestibility of the cellulose and ADF in the CS and S rations. On the other hand, the degradability (a+b) of ADF of S was significantly increased ($P<0.01$) than CS, but the digestibility of the cellulose and ADF in S ration were significantly ($P<0.01$) lower than in CS ration as a result of the increase in the rate of ADF disappearance and a slow rate of passage of particulate matter through the rumen and total digestive tract with decreasing feed intake (Staples *et al.*, 1984). On the other hand, cellulolytic bacteria generally degrade hemicellulose, the products of such degradation may fail to be utilized for growth (Rowatt Research Institute, 1997). So, that was the reason of increasing the degradability (a+b) and digestibility of ADF and cellulose in CH ration than CS or S ration.

It should be pointed out that pH, NH_3-N and VFA in rumen liquor were studied to postulate the suitability for fermentation. The pH values always were always below 6.0 after feeding on CH or CS ration than S ration, especially the decrease was more with CH ration. Fischer *et al.* (1994) studied the fibrosity of the main forage source, in the total mixed ration (TMR) contained 45% forage, and found that when hay was fed the amount of alfalfa silage in the corresponding TMR was reduced, and depressed rumen pH. While the normal range of 6-7 for pH is suitable for the growth and activity of cellulolytic bacteria (Prasad *et al.*, 1972). Erdman (1988) showed that when cows were fed for *ad libitum* consumption corn silage and grain separately in a 40: 60 ratio where treatments consisted of a corn silage (pH = 3.64) or corn silage partially neutralized with sodium bicarbonate prior to feeding (pH = 5.44). Neutralization of corn silage increased forage DM intake. So, he reported that the optimal pH for maximum intake was 5.7. While Hoover (1986) reported that the presence of starch and sugars reduces fiber digestion, which may in turn depress intake. Moderate depression in pH, to approximately 6.0, results in small decrease in fiber digestion, but numbers of fibrolytic organisms are usually not affected. Further decreases to 5.5 or 5.0 result in depressed growth rates and decreased fibrolytic microbes and fiber digestion may be completely inhibited. Mehrez (1992) reported that the optimal NH_3-N concentration for maximal rate of rumen fermentation is associated with dietary source and level of energy to be fermented in the rumen. In addition, Hoover (1986) reported that the value of amino acids to cellulolytic organisms appears to be primarily as source of isobutyric, isovaleric and 2-methylbutyric acids. This raiforces the need to establish dietary requirements for non-protein-nitrogen, degradable protein and isoacids. So, in the present study it was found that NH_3-N concentration was higher when feeding on CS and the concentration of VFA was lower than feeding on CH ration. This loss of protein and consequent loss of NH_3 from the rumen is referred to as "ammonia overflow" (Broderick, 1995). While when feeding on S, "without ears which was low in readly fermentable carbohydrate", the concentration of VFA was decreased ($P<0.01$) and then the NH_3-N concentration was also decreased ($P<0.01$) than feeding on CH or CS rations. The VFA concentrations were related more to forage substrate than diet source (Jung and Varel, 1988).

As previously mentioned, it appears that degradation of dietary components may vary greatly, depending primarily on the predominant type of microorganism present (Scheifingers *et al.*, 1976). The *Anaerovibrio lipolytica* was higher in numbers when fed on CS than S and at least on CH ration, and this was related to EE% in the ration and EE% in the roughage. *Bacteroids amylophilus* which is related to starch digestion was higher with feeding on CS than S or CH. *R. succinogenes* were affected by the pH value in the rumen when fed on CH at 8 hrs after feeding, although the percentage of isolation throughout a period of 8 hrs of feeding was higher than feeding on CS or S rations. *S. ruminantium* was higher when feeding on CS than CH or S, while *S. ruminantium* is a major bovine propionate producer and has two subspecies that differ greatly in phenotype (Bryant, 1956). The importance of this genus is becoming increasingly recognized since being implicated as one of the major organism involved in interspecies rumen propionate production (Scheifinger and Wolin, 1973). Subspecies *lactilytica* demonstrates greater metabolic capabilities than *ruminantium*, growing on lactate, glycerol and pyruvate and produce H_2 from hexose and triose while *ruminantium* cannot. So, in the present study, the mean of total viable bacterial count (CFU/ml) x 10^6 was higher when feeding on CS than CH or S.

With regard to the feeding value of the experimental rations, it should be pointed out that the rations were initially relaying on the published feeding values of the constituents. They were then evaluated *in vivo* during the experiments. On the other hand, from an economical point of view, it should be pointed out also. The values could be summarized as follows:

Items	TDN%			DCP%			The cost (LE/ton)
	Calcul-ated	Deter-mined	Relative change %	Calcul-ated	Deter-mined	Relative change %	
48% CH + 14% BS + 38% CFM	54.96	60.67	110	7.5	9.25	123	481
25% CS + 20% BS + 55% CFM	56.30	62.67	111	7.1	10.19	143	452
32% S + 18% BS + 50% CFM	58.80	47.06	80	6.4	8.16	127	409

* (CH = 7.1% DCP, 52% TDN), (CS = 4.5% DCP, 52% TDN), (S = 3.0% DCP, 61% TDN), (BS = 2.2% DCP, 46% TDN), (CFM = 10.0% DCP, 62% TDN).

** Price of one ton "LE" of: CH = 380; CS = 80; S = 50; BS = 100 and CFM = 750).

It is clear that the feeding value of the CH and CS rations were not less than 52% TDN which were recommended and sufficient for local cows and beef cattle during the first stages of growth and generally for ruminants of medium production level (Ministry of Agriculture, 1996).

CONCLUSION

The results showed that the quality of fermentation affected by the type of forage. So, the relationships between DMD, DMI and fiber fractions differ between forage classes. On the other hand, energy supplementation to meet the requirements and production, depends on the source of supplemental energy which is varying widely and includes grains, readily digestible fiber sources, and high-quality forages. It is clear that the dietary concentrate level has more influences on passage rate of low-quality forage (S) than on passage rate o high-quality forage (CH and CS). On the other hand, the reduction in ruminal pH often cited as the major cause of reduced fiber digestion. So, when added sodium bicarbonate to CH or CS rations may increase digestion of NDF of both forages, but when feeding on S ration, forage : grain ratio and source of concentrate not less than 43% NFC must be considered prior to recommending that diet to be balanced for NDF.

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