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EFFECTS OF DIFFERENT N SUPPLEMENTS ON INTAKE AND DIGESTIBILITY OF WHEAT STRAW.

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SUMMARY

The effect of urea (U), alfalfa meal (ALFM), whey (W) and soybean meal (SBM) as different N supplements on digestibility and intake of wheat straw based diet were studied. The N supplements were added to insure 11% dietary crude protein. The ground untreated wheat straw (GUWS) or chopped NaOH treated wheat straw (CTWS) was fed *ad libitum*. Twenty-four wethers were assigned randomely to 2 (straw types) x 4 (N sources) factorial arrangement design. Each treatment was offered to 3 animals at the same time. The experiment was repeated twice after random redistribution of wethers. Dry matter intake (DMI), intake of digestible dry matter (IDDM), digestibility of dry matter (DMD), neutral detergent fiber (NDFD) and acid detergent fiber (ADFD) were studied. The DMI of GUWS was significantly greater ($P<0.0001$) than the CTWS. The DMD, IDDM and NDFD were significantly higher for CTWS than GUWS diet. No significant difference was detected between U, W or SBM in any of the items measured. The DMD and ADFD were significantly ($P<0.05$) lower for the ALFM supplemented diet in comparison with other N sources. Wethers fed W or SBM supplements showed significantly ($P< 0.05$) greater $DMIW^{.75}$ and IDDM than those fed the ALFM supplement. It seems that U as a nonprotein nitrogen source had a similar effect on DMI and fiber digestibility of straw based diet as W or SBM protein when fed to mature wethers. In this situation,it seems that the fiber digesting microorganisms were not strictly dependent on dietary protein or the small amount remaining in the CTWS was enough to meet their needs.

Keywords: Sheep, N supplements, wheat straw, digestibility

INTRODUCTION

The need for a substantial and stable population of fiber degrading microorganisms is one of the factors that determines the efficient utilization of fibrous plant residues (Chesson and Ørskov, 1984). Production of microbial mass represents a need for degradable organic matter, nitrogen source, minerals and vitamins. The N requirements for maximal microbial growth rate is interrelated with substrate availability, fermentable rate, microbial mass and yield (Russel and Hespell, 1981). Different N sources were found elicit different responses in microbial growth and fiber digestibility, with protein supplement being more effective than nonprotein nitrogen (McAllan and Smith, 1983). Branched chain volatile fatty acids (VFA) can exert beneficial effects on feed intake (Van Soest, 1973), growth rates (Felix *et al.*, 1980) and nitrogen retention (Oltijen *et al.*, 1971). Gorosito *et al.* (1985) found that the peptide source, trypticase enhanced cell wall digestion more than branched chain VFA alone and suggested that fiber digesting bacteria may be stimulated directly by amino acids or peptides. Positive associative effects have been observed for intake, digestibility and daily gain when alfalfa was added to poor quality roughage (Hunt *et al.*,. 1985). Brandt and Klopfenstein in a sries of publications (1986a, b, c) reported large associative effects of adding relatively small increments (15 to 30%) of alfalfa to NH_3 treated cobs. However, Hunt *et al.* (1987 and 1988) found little associative effect with alfalfa and wheat straw combinations.

On the contrary there is evidence of a wide variety of ruminal bacteria that excrete amino acids during growth in medium with NH_3 as main source of N (Viviani, 1976 and Stevenson, 1978).

This work was designed to study the effect of urea, alfalfa meal, whey and soybean meal as different N supplements on the intake and digestibility of wheat straw or NaOH treated wheat straw based diet when fed to mature wethers. In this study straw was ground or NaOH treated in order to increase intake and reduce rumen retention time and have a situation of fast dilution rate and sensetive microbial environment to the supplemented N source.

MATERIALS AND METHODS

Animals

Twenty four mature wethers (40-50 kg) were kept in metabolic crates for 42 days in two consecutive periods of 21 days each. Total fecal collection was carried out for 7 days after 14 days prefeeding period. The animals were fed *ad libitum* and the feed was offered twice daily at 9:0 am and 6:0 pm.

Feeds

The constituents of used rations are shown in Table 1. Wheat straw was ground to pass through a 6.5 mm sieve and fed as ground wheat straw (GUWS) or chopped to about 10 cm length particles then treated with NaOH and fed as chopped treated wheat straw (CTWS). The treated straw was soaked for 24 h. in a 0.4 N. NaOH solution using 1:15 w/w ratio. Thereafter the treated straw was rinsed in a barrel of running tap water for 24 h., spread for 48 h. in a thin layer to allow evaporation of the excessive water, packed and stored in a cooler until feeding.

The dry matter content of this treated straw ranged from 20 to 25% as it was determined daily during the feeding period. Straw represented 80% of the dietary dry matter, while the different N supplements, mineral mixture and corn starch contributed the remaining 20%.

Supplements

Urea (U), alfalfa meal (ALFM), whey (W) and soybean meal (SBM) were used as nonprotein nitrogen (U) and intact protein nitrogen (ALFM, W and SBM) sources. Different amounts of these N sources were used to provide 25% of the dietary crude pritein (11%), while the rest was provided from urea and wheat straw (Table 1). Salt, dicalcium phosphate, potassium chloride, ammonium sulfate and trace minerals mixture (10% Mn, 10% Fe, 10% Zn, 1% Cu, 0.3% I and 0.1% Co) was used to meet the mineral requirements for sheep (NRC, 1975). Starch was used as a filler.

Analytical procedures

Dry matter determinations of feed samples were conducted according to (A.O.A.C.,1984). Representative fecal samples were freeze dried, ground and used for subsequent determinations. Neutral detergent fiber, acid detergent fiber and acid detergent lignin determinations were done following, Goering and Van Soest (1970). Tilley and Terry (1963) procedure was used for in vitro organic matter digestibility measurement.

Statistical analysis

A randomized factorial arrangements, two straw types, four N supplement sources, were applied. Three animals were fed on each treatment at the same time. The experiment was repeated twice in two successive periods. The statistical analysis of the data was done using the general linear models procedure (SAS, 1982).

$$Y = U + Straw_{i\,(1,2)} + Supplement_{j\,(1\text{-}4)} + Period_{k\,(1,2)} + (Straw_i \times Supp_j) + (Straw_i \times Period_k) + (Supp_j \times Period_k) + (Straw_i \times Supp_j \times Period_k) + e_{ijkl}$$

Y = An observation. U = General mean. $Straw_i$ = Two types of straw 1 and 2. $Supplement_j$ = Four N sources$_{1,2,3,4}$.
$Period_k$ = Two successive periods$_1$ and $_2$.
$Straw_i \times Supp_j$ = The interaction between straw type and N-supplement.
$Straw_i \times Period_k$ = The interaction between straw type and Period.
$Supp_j \times Period_k$ = The interaction between N-supplement and Period.
$Straw_i \times Supp_j \times Period_k$ = The interaction of straw types x N-supplement x Period., e_{ijkl} = The experimental error.

Table 1. The rations formulation.

Ingredient%	Untreated wheat straw				Treated wheat straw			
	Urea	Alfalfa	Whey	Soybean	Urea	Alfalfa	Whey	Soybean
Untreated straw	80.00	80.00	80.00	80.00				
Treated straw					80.00	80.00	80.00	80.00
Supplements:								
Urea	2.78	1.84	1.84	1.84	3.78	2.83	2.83	2.83
Alfalfa		15.36				15.36		
Whey			15.28				15.28	
Soybean meal				5.34				5.34
Mineral mixture*	0.82	0.59		0.59	2.81	1.6	0.17	2.24
Trace minerals**	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Starch	10.05	1.86	2.53	11.88	13.06		1.37	9.24
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated CP%	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00

* Dicalcium Phosphate, Calsium chloride and ammonium sulphate were mixed in different proportion to adjust for calcium, phosphorus, potasium and sulpher concentration according to NRC, 1975 requirements.

** It contains 10% manganise, 10% iron, 10% zinc, 1% cupper, 0.3% iodine and 0.1% cobalt.

RESULTS

The organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and *in vitro* organic matter disappearance of GUWS and CTWS are shown in Table 2. Treatment with NaOH solution followed by rinsing in running water washed out the soluble organic constituents. As a result, the proportions of insoluble or less soluble constituents were increased. While OM, NDF, ADF, cellulose and ADL proportions were increased by 6.82, 9.60, 25.78, 28.14 and 8.53%, the hemicellulose proportion was decreased by 22.70%.

Table 2. The nitrogen and fiber fractions contents and IVOM of wheat straw and NaOH treated straw on dry matter basis.

Item	Organic matter	Nitr-ogen	NDF	Hemice-llolose	ADF	Cellu-olose	ADL	IVOMD
Untreated straw	89.64	0.91	77.51	25.88	51.63	45.41	6.22	50.46
SE	±0.20	±0.02	±0.17		±3.42		±0.60	±1.04
Treated straw	95.75	0.49	84.95	20.01	64.94	58.19	6.75	68.40
SE	±0.32	±0.00	±0.58		±2.23		±0.84	±2.95
% Change	6.82	-46.20	9.60	-22.70	25.80	28.10	8.50	35.60
Rewashed Treated straw		0.34						
SE		±0.03						

SE: standerd error of the mean.
NDF: neutral detergent fiber, ADF: acid detergent fiber and ADL: acid detergent lignin.
Hemicelluolose figure is the result of NDF-ADF, celluloose figure is the result of ADF-ADL.

The *in vitro* OM disappearance (IVOMD) was improved by 35.55% as the straw was NaOH treated, even though the soluble constituents were washed out. The N contentwas reduced by 46% as the straw was treated and washed. Rewashing this treated straw with warm water further reduced the N content by 31% (Table 2).

The DMI of the ground untreated wheat straw (GUWS) was significantly ($P<0.0001$) greater than the shopped treated straw (CTWS) diet (Table 3). The DMD, NDFD, and ADFD values were significantly ($P<0.0001$) greater for the CTWS diet as compared with the GUWS diet. The IDDM was significantly ($P<0.0066$) higher for the CTWS diet, 616.02 vs 531.76 g d^{-1} . Results in Table 3 showed no significant difference between urea and other intact protein sources (ALF, W and SBM) in DMI, $DMIW^{0.75}$, IDDM and NDFD of the straw based diet. Mean while the DMD and ADFD of U supplemented diet was significantly ($P<0.05$) greater than the ALFM supplemented diet. When U was compared with W or SBM as N sources, no significant difference was detected. On the other hand ALFM supplement significantly ($P<0.05$) decreased the DMI, DMD, IDDM and ADFD values when compared with whey or soybean meal as protein sources. The probabilites and significance levels of studied factors affecting digestibility and intake data are presented in Table 4.

DISCUSSION

The proportions of fiber fractions of untreated and NaOH treated straw (Table 2) reflect the alterations occured in the cell wall components of wheat straw as it was treated and washed. NaOH treatment improved the digestibility of the fibrous material as it disrupts the linkages between cellulose-hemicellulose and lignin. As a result, the residual fiber is rendered more susceptible for rumen microorganisms adhesion, colonization and fermentation (Fahmy and Sundstol, 1984 and Chesson and Ørskov, 1984).

Table 3. The intake and digestibility of untreated and NaOH treated wheat straw based rations as supplemented by different N sources.

Item	Straw type		Urea	N supplements			
	Untre-ated	Tre-ated		Alfalfa meal	Whey	Soybean	Mean SE
Dry matter intake (DMI g d^{-1})							
	1055.8^{a}	842.3	925.5^{ab}	874.9^{b}	1009.3^{a}	986.4^{ab}	42.9
Dry matter intake metabolic weight (DMI W$^{0.75}$)							
	34.9^{a}	27.2^{b}	30.4^{ab}	27.8^{b}	32.3^{a}	32.4^{a}	1.3
Dry matter digestibility(DMD)							
	49.9^{b}	73.2^{a}	63.4^{a}	57.4^{b}	62.5^{a}	63.0^{a}	0.9
Intake of digestible dry matter (IDDM)							
	531.8^{b}	616.0^{a}	576.7^{ab}	501.6^{b}	612.4^{a}	604.8^{a}	29.0
Neutral detergent fiber digestibility (NDFD)							
	44.9^{b}	81.9^{a}	6.8	62.4	62.4^{a}	65.2^{a}	1.0
Acid detergent fiber digestibility (ADFD)							
	37.9^{b}	80.9^{a}	61.8^{a}	55.0^{b}	59.8^{a}	60.9^{a}	1.3

a,b Values in the row with different superscripts differ ($P<0.05$).

The washing process eliminated the high intake of sodium and it's negative effect on the rumen retention time (Berger *et al.*, 1980). Accordingly more substrate is made availabe for fermentation and the microbial N requirements for efficient utilization would be increased and a suitable source of N would be necessary (McAllan and Smith, 1983).

Shah and Klopfenstein (1985, unpublished data) added casein in amounts that represent 1% of the dry matter intake. No benefit was gained on dry matter digestibility from casein supplementation (50.69 vs 50.39%). Casein supplementation (1%) had no positive effect on intake of digestible dry matter of NH_3 straw, whatever the straw was fed, chopped 273.33 vs 236.30 g d^{-1} or fine ground restricted to the same intake of chopped 257.20 vs 225.37 g d^{-1} or fine ground fed *ad libitum* 374.87 vs 373.98 g d^{-1}.

The data obtained indicated that urea as nonprotein N source behaved as other supplemental protein N sources (W and SBM) and significantly ($P<0.05$) better than ALFM diet in DMD and ADFD as N source to meet the microbial requirements. This result is contradictory to that of Brandt and Klopfenstein (1986) that alfalfa contains ruminal degradable and escapable protein fractions that may increase ruminal digestion of low protein roughage. However, Hunt *et al.* (1987 and 1988) found little associative action with alfalfa and wheat straw combinations. Alfalfa contains 12.4% lignin, that may be responsible for the low figures obtained for this diet. Moreover starch was added in very small proportion to the alfalfa meal supplemented diet in comparison with urea supplemented diet as starch was used as filling agents. These may explain the superiority of urea above the alfalfa as N sources in this study.

Russel and Sniffen (1984) reported that many fiber digesters require ammonia and may require branched chain VFA for protein synthesis and growth. McAllan and Griffith (1987) concluded that the type as well as the amount of rumen degradable N provided in ruminant diets are important in optimizing the digestion of dietary fiber in the rumen. Russel, *et al.* (1979)concluded that amino acids and branched chain VFA are required by cellulolytic bacteria *in vitro*, but cross feeding cellulolytic bacteria can meet this need in the rumen under most circumstances. Salter *et al.* (1983) explained the relative inefficiency of urea N utilization when it represents the only N source in the diet, as the rate of ammonia release from urea and energy from carbohydrate were not matched. In the present work, starch was included in urea supplemented diet and represented 16.05 and 13.06% of the GUWS and CTWS diets respectively. Sulfur was added to the diet to accomplish 0.15% of the diet. The ratio of total N : total sulfur was 11.73 : 1 in these diets. Harrison and McAllan (1980) suggested a ratio of 20 : 1 total N : total sulfur is necessary to meet microbial requirements. NRC (1989) recomonded a 12 : 1 for N : sulfur in the diet. Viviani (1976) and Stevenson (1978) gave evidence that ruminal bacteria excrete amino acids during growth in a medium with NH_3 as a main source of N Orskov (1982) concluded that it is not known for certain whether or not the content of amino N or branched chain fatty acids ever limit microbial yield and rates of fermentation of natural diets. It is important to point out that the N content of the straw used in this experiment was 0.91 and 0.49% for the untreated and treated straw respectively. Rewashing this treated straw with warm water reduced the N content to 0.34% level. This 0.15% (0.49 - 0.34) N was likely available for the rumen organisms. Unedr circumstances like this (highly digestible NaOH chopped straw and ground straw that have relatively short rumino-reticular retention time) urea as nonprotein N had similar effects on intake and digestibility of DM and fiber fractions as whey or soybean meal.

Therefor it seems that microbial requirement for rumen degradable protein is very small (less than 0.15% N of the DM) or there is no requirement. Detailed studies taking into account the NH_3, branched chain fatty acids concentrations and the rate of microbial synthesis and yield are required, and they may give precise explanations for the results obtained.

Table 4. Means and probability figures of the independant variables studied as affected by different sources of variance.

	DMI	$DMIW^{.75}$	IDDM	DMD	NDFD	ADFD
Means	949.01	30.72	573.89	61.54	63.43	59.38
± S.E.	±42.88	±1.32	±28.98	±0.94	±0.96	±1.33
Source of variance						
Periods	0.2100	0.1209	0.0470	0.279	0.104	0.555
Straw type	0.0001***	.0001***	.0066**	.0001***	.0001***	.0001***
Per* straw	0.0299*	0.1858	.0121*	.206	0.334	0.0927
Supp	0.1323	0.0581	.0431*	.0002**	0.152	0.005**
Per* supp	0.5255	0.7715	0.7627	0.139	0.135	0.253
Straw* Supp	0.1667	0.1237	0.1888	0.451	0.644	0.556
Per* Straw*Supp	0.4567	0.4125	0.3159	0.125	0.281	0.356

However, the present results are in agreement with those of Nicholson *et al.* (1992). They did not find significant difference among urea, soybean meal and fish meal when added as supplemental N sources to growing beef cattle fed legume silage, on feed intake, weight gain and feed efficiency, although animals fed fish meal gained the highest and those fed urea gained the least. Moreover Horton *et al.* (1992) demonstrated that urea equalled soybean meal and dehydrated alfalfa meal as a N sources in a corn silage diet fed to growing steers as measured by overall performance and carcass characteristics.

REFERENCES

A.O.A.C., 1984. Official methods of analysis (14th Ed.). Association of Official Analytical Chemists, Washington, DC.

Berger, L. L., T. J. Klopfenstein and R. A. Britton, 1980. Effect of sodium hydroxide treatment on rate of passage and rate of ruminal fiber digestion. J. Anim. Sci.,50: 745.

Brandt, R.T. and T. J. Klopfenstein, 1986a. Evaluation of alfalfa- corncob associative action. II. Comparative tests of alfalfa hay as a source of ruminal degradable protein. J. Anim. Sci. 63: 902.

Brandt, R. T. and T. J. Klopfenstein, 1986b. Evaluation of alfalfa-corncob associative action. III. The effect of mechanically separated alfalfa fractions on intake, digestibility and ruminal characteristics of ammonia treated corncob diets fed to sheep. J.Anim. Sci. 63:911.

Chesson, A. and E. R. Orskov, 1984. Microbial degradation in the digestive tract. In: Straw other fibrous as feed. F. Sundstol and E. Owen (editors), Elsevier.

Fahmy, S. T. M. and F. Sundstol, 1984. The effect of urea and intact protein supplementation on the in vitro digestibility of untreated or alkali treated barley straw. Z. Tierphysiol., Tierernahrg. U. Futtermittelkde. 52:118.

Felix, A., R. M. Cook and J. T. Huber, 1980. Effect of feeding iso acids with urea on growth and nutrient utilization by lactating cows. J. Dairy Sci. 63:1934.

Goering, H. K. and P. J. Van Soest, 1970. Forage fiber analysis. ARS, USDA Agr. Handbook 379.

Gorosito, A. R., J. B. Russell, and P. J. Van Soest, 1985. Effect of $carbon_4$ and $carbon_5$ volatile fatty acids on digestion of plants cell wall in vitro. J. Dairy Sci.68:840.

Harrison, D. G. and A. B. McAllan, 1980. Factors affecting microbial growth yields in the reticulo rumen. P. 205. In: Digestive physiology and metabolism in ruminants, Y. Ruckebusch and P. Thivend, eds. Lancaster, England: MTP press.

Horton, G. M. J., W. D. Pitman, and F. M. Pate, 1992. Protein supplements for corn silage diets and their effect on subsequent growth and carcass characteristics in beef cattle. Can. J. Anim. Sci. 72:595.

Hunt, C. W., T. J. Klopfenstein, and R. A. Britton, 1987. The effect of alfalfa quality and wheat straw ammoniation on intake and digestibility of alfalfa wheat straw combination diets fed to sheep. Nutr. Rep. Int. 37:675.

Hunt, C. W., T. J. Klopfenstein, and R. A. Britton, 1988. Effect of alfalfa addition to wheat straw diets on intake and digestion in beef cattle. Nutr. Rep. Int. 38:1249.

Hunt, C. W., J. A. Paterson and J. E. Williams, 1985. Intake and digestibility of alfalfa-tall fescue combination diets fed to lambs. J. Anim. Sci. 60:301.

McAllan, A. B. and E.S. Griffith, 1987. The effects of different sources of nitrogen supplementation on the digestion of fiber components in the rumen of steers.

Anim. feed Sci. Technol. 17:65.

McAllan, A. B. and R. H. Smith, 1983. Factors influencing the digestion of dietary carbohydrates between the mouth and abomasum of steers. Br. J. Nutr. 50:445.

Nicholson, J. W., G. E. Charmley, and R. S. Bush, 1992. The effect of supplemental protein source on ammonia level in rumen fluid and blood and intake of alfalfa silage by beef cattle. Can. J. Anim. Sci. 72:583.

NRC, 1975. Nutrient requirements of domestic animals, No. 5. Nutrient requirements of sheep. Fifth Revised Ed. National Academy of Sciences. National Research Council, Washington, DC.

Oltjen, R. R., L. L. Slyter, E. E. Williams, Jr., and D. L. Karen, 1971. Influence of the branched chain volatile fatty acids and phenylacetate on ruminal microorganisms and nitrogen utilization by steers fed urea or isolated soy protein.J. Nutr. 101:101.

Ørskov, E. R. 1982. Protein nutrition in ruminants. Academic press.

Russell, J. B., F. J. Delfino, and R. L. Baldwin, 1979. Effects of combinations of substrates on maximum growth rates of several rumen bacteria. Appl. Environ. Microbiol. 37:544.

Russel, J. B. and R. E. Hespell, 1981. Microbial rumen fermentation. J. Dairy Sci. 64:1153.

Russel, J. B. and C. J. Sniffen, 1984. Effect of $carbon_4$ and $carbon_5$ volatile fatty acids on growth of mixed rumen bacteria in vitro. J. Dairy Sci. 67:987.

Salter, D. N., R. H. Smith and D. Hewitt, 1983. Factors affecting the capture of dietary nitrogen by microorganisms in the forestomachs of yhe young steers. Br. J. Nutr. 50:427.

SAS, 1982. User's guide: Statistics. Statistical Analysis System Institute, Cary, N. C.

Stevenson, I.L., 1978. The production of extra cellular amino acids by rumenbacteria. Can. J. Microbiol. 24:1236.

Tilley, J. M. A. and R A. Terry, 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104.

Van Soest, P. J., 1973. The uniformity and nutritive availability of cellulose. Fed. Proc. 32:1804.

Viviani, R., 1976. Biosynthesis of essential amino acids in ruminal bacteria. Folia Vet. Lat. 6:120.

تأثير الإضافات النيتروجينية المختلفة على المأكول والمهضوم من تبن القمح

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تمت إضافة أربعة مصادر أزوتية مختلفة وهى اليوريا - مسحوق نبات الألفالفا - الشرش المجفف - كسب فول الصويا إلى عليقة يمثل تبن القمح ٨٠٪ منها ودرس أثر هذه الإضافات على الكمية المأكولة ومعاملات الهضم. وقد أضيفت هذه المصادر الأزوتية بكميات مختلفة بما يحقق ١١٪ بروتين خام فى العليقة. وكان تبن القمح المستخدم إما مطحونا أو مقطعا إلى قطع طول كل منها ١٠ سم ثم عومل ب ص أ يد بطريقة النقع.

وقد غذى ٢٤ من ذكور الأغنام المخصية على هذه العلائق الثمانية (صورتين من تبن القمح أربعة مصادر ازوتية) وقدمت كل معاملة إلى ثلاثة حيوانات وذلك لحد الشبع.

وقد أجريت تجربتين للهضم طول كل منها ٢١ يوما ثم جمع الروث جمعا كليا فى السبع أيام الأخيرة من كل تجربة. وتم توزيع الحيوانات توزيعا عشوائيا على كل من المعاملات فى كل من التجربتين. وقد تم حساب معاملات الهضم لكل من المادة الجافة ومستخلص الألياف المتعادل والحامضى وكذلك الكميات المأكولة من المادة الجافة.

وكانت أهم النتائج المتحصل عليها هو عدم وجود إختلافات معنوية بين إضافة اليوريا وكل من إضافة الشرش المجفف أو كسب فول الصويا فى كل من التقديرات التى درست. كما أوضحت النتائج أيضا أن إضافة مسحوق الألفالفا كان له تأثير سلبى معنوى على معامل هضم المادة الجافة وكذلك معامل هضم المستخلص الحامضى للألياف وذلك عند مقارنتها بباقى المصادر الأزوتية المختبرة.

إضافة كل من الشرش أو كسب فول الصويا أدى إلى زيادة معنوية فى كمية المادة المأكولة منسوبة إلى وزن الجسم الميتابوليزمى وكذلك المأكول من المادة الجافة المهضومة بالمقارنة فى حالة إضافة مسحوق نبات الألفالفا.

ومن هذه الدراسة يمكن استخلاص أن استخدام اليوريا كمصدر أزوتى غير بروتينى له تأثير مشابه لباقى المصادر الأزوتية المختبرة وذلك فيما يتعلق بكميات المادة الجافة المأكولة وهضم الألياف لعليقة يمثل تبن القمح ٨٠٪ منها. وبكلمات أخرى فإن تغذية ذكور الأغنام المخصية تامة النمو على عليقة أساسية من تبن القمح فإن نشاط الكائنات الحية الدقيقة بالكرش وخاصة فيما يتعلق بهضم الألياف والمادة الجافة لا يعتمد أساسا على الصورة التى يوجد عليها الأزوت فى الغذاء أو أنه كميات الأزوت البسيطة المتبقية فى تبن القمح المعامل ب ص أ يد والمغسول بعد المعاملة كانت كافية لمواجهة احتياجات تلك الميكروبات.