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PROTEIN SOLUBILITY IN DIFFERENT SOLVENTS AND IN- SITU RUMEN PROTEIN DEGRADABILITY OF SOME RUMINANT PROTEIN SOURCES

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ABSTRACT

The relationship between in situ protein degradability (PD) in the rumen of male buffalo bulls and protein solubility (N) in three solvents was investigated using some protein meal feeds with different physical characteristics and crude protein (CP) content (undecorticated cotton seed meal, soybean meal, linseed meal and sunflower meal). In addition, The relationships between protein solubility in the three solvents were examined. There was a positive relationship between rumen protein degradation and solubility in the three solvents. A negative relation was found between CP content of the meals and solubility.

Key words: Ruminant protein meals – Nitrogen – Solubility - Protein degradability.

INTRODUCTION

Protein degradability in some feedstuffs has been measured by numerous procedures. The degradability of dietary protein in the rumen could vary according to the type of protein, solubility, rate of passage, roughage: concentrate ratio and NH₃-N concentration (Mehrez and Orskov, 1977 and Abd El-Maksoud, 1990). Moreover, Mahadevan *et al.*, (1980) suggested that the lack of disulfide bonds in feed protein could indicate high protein degradability in the rumen. The composition of feed protein have been suggested to be the main reason for the differences in the protein degradation among the feeds (El-Ayek *et al.*, 1997).

The present study was designed to investigate the solubility of different ruminant protein meals in different solvents as indicators for their degradability in the rumen.

Materials and methods

The study on animals was carried out in Agricultural Experimental Station belonged to Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Ismailia Governorate. The laboratories of Animal Production Department in Faculty of Agriculture, Ain Shams University and laboratories of APRI in El-Dokki district, Giza governorate. The experiment lasted a year during July, 2003 up to June, 2004.

The aim of the study was to find out the possibility of using nitrogen solubility of some protein meal feeds as an indicator for protein degradability in the rumen of ruminants. The experimental protein sources were undecorticated cotton seed meal (UCSM), soybean meal (SBM), linseed meal (LM) and sunflower meal (SM). All sources were obtained from local feedstuff market. Nitrogen solubility of the meals and in situ degradability trials were schemed for this study.

Nitrogen solubility trial

Nitrogen solubility was determined for the tested sources using distilled water (DW), McDogal's artificial saliva (McD) and cheese cloth filtered rumen fluid (RF) as the three tested solvents. The chemical composition of McD solvent was 0.470 gm NaCl + 3.68 Na₂HPO₄ + 0.13 gm MgCl₂.6H₂O + 0.53 gm MgCl₂.2H₂O + 0.070 gm CaCl₂. H₂O as described by Krishnamurthy *et al.* (1982). An amount of 100 ml filtered rumen fluid was obtained for each sample by filtering an appropriate amount of rumen liquor taken from a fistulated male buffalo animal.

The procedure of Cooker *et al.* (1978) was applied to determine the percentage of insoluble N of the tested protein sources. In this procedure, 0.5 gm air dried sample was mixed with 100 ml of the solvent in stoppered 250 ml flasks. Solubility was determined at pH values ranged from 6.5 to 7.0 and temperature of 39°C. Flasks were then shacked at 110-120 rpm for 60 minutes. Samples residues were filtered, washed with 250 ml cold distilled water. Nitrogen was determined by A.O.A.C. (1990) in the residues plus filter paper.

In situ experiment

Two male rumen fistulated buffalo bulls with an average live body weight of 450 kg were used. Each animal was fitted with a 20 cm diameter permanent rumen cannula. The experimental bulls were fed on berseem hay as basal diet in two equal meals two times daily at (6.00 am and 6.00 pm). Fresh water was available at all times. The artificial fiber bag technique (in situ) developed by Mehrez and Orskov (1977) was applied to determine the rate of N degradability after suspended in the rumen of the cannulated animals for 2, 4., 6., 8, 12.0,24.0 and 48.0 hours which was separated on two sequence days. Differences among the obtained values before and after the incubation in each time were used to determine N degradability (Orskov and McDonaled, 1979).

Chemical analysis:

The proximate analysis of the tested materials was determined according to the standard methods outlined by A.O.A.C. (1980) for dry matter, organic matter, crude protein, ether extract and crude fiber while nitrogen free extract was determined by difference.

Statistical analysis:

The obtained results of solubility results and in situ disappearance of nitrogen were statistically analyzed according to SAS (1999). The means were tested for differences using Multiple Range Test at 0.05 levels.

RESULTS AND DISCUSSION

Chemical composition of the tested protein sources:

Chemical composition of the tested protein sources is presented in table (1). The DM content ranged from 88 to 90.83%. Organic matter content of the plant protein sources was nearly similar. The obtained values of CP and EE contents of the tested plant protein feeds were higher than those recorded by Mehrez (1981b) and Abd El-Maksoud (1990) for native sources.

Crude protein content of soybean meal ranked the first among the tested feeds while the lowest value was for linseed and cotton seed meals in addition to sunflower meal in an average value. The CF and NFE contents of plant protein feeds were within the normal ranges recorded by Abou-Raya (1967).

Table (1): Chemical composition of the tested protein meals

Protein sources	DM	On DM basis (%)					
		OM	CP	EE	CF	NFE	Ash
Cotton seed meal (undecorticated)	90.7	94.8	27.0	5.9	24.0	37.9	5.2
Soybean meal	90.83	92.9	48.3	1.2	5.2	38.1	7.1
Linseed meal	88.0	94.0	28.0	13.0	10.0	43.0	7.0
Sunflower meal	88.0	93.0	38.0	8.0	12.0	35.0	7.0

Each value is an average of three replicate samples

Percentages of insoluble CP remaining after solubilisation of the tested feeds by different solvents are presented in Table (2) and figure (1).

The results show that the highest insoluble protein mean by the different solvents was recorded for sunflower meal (73.3%). Soybean meal ranked the second (70.2%) while the linseed meal and undecorticated cotton seed meal showed almost similar insoluble protein being 66.7 and 65 %, respectively. Such variation in CP insolubility might depend to large extent on the type of proteins and amino acids content as suggested by Nugent *et al.* (1983). The highest protein insolubility was observed by using DW followed by similar values recorded for McD and RF solvents being 75.1 versus 66.2 and 65.2%.

It was apparent that different tested protein sources responded differently to the solvents. The highest insolubility values were observed for treating undecorticated cotton seed meal and sunflower meal with DW (79.9 % and 75.9%) whereas RF solvent showed the highest values with sunflower meal (72.5%).

Table 2. Insoluble protein percentages of the tested materials remained unextracted by different solvents.

Protein sources	DW	McD	RF	Effect of meals*
Cotton seed meal	79.9 ^a ±1.2	60.3 ^b ±0.7	54.7 ^c ±0.9	65.0 ^c ±1.0
Soybean meal	72.8 ^b ± 0.8	67.9 ^a ±0.7	69.8 ^{bc} ±0.7	70.2 ^b ±0.8
Linseed meal	71.6 ^b ±1.6	64.8 ^{ab} ±0.8	63.6 ^c ±0.7	66.7 ^c ±1.1
Sunflower meal	75.9 ^{ab} ±1.2	71.9 ^{bc} ±1.2	72.5 ^a ±1.2	73.3 ^a ±1.2
Average**	75.1 ^a ±1.3	66.2 ^b ±1.1	65.2 ^b ±1.2	

a,b,c Letters differ in the same column are significantly different (P < 0.05).

Each value is an average of three replicate samples.

Average of means, **Average of the insolubility method.

(DW) distilled water, (McD) McDogal's artificial saliva and (RF)cheese cloth filtered rumen fluid

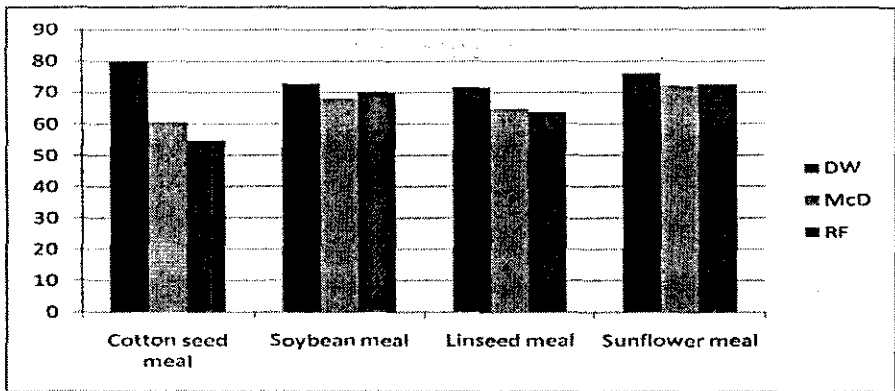


Fig. (1): Insoluble protein percentages of the tested sources remained unextracted by different solvent.

In situ trial results

Values of in situ disappearance of nitrogen are represented in Table 3 and Figure (2). It is clear from the results that nitrogen disappearance percentages increased with incubation time.

The highest degradable percentage was recorded for cotton seed meal being 58.6% in average followed by average value of linseed meal being 56.6% while the lowest value was recorded for sunflower meal.

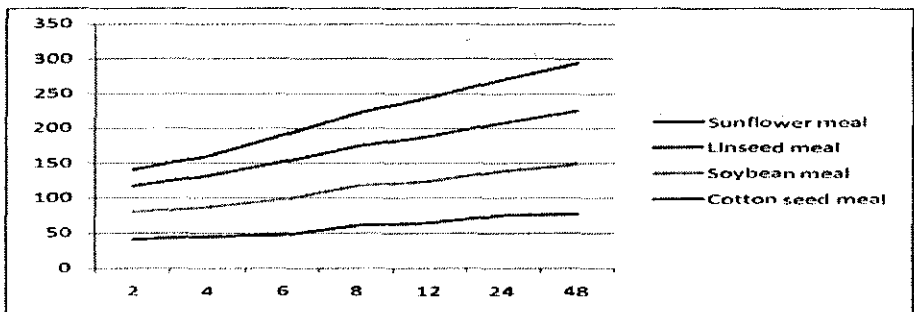


Fig. (2): Effect of incubation on disappearance of N (g/100g) from artificial fiber bags incubated in the rumen of buffaloes.

It appears from the results in Tables 2 and 3 that there was an irreversible relationship between the insolubility of the meal and its degradation percentage in the rumen. In addition, it appears that the higher content of crude protein in the meal, the lower degradation in the rumen. These results are in line with the results of El-Ayek *et al.*

Table (3): Effect of incubation time on disappearance of N(g/100g) from nylon bags incubated in the rumen of buffalo bulls.

Incubation time (h)	Nitrogen disappearance (g / 100g)				Mean effect of time
	Cotton seed meal	Soybean meal	Linseed meal	Sunflower meal	
2	41.2 ^c ±3.2	39.5 ^d ±2.5	36.2 ^e ±2.5	24.2 ^d ±2.7	35.3 ^{dc} ±2.8
4	45.3 ^c ±2.9	42.3 ^d ±2.6	44.1 ^e ±2.6	28.4 ^d ±3.1	40.3 ^e ±2.7
6	47.1 ^c ±2.9	51.4 ^c ±2.6	52.5 ^c ±2.7	38.5 ^c ±2.6	47.4 ^d ±2.7
8	60.4 ^b ±2.6	57.5 ^b ±1.9	55.3 ^c ±2.6	48.1 ^c ±2.6	55.3 ^c ±2.4
12	64.2 ^b ±2.9	60.1 ^b ±2.3	63.5 ^b ±2.6	56.5 ^b ±2.7	58.6 ^{bc} ±2.6
24	75.4 ^a ±2.3	63.4 ^b ±2.5	68.4 ^{ab} ±1.9	62.4 ^a ±2.9	67.4 ^{ab} ±2.4
48	76.4 ^a ±2.3	71.5 ^a ±2.5	76.2 ^a ±1.8	68.1 ^a ±2.7	73.1 ^a ±2.4
Mean effect of meals	58.6 ^A ±2.7	47.8 ^B ±2.6	56.6 ^A ±2.3	47.5 ^B ±2.8	

a, b, c, d, e, f letters differ in the same column are significantly different ($P < 0.05$).

A,B letters differ in the same row are statistically differ ($P < 0.05$)

Each value is an average of three replicate samples.

(1997). They reported that one of the possibilities to decrease degradation of dietary protein is to formulate of diets from ingredients with low protein solubility. However differences in protein degradability are mainly attributed to composition of feed proteins as reported by

Stern and Satter,1985. Crauford *et al.* (1978) found that high solubility often means rapid degradation of feed proteins in the rumen.

Conclusion

Results indicated that there was a positive relationship between the solubility of the leaf meals tested and rumen degradable nitrogen. However, meals differed in their response to different solvents used or different incubation times and that most probably related to their dietary protein structure. Other investigations are recommended to correlate among different protein sources structures, solubility and degradation.

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ذوبان البروتين في محاليل مختلفة لبعض الأعلاف البروتينية للمجترات ومعدلات هدمه في الكرش

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تم دراسة العلاقة بين درجة ذوبان البروتين ومعدلات اختفائه في كرش عجول جاموسي باستخدام ثلاثة محاليل إذابة مختلفة (الماء المقطر ومحلول مكدونالد وسائل الكرش المصفي) وأربعة من مصادر البروتين تختلف في صفاتها الفيزيائية من مواد العلف الخاصة بالمجترات وهي (كسب بذرة القطن غير المقشور و كسب الكتان وكسب عباد الشمس وكسب فول الصويا) وقد أوضحت النتائج أن محاليل الإذابة تختلف في درجة هدمها للمصادر البروتينية المختلفة وأن لوقت التحضين تأثير علي معدلات الهدم داخل الكرش وانه كلما زادت درجة ذوبان المصدر البروتيني كلما زادت معدلات هدمه داخل الكرش وانه كلما زاد محتوى البروتين في مادة العلف كلما قلت معدلات هدمه داخل الكرش.