A COMPARATIVE STUDY OF THE PROTECTION OF DHAINCHA (*Sesbania aculeata*) SEED MEAL AND FISH MEAL FROM RUMEN DEGRADATION USING NYLON BAG TECHNIQUE

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Summary

The protection of dry matter and nitrogen from rumen degradation of dhaincha seed (*Sesbania aculeata*) meal was studied using nylon bag technique. The dhaincha seed meal was subjected to various heat treatments that included oven drying, autoclaving and boiling. Similar experiment was conducted with fish meal as reference for comparison. The oven-dried dhaincha meal was found to retain more dry matter and nitrogen than was found boiled or autoclaved meal. While autoclaving appeared to improve nitrogen and dry matter retention to some extent, boiling seemed to cause more loss of dry matter from nylon bag. Heat treatment caused high retention of nitrogen by fish meal. The calculated effective protein degradation was 80.4% and 83.2% for the oven dried fish meal and dhaincha seed meal whereas same values were 74.2% and 86.7% for autoclaved fish and dhaincha seed meal respectively at the outflow rate of 4.4% per hour. The *in vitro* study revealed higher digestibility for heat treated samples by pepsin. The dry matter, nitrogen and ash content of dhaincha seed meal were 85.93%, 5.93% and 7.31% respectively.

(**Key Words**: Dhaincha, Nylon Bag, Rumen, Dry Matter, Fish Meal and Degradation)

Introduction

In view of the scarcity of protein-rich feedstuff, it is necessary to efficiently utilize whatever protein rich feeds available when fed to animals. Apart from microbial protein, the ruminants derived a part of their protein needs from dietary source which escape ruminal degradation. It is suggested that a reduction in protein degradation in rumen could lead to an increase in total nitrogen absorbed from the alimentary canal. Additional gains achieved in growing calves by supplementation of feeds with fish meal was attributed by Saadullah et al. (1982) to the undegradation of fish meal in the rumen. The property of resistance of feedstuff to degradation in rumen depends on the nature of the feedstuff (Moller, 1982) and also on the processing of feeds (Tamminga et al., 1979). Various heat treatments of protein-rich feedstuff are known to protect them from degradation (Chalmers and Synage, 1954).

The principal objective of protecting the feed protein, aimed at enhancing the quality of undegraded protein, is to increase the supply of essential amino acids to the abomasum and small intestine for production purposes (Beeves et al., 1977). The present study was undertaken with a view to protecting the dhaincha seed meal as well as fish meal from rumen degradation by subjecting them to various heat treatments adopting nylon bag technique.

Materials and Methods

Dhaincha seed (*Sesbania aculeata*) meal and fish meal collected from Bangladesh Agricultural University daily farm were used as animal feed in this experiment. Two, 4 years old straw fed cows raised in the experimental farm of the General Animal Science Department, Bangladesh Agricultural University, were utilized as experimental animals for the study. These cows were fitted with large rumen cannulae with stoppers where the feed samples were introduced and

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Received July 9, 1992

Accepted December 7, 1992

incubated in nylon bag according to the method devised by Kristensen et al. (1982).

The nylon bag was made of polyamide cloth with a pore size of 36 micrometer and an aperture area of 36%. The cloth was of the size of 7.5 × 10 cm and bags were sewn with double line rim and round corner in order to permit easy withdrawl of undegraded material.

The various portions of air-dried dhaincha seed meal, ground to pass 2 mm screen, was subjected to (a) heating in an oven at 80℃ for 30 minutes, (b) autoclaving under 15 1b pressure per square inch at 121℃ for 15 minutes and (c) boiling under cover for 10 minutes. The fish meal was subjected to heat treatments (b) and (c) only as mentioned above excluding boiling. Dry matter, nitrogen and ash contents of meals were analysed according to AOAC (1965).

One gram of air-dried material in triplicate was placed in rumen in nylon bag. The bags were suspended from rubber plugs by self-locking plastic string. Upto 7 plugs were fixed to a plastic stick which is attached to the rumen cannula by a 50 cm piece of nylon string. The position was maintained by two sinkers at each end of the stick. The bags were withdrawn from rumen after 1, 3, 5, 8, 16 and 48 hours of incubation following the method of Kristensen et al. (1982) and rinsed thoroughly under running tap water at room temperature to make the bags free of adhering rumen particles. It was decided to use incubation not longer than 48 hours since with the continuous and increasing degradation, the nitrogen disappearance approaches zero at less than 48 hours of incubation (Kristensen et al., 1982).

The *in vitro* digestibility of protein of treated samples was determined by incubating the sample with pepsin in acid solution according to Vestergarrd and Henriksen (1976).

Analysis of variance was computed to determine the difference of degradability of protein sources. The significance of the difference was adjudged as per Duncan's new multiple range test.

Results and Discussion

The dry matter, nitrogen and ash contents of untreated dhaincha seed and fish meal samples did not differ from those of the heat treated samples, though insignificant but somewhat higher dry matter contents of dhaincha seed meal were obtained. The nitrogen and ash contents of fish meal were much higher than those of dhaincha seed meal. The dry matter, nitrogen and ash contents of seed meal were 85.93-91%, 5.1-5.31% and 6.84-7.1% respectively (table 1) and those of fish meal were 86.75-88.92%, 8.31-8.46% and 28.92-29.30% respectively (table 2).

TABLE 1. DRY MATTER, NITROGEN AND ASH CONTENTS OF DHAINCHA SEED MEAL (%)

Dhaincha	Dry matter	Nitrogen g/100 g dry matter	Ash
Untreated	85.93	5.39	7.30
Oven-dried	91.00	5.31	7.10
Autoclaved	88.18	5.05	6.94
Boiled	88.00	5.15	6.84

Each figure is an average of three determinations.

TABLE 2. DRY MATTER, NITROGEN AND ASH CONTENTS OF FISH MEAL (%)

Fish meal	Dry matter	Nitrogen g/100 g dry matter	Ash
Untreated	86.73	8.46	29.30
Oven-dried	88.92	8.31	29.20
Autoclaved	87.24	8.42	28.92

Each figure is an average of three determinations.

Oven drying caused the highest retention of dry matter in dhaincha seed meal whereas boiled seed meal had the highest rate of dry matter disappearance (table 3). The rate of loss of dry matter from the autoclaved dhaincha seed meal was the minimum upto third hour of incubation period and thereafter the rate gradually increased to exceed that of oven dried meal. It was interesting to note that boiled sample lost more dry matter than even the untreated one. Statistical analysis showed that all treatments were significantly different from one another. The situation was somewhat different with fish meal. The oven dried fish meal showed faster disappearance of dry matter than the untreated fish meal (table 4). The autoclaved fish meal retained most dry matter. The rate of disappearance of dry matter from autoclaved fish meal was significantly different from that of the untreated one. Statistical analysis did not reveal any difference between untreated and oven dried fish meal. It may be noted that fish meal sample was not subjected to boiling.

The nitrogen degradation was significantly slower initially in the heat treated dhaincha seed meal upto the third hour of incubation than that in the untreated meals. Afterwards, the rate of nitrogen loss from both treated and untreated samples became almost the same right upto forty eighth hour of incubation. The retention of nitrogen was the highest in the oven dried dhaincha seed meal upto the third hour of incubation. The rate of disappearance of nitrogen from oven dried sample rose sharply from 49.59% at the third hour of incubation to 90.16% at the eighth hour of incubation (table 5). The nitrogen degradation from oven dried dhaincha seed meal was significantly different from the untreated and the other treated ones upto the eighth hour of incubation. Results obtained in the present study with the dhaincha seed meal were found to be similar to those found with mustard oilcake meal

TABLE 3. DRY MATTER DISAPPEARANCE FROM DHAINCHA SEED MEAL IN NYLON BAG (%)

Hour of incubation	Oven-dried	Autoclaved	Boiled	Untreated
1	49.57[a] (±4.2)*	46.16[b] (±2.0)	52.37[c] (±1.6)	54.14[d] (±2.2)
3	51.36[a] (±0.2)	49.55[b] (±0.2)	60.31[c] (±1.4)	56.86[d] (±1.0)
5	54.03[a] (±1.1)	56.83[b] (±0.8)	64.64[c] (±1.3)	57.52[d] (±1.6)
8	68.24[a] (±1.0)	71.66[b] (±1.8)	77.37[c] (±2.1)	75.12[c] (±1.2)
16	75.66[a] (±0.4)	84.30[b] (±0.8)	91.49[c] (±1.9)	88.87[d] (±0.9)
24	80.56[a] (±0.8)	94.0[b] (±3.4)	98.03[c] (±0.4)	95.57[b] (±2.1)
48	92.91[a] (±0.5)	98.07[b] (±0.4)	98.56[b] (±0.2)	99.45[c] (±0.0)

[a,b,c,d] Values within the same horizontal line with different superscript are significantly different ($p < 0.05$).
* Figures in parentheses are standard deviations.

TABLE 4. DRY MATTER DISAPPEARANCE FROM FISH MEAL IN NYLON BAG (%)

Hour of incubation	Oven-dried	Autoclaved	Untreated
1	55.49[b] (±2.0)*	50.63[a] (±0.9)	50.72[a] (±1.5)
3	58.42[a] (±0.5)	51.77[a] (±0.6)	57.45[a] (±2.0)
5	61.48[b] (±3.0)	55.43[a] (±3.0)	60.14[b] (±0.5)
8	65.62[c] (±1.0)	55.12[a] (±0.4)	61.05[b] (±0.7)
16	67.56[b] (±3.0)	56.24[a] (±1.8)	63.52[b] (±2.0)
24	70.49[b] (±2.0)	60.0[a] (±3.8)	66.66[b] (±0.7)
48	77.4[c] (±0.2)	64.54[a] (±1.7)	70.42[b] (±0.2)

[a,b,c,d] Values within the same horizontal line with different superscript are significantly different ($p < 0.05$).
* Figures in parentheses are standard deviations.

investigated likewise using nylon bag technique (Hussain et al., 1989).

Fish meal behaved quite differently. The oven dried fish meal lost nitrogen faster than the untreated one. Autoclaved fish meal lost the minimum nitrogen (table 6). Statistical analysis showed that there was significant difference of nitrogen disappearance between autoclaved and untreated fish meal at third and fifth hour of incubation.

The exceptional property of untreated fish meal in retaining more nitrogen may be accounted for by the fact that the fish meal was already processed. Further heat treatment made it more liable to rumen degradation by extensive denaturation. These findings indicated that the nature of feed protein as well as their physical characteristics greatly influenced the rate of dry matter and protein degradation in the rumen. Schoeman et al. (1972) and Mohammed et al. (1977) reported that heat treatment affected the digestibility of soybean meal and reduced digestibility depended on the intensity and period of heating. The lower degradability of protein of fish meal was found by Moller et al. (1982). However, Mehrez et al. (1979) reported high protein degradation rate of fish meal. This contradictory report may be attributed to the difference in quality as well as incubation methods. The extensive degradation of dhaincha seed meal is comparable to the values reported for linseed oilcake (Moller, 1982).

The degradation rate measured with nylon bags does not seem to precisely reflect the true degradation at any given time, as the feed particles are not allowed to leave the rumen. The rate is an overestimation of true degradation. It

TABLE 5. NITROGEN DISAPPEARANCE (PD) EXPRESSED IN PERCENT OF DHAINCHA SEEDMEAL IN NYLON BAG AS A FUNCTION OF TIME (t) AND THE ESTIMATED EFFECTIVE NITROGEN DEGRADATION (EPD) IN PERCENT AT THE RATE OF 4.4 PERCENT PER HOUR

Hour of incubation (t)	(f)	Dhaincha seedmeal								Standard error of means
		Untreated		Oven dried		Boiled		Autoclaved		
		PD	EPD	PD	EPD	PD	EPD	PD	EPD	
1	1	73.97[c] (±2.0) *	74.0	45.91[a] (±2.6)	45.9	57.21[b] (±1.0)	57.2	61.89[b] (±7.0)	61.9	3.54
3	0.92	77.12[c] (±0.7)	76.9	49.59[a] (±2.0)	49.3	72.36[bc] (±4.0)	71.1	67.89[b] (±4.4)	67.4	2.66
5	0.84	78.84[c] (±1.7)	78.3	61.68[a] (±1.6)	59.5	74.30[b] (±1.3)	72.2	73.24[b] (±2.6)	71.9	1.65
8	0.75	81.51[c] (±1.6)	80.3	90.16[a] (±0.0)	80.9	85.82[b] (±2.0)	81.3	79.91[c] (±2.5)	76.9	1.64
16	0.60	91.88[a] (±1.6)	86.5	92.73[a] (±0.1)	82.4	95.76[a] (±0.0)	87.3	91.61[a] (±1.3)	83.9	4.66
24	0.42	98.87[bc] (±0.0)	89.4	92.93[a] (±0.7)	82.5	99.16[b] (+0.0)	88.7	97.19[c] (±0.9)	86.2	0.51
48	0.23	99.80[c] (+0.0)	89.6	95.97[a] (±0.3)	83.2	99.58[bc] (±0.0)	88.8	99.43[bc] (±0.2)	86.7	0.20

[a,b,c] Values within the same horizontal line with different superscript are significantly different ($p < 0.05$).

* Figures in the parentheses represent standard deviations. Calculation for EPD may be seen in footnote in the table 6.

TABLE 6. NITROGEN DISAPPEARANCE (PD) EXPRESSED IN PERCENT FORM FISH MEAL IN NYLON BAG AS A FUNCTION OF TIME (t) AND THE ESTIMATED EFFECTIVE NITROGEN DEGRADATION (EPD) N PERCENT AT THE RATE OF 4.4 PERCENT PER HOUR

Hour of incubation (t)	(f)	Fish meal						Standard error of means
		Untreated		Oven dried		Autoclaved		
		PD	EPD	PD	EPD	PD	EPD	
1	1	54.43[a] (±0.5)*	54.4	59.32[b] (±2.6)	59.3	56.61[a] (±0.6)	56.6	1.13
3	0.92	67.65[a] (±2.4)	66.5	66.20[a] (±0.5)	65.5	58.34[b] (±1.3)	58.2	1.15
5	0.84	70.39[a] (±1.5)	68.8	74.84[b] (±1.7)	72.9	62.42[c] (±2.1)	61.6	1.41
8	0.75	70.78[a] (±3.6)	69.1	76.85[b] (±1.8)	74.4	69.56[a] (±2.2)	67.0	2.47
16	0.60	71.39[a] (±4.6)	69.5	80.81[b] (±2.0)	76.8	73.64[a] (±1.3)	69.4	2.36
24	0.42	75.34[a] (±0.4)	71.2	87.13[b] (±0.6)	79.5	81.10[c] (±2.5)	72.5	1.47
48	0.23	87.56[a] (±2.1)	74.0	90.87[a] (±1.6)	80.4	88.34[a] (±1.0)	74.2	1.62

[a,b,c] Values within the same horizontal line with different superscript are significantly different ($p < 0.05$).

* Figures in the parentheses represent standard deviations. f=average proportion of nitrogen remaining in the rumen during preceding time interval.

Example of calculation: $f\ (5,8) = (e^{-0.044\times5} + e^{-0.044\times8})/2 = 0.75$

$EPD = 0.75\ (70.78 - 70.39) + 68.8 = 69.1$

is, therefore, necessary to adjust the degradation results according to the rate of passage out of the rumen e.g. outflow rate. A method has been described by Kristensen et al. (1982) to calculate the effective protein degradation in keeping with the outflow rate. The effective degradation has been calculated only on the basis of an outflow rate of 4.4% per hour. The nitrogen disappearance between zero and one hour of incubation was assumed to be instantaneous, that is, f (0, 1) is equal to one. Figure 1 shows the effective protein degradation as a function of the expected outflow rate from the rumen per hour following the method of Kristensen et al. (1982).

A study of the figure 1 revealed that a rise in the outflow rate from 2.2 to 8.8% caused a reduction in the effective protein degradation for untreated and treated dhaincha seed meal and fish meal. The maximum decrease was found in case of autoclaved fish meal followed by the decrease found in case of oven dried dhaincha seed meal. Soluble protein like albumin was reported to be degraded slowly (Orskov et al., 1980). Some of the proteolytic enzymes may require the native protein with their unchanged secondary and tertiary structure. However, the chemical properties of proteins which give them the property of degradation at different rates are poorly understood. Heat-treatment may have caused Maillard reaction between amino group of protein with the aldehydic group of sugar, thereby reducing the rumen degradation of the

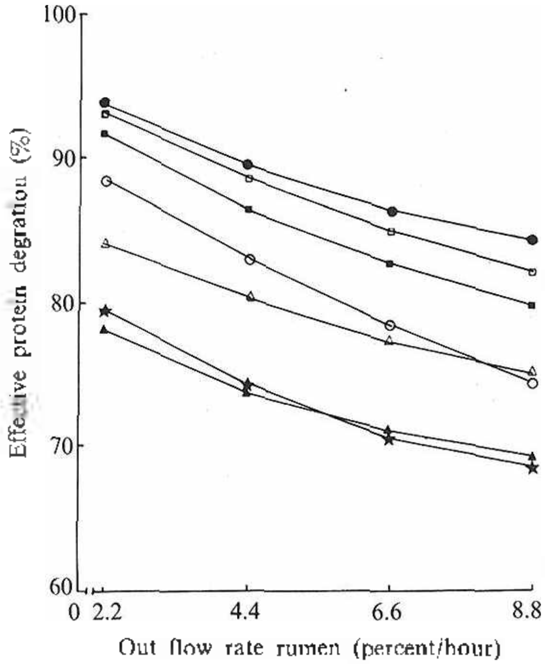

Figure 1. The effective protein degradation in the rumen as a function of out flow rate for different protein sources.

TABLE 7. *IN VITRO* DIGESTIBILITY OF DHAINCHA SEED MEAL AND FISH MEAL BY PEPSIN

Protein source	Nitrogen digestibility %
Untreated dhaincha seed meal	58.07
Oven-dried dhaincha seed meal	78.34
Autoclaved dhaincha seed meal	70.70
Boiled dhaincha seed meal	63.11
Untreated fish meal	82.86
Oven-dried fish meal	85.80
Autoclaved fish meal	85.80

protein-rich feedstuff.

In vitro digestibility study showed that there was not much difference in nitrogen digestibility among the various heat treatments except untreated dhaincha seed meal and boiled dhaincha seed meal where nitrogen digestibility was the lowest (table 7).

In conclusion, it may be stated that depending on the nature of the feedstuff, one or the other kind of heat treatment rendered nitrogen sources better utilizable by the ruminants.

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