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RUMINAL DEGRADABILITY CHARACTERISTICS IN ANIMAL PROTEIN SOURCES OF PAKISTAN

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ABSTRACT

Study on ruminal degradability characteristics of six different animal protein sources found in Pakistan was carried out through in situ procedure using rumen fistulated Nili-Ravi buffalo steer. Samples of fish meal, poultry byproduct meal, meat meal, bone meal, feather meal and blood meal were obtained from 10 different locations. Crude protein (CP) ruminal degradability was determined at 0, 3, 6, 12, 24 and 48 hours in triplicate. Data obtained at different hours of ruminal incubation were fitted to Orskov and McDonald equation to determine fractions a, b, degradation rate and effective degradability at 2, 5 and 8 percent. In CP ruminal degradation kinetics, both fractions "a" and "b" were significantly varied ($P<0.001$) while, CP degradation rate was statistically similar. Effective CP degradability at different rumen passage rates (0.02, 0.05, 0.08 %) were significantly varied ($P<0.001$). The effective degradability was less than 50% at 5% rumen passage rate in all studied animal protein sources.

Key words: Ruminal degradability, animal protein sources, undegradable protein, Nili- Ravi buffalo.

INTRODUCTION

Diet formulation of ruminants animals require crude protein based on rumen degradable protein (RDP) and rumen undegradable protein (RUP) proportions. The parts of protein or amino acids that remain inert in the rumen and available in small intestine vary greatly among different protein sources (Haresign and Cole, 1988). The imbalance in RDP and RUP proportion in diet results in inefficient utilization of the feed nutrients and hence, production performances of growing and lactating animals are affected (Reynal and Broderick, 2003). Animal protein sources are often have more RUP (Waltz *et al*., 1989, Habib, 2009) that have considerable variations among and within protein sources (Stern *et al*., 2006). It is reported (Howie *et al*., 1996) that RUP ranged from 51.3 to 60.8% in meat and bone meal, 53.6 to 87.9 % in hydrolyzed feather meal, 76.4 to 86.4% in ring dried blood meal and 77.6 to 94.4 % in batch dried blood meal.

Animal protein sources are less palatable and are rarely used in formulation of ruminant diets in Pakistan. However, with increasing trend in large commercial dairy and fattening farms, the existing feeding practices have also changed for enhancing animal productivity. The use of total mixed ration is getting popular among livestock farmers. This has facilitated inclusion of animal protein sources for achieving adequate RUP levels in the diet. However, in view of large variation reported in the literature, knowledge regarding degradability characteristics of indigenous animal protein sources is a pre-requisite for effective ration formulation. In Pakistan, information on protein degradability of protein feeds is scanty. The present study was designed to determine degradability parameters of local animal origin protein sources using *in situ* technique (Cottrill and Evans, 1984).

MATERIALS AND METHODS

Samples were collected from various feed mills and main feed markets located in different parts of Punjab province. Approximately one kg representative samples of fish meal, poultry byproduct meal, bone meal, meat meal, blood meal and feather meal were collected from 10 different locations. These were ground though 2 mm screen in a Willey grinding mill and stored in plastic jars labeled with particulars of the samples. All test feeds were chemically analyzed for dry matter, ash, crude protein, crude fiber and ether extract according to the standard procedures of AOAC (2000).

a) *In situ* procedure: *In situ* degradability of test feeds was measured in an adult buffalo steer (Nili-Ravi, body weight = 410 kg) fitted with a permanent rumen fistula. The steer was fed a commercially prepared TMR *ad libitum* (Table 1). Triplicate, 5 g samples, of each protein source were placed in pre-weighed dacron bags (pore size 50 µm), which were then incubated in the rumen for 3, 6, 12, 24 and 48 h. The incubation of samples was done in reverse order so that after 48 h all bags were removed from the rumen simultaneously. These were then washed with water cold running tap water until the water flowing out of the bags was with no visible color. Zero hour degradability was determined without ruminal

incubation; the dacron bags containing sample were rinsed with cold water in the same way as the other bags that were removed from rumen (Woods *et al*., 2003; Kamalak *et al*., 2005). After complete washing, the samples were oven-dried at 60 ^{0}C for 48 h. After cooling in a dessicator the dried bags were weighed. The residue from each of the (sample) triplicate bags was pooled and stored (in labeled bottles) for subsequent CP analyses.

Data obtained on CP degradability at different hours of incubation were subjected to the following equation (Orskov and McDonald, 1979) to find out degradation kinetic parameters (a, b and c) and effective degradability.

$Y = a + b (1-\exp^{-ct})$

Where, Y= Degradability of CP at time "t"; a= quickly soluble fraction; b= potentially degradable fraction; c= rate of degradation of fraction "b".

The effective degradability (ED) at different (0.02, 0.05 and 0.08) rumen passage rates was calculated as;

$ED = a + [(bc)/ (c+k)]$

Where, k= fractional passage rate

b) Statistical analyses: Data on ruminal CP degradation kinetics (a, b, c) and effective CP degradability (0.02, 0.05, 0.08 h^{-1}) of test feeds were statistically analyzed using analysis of variance (Steel *et al.,* 1997), where difference between test feeds were examined. Means were compared for significance by applying Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The chemical composition of the animal protein sources is given in Table 2. The DM, ash, CP, ether extract and crude fiber contents varied significantly (P<0.001) among the test feeds. The highest (P<0.05) CP was contained in blood meal followed by feather meal whilst in bone and meat meal had the lowest (P<0.05) CP content. Fish meal, PBM and meat meal were of intermediate in CP contents that ranged from 42.45 to 54.45 %. Ether extract was highest (P<0.05) in PBM and lowest (P<0.05) in bone and meat meal, feather meal and blood meal. Crude fiber was highest (P<0.05) in fish meal whilst lowest (P<0.05) in feather meal, blood meal, bone and meat meal, ranging from 1.02 to 1.85%. Ash contents were highest (P<0.05) in bone and meat meal and lowest (P<0.05) in feather meal, blood meal and PBM that ranged from 6.25 to 8.06%.

The chemical composition of the test feeds showed similarity as well as variation in the range of values from the reported literature. The CP contents of blood meal PBM are similar to those reported by Kamalak *et al*. (2005); however, they reported considerably higher CP values for fish meal (63.8%), meat meal (58.4%) and feather meal (78.6%). Higher CP contents, as compared to our study, have been previously reported (England *et al*., 1997) for feather meal (80.7%), blood meal (95.2%) and fish meal (72.1%). Higher CP contents of fish meal have also been reported by Chumpawadee *et al*., (2005) and Harstad and Prestlokken (2001). Adulteration with sand and other feed particles were observed in meat meal used in this study which may have contributed in its lower CP contents than reported literature. Often variations in chemical composition in test feeds are due to different techniques used for feed processing in various countries.

Results for the CP degradation kinetics of the test feeds are given in Table 3. The quickly soluble fraction "a" was higher (P<0.05) in fish meal, PBM and meat meal and lower (P<0.05) in blood meal, feather meal and bone and meat meal. Fraction "b" was maximum (P<0.05) in bone and meat meal and PBM and minimum (P<0.05) in blood meal and feather meal. The degradation rate "c" did not differ among the test feeds and ranged from 0.07 h^- to 0.16 h^- .

In CP degradation kinetics (a, b and c fractions), the results for some test feeds varied to those of Kamalak *et al*. (2005) who reported higher values for fractions "a" and "b" and lower degradation rate "c" in fish meal, blood meal and PBM. England *et al*. (1997) reported lower values for quickly soluble fraction "a" and degradation rate "c" but the same range of values for potentially degradable fraction "b" in blood meal. In the case of feather meal, they reported higher values for quickly soluble fraction "a" and degradation rate "c" but a lower range of values for potentially degradable fractions "b". Chumpawadee *et al*. (2005) reported higher values for fractions "a" and "c" while lower value for fraction "b" in fish meal. In the case of meat meal, values were lower for fractions "a" and "c" but similar for fraction "b", as reported by Lee and Moon (1997). Variations in quickly soluble fraction and potentially degradable fraction in some test feeds are due to different processing methods used for animal origin meals in different countries. In addition, differences in the animal species and the diets fed would have also contributed to variations in the results.

Effective degradability of CP at 0.02, 0.05 and 0.08 rumen passage rates varied significantly (P<0.001) among the test feeds (Table 3). Meat meal showed maximum CP degradability at all the three rumen passage rates; however, it was similar (P>0.05) to that of PBM at 0.02 and 0.08 kp and fish meal at 0.08 kp. Minimum (P<0.05) ED of CP was exhibited by blood meal at all the rumen passage rates; however, at 0.08 rumen passage rate, it was not different (P>0.05) to that of feather meal.

Table 1. Composition of total mixed ration fed to Nili-Ravi buffalo steer during *In situ* experiment

Ingredients	**Percent**
Wheat straw	50
Wheat bran	15
Rice polishing	7
Molasses	8
Corn gluten meal 60%	4
Sunflower meal	5
Cottonseed meal	3
Blood meal	4
Poultry byproduct meal	2
*Mineral mixture	1.9
Vitamins	0.1
Total	**100**
ME Mcal/kg DM	**2.1**
CP g/100g DM	**12**

ME = Metabolizable energy; C.P= crude protein

*Mineral mixture composition (per kilogram): Dicalcium phosphate 708g; Sodium choloride 189g; Magnassium sulphate 86.0g; Ferous sulphate 8.9g; Manganese sulphate 4.9g; Zinc sulphate 3.2g; Copper sulphate 0.3g; Potassium iodide 0.087mg and Cobalt chloride 0.0089mg ; Sodium selenate 0.015mg.

Comparatively, ED of CP in the test feeds were lower than those reported by Kamalak *et al*. (2005) for fish meal, meat meal, blood meal and feather meal at 0.02 and 0.05 rumen passage rate. Lee and Moon (1997) reported lower ED values (39.57 to 35.31%) at 0.02, 0.05 and 0.08 passage rates for fish meal while higher values (65.83 to 59.61%) for meat meal at 0.02, 0.05 and 0.08 rumen passage rates than found in this study. Similarly, Moreira *et al*. (2003) found higher ED in fish meal, blood meal and feather and viscera meal at 0.05 rumen passage rate. Oliveria *et al*. (2003) reported lower ED in fish meal and higher in feather meal at 0.05 passage rate.

Considering the range of values of different test feeds reported in the literature, the results of this study are in line with earlier findings which summarize that among commonly used animal protein sources, e.g. blood meal (Piepenbrink and Schingoethed, 1998) and feather meals (Kamalak *et al*., 2005) have least ruminal protein degradability (68-90%) while fish meal (Chumpawadee *et al*., 2005, Mehrez *et al*., 1980), PBM (Bohnert *et al*., 1998) and meat and bone meal (Orskov and MacLeod, 1983; Howie et. al., 1996) have degradability values which range from 40-60%.

Table 2. Chemical composition of animal protein sources (**Note:** Tables 2 &3 were not according to their titles, so changed accordingly

Feeds	**Dry matter**	**Ash**	**CP**	**Ether extract**	**Crude fiber**
		(as percent in DM)			
Fish meal	93.34±0.50^{bc}	19.94±1.33^{c}	53.02±0.78^{d}	10.95±0.78^{b}	10.41±0.71^{a}
PBM	95.55 ±0.47^{a}	8.06±0.54^{d}	54.45±0.89^{c}	20.37±0.79^{a}	3.77±0.67^{b}
Meat meal	82.41±1.13^{d}	28.71±1.43^{b}	42.45±1.21^{e}	6.8±0.45^{c}	1.85±0.22^{c}
Bone and meat meal	94.11±0.69^{ab}	65.4±1.13^{a}	22.77±0.68^{f}	0.92±0.14^{d}	1.81±0.17^{c}
Blood meal	91.96±0.63^{c}	7.84±0.52^{d}	81.84±1.04^{a}	1.75±0.17^{d}	1.10±0.10^{c}
Feather meal	94.89±0.46^{ab}	6.25±0.53^{d}	71.75±0.96^{b}	1.52±0.19^{d}	1.02±0.11^{c}
Significance level	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

Means with different superscripts within same column are significantly different (P<0.05).
PBM= poultry byproduct meal; DM= dry matter; CP= crude protein

Table 3. *In situ* crude protein degradation kinetics and effective degradability of animal protein sources at different rumen passage rates

Particulars	**CP degradation kinetics**			**Effective degradability (%)**		
	a (%)	**b (%)**	**c (h^{-1})**	**k= 0.02**	**k= 0.05**	**k=0.08**
Fish meal	27.38 ±1.85^{a}	28.95 ±1.62^{c}	0.0697±0.00	49.47 ±2.10^{b}	43.79 ±2.21^{bc}	40.67 ±2.20^{a}
PBM	25.93 ±1.19^{a}	39.31 ±2.24^{ab}	0.1072±0.04	55.22 ±1.21^{a}	47.18 ±0.92^{ab}	42.64 ±0.90^{a}
Meat meal	25.79 ±1.66^{a}	35.12 ±1.46^{b}	0.0881±0.00	54.11 ±0.90^{a}	47.77 ±1.19^{a}	43.77 ±1.33^{a}
Bone meal	18.41 ±1.10^{b}	40.41 ±2.10^{a}	0.1121±0.04	49.13 ±0.47^{b}	41.15 ±0.61^{c}	36.51 ±0.79^{b}
Blood meal	15.70 ±0.76^{b}	17.31 ±1.18^{d}	0.1047±0.02	29.65 ±0.88^{d}	26.57 ±0.75^{e}	24.65 ±0.71^{c}
Feather meal	17.40 ±0.90^{b}	20.05 ±0.80^{d}	0.1553±0.07	33.74 ±0.89^{c}	30.09 ±1.07^{d}	27.85 ±1.14^{c}
Sig.	***	***	NS	***	***	***

Means with different superscripts within same column are significantly different (P<0.05).
a= quickly soluble fraction; b= potentially degradable fraction by rumen microbes; c= degradation rate of fraction b; k= rumen passage rate
NS= non significant (P>0.05); Sig.= significance level; *** = (P<0.001).

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