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Determining Nutritive Value of Sunflower Meal for Ruminants using Nylon Bags Technique

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Abstract: This study was carried out to determine the chemical composition and ruminal degradability of sunflower meal. Samples were collected from commercial sources in Iran. Chemical composition for Dry Matter (DM), Crude Protein (CP) and Neutral Detergent Fiber (NDF) of pooled samples were 95.88, 30 and 45.08%, respectively. Degradation procedure was performed using nylon bags filled with 5 g of sunflower meal and suspended in the rumen of three fistulated Gezel rams for 0, 2, 4, 8, 16, 24 and 48 h and obtained data were fitted to a non-linear degradation model to calculate ruminal degradation characteristics. Results showed that soluble fraction (a), potentially degradable fraction (b), rate degradability (c) and Potential degradability (a + b) of sunflower meal for Organic Matter degradability were 25.081, 52.546, 0.0987 and 77.627% and for effective degradability (Out flow rate 0.02, 0.05 and 0.08/h) were 68.766, 59.933 and 45.10%, respectively.

Keywords: Dry matter, neutral detergent fiber, nutritive value, nylon bags technique, sunflower meal, organic matter digestibility

INTRODUCTION

Shortage and high price of conventional animal feeds such as Lucerne and grains in arid and semi arid areas of the world like Iran, leads the animal nutrition to effective use of agro-industrial by-products (Maheri-Sis *et al*., 2011). Developing food industrial factories consequently produced large amount of wastes and by-products which can play an important role in livestock nutrition (Mirzaei-Aghsaghali and Maheri-Sis, 2008; Mirzaei-Aghsaghali *et al*., 2008). Chumpawadee *et al*. (2007) stated that nutritive value of ruminant feeds is determined by the concentration of its chemical compositions, as well as rate and extent of digestion in the rumen. Three common methods including: *in situ*, *in vivo* and *in vitro* techniques have been used in order to evaluate the nutritive value of feedstuffs (Maheri-Sis *et al*., 2008). The nylon bag (*in situ*) technique provides a powerful tool for the initial evaluation of feedstuffs and for improving our understanding of the processes of degradation which occur within the rumen. It is the more efficient method for measuring rate and extent of digestion in the rumen (Ørskov *et al*., 1980; Maheri-Sis *et al*., 2011).

The aim of this experiment was to determine the nutritive value of sunflower meal including Organic Matter (OM) degradability using nylon bags (*in situ*) technique.

MATERIALS AND METHODS

Sample collection: Sunflower meal samples were obtained from commercial sources in Iran.

Chemical analysis: Dry Matter (DM) was determined by drying the samples at 105ºC overnight and ash by igniting the samples in muffle furnace at 525ºC for 8 h and Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990).

Crude Protein (CP) was calculated as N×6.25. Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined by procedures outlined by Goering and Van Soest (1991) with modifications described by Van Soest *et al*. (1991).

In situ degradation procedures: Three ruminally cannulated Gezel rams (about 55 kg BW) were used to determine *in situ* degradation characteristics. Rams were housed in individual tie stalls bedded with sawdust. Rams fed diets containing alfalfa hay (70%) and concentrate mixture (30%) at the maintenance levels. Dacron bags (18*9 cm; 40-45 micron pore size) were filled with 5 g dried and ground samples and then incubated in the rumen of rams for the periods of 0, 2, 4, 8, 16, 24 and 48 h.

After the removal of bags from the rumen, bags were washed in cold water until rinse were clear and dried at 60ºC for 48 h (Karsli and Russell, 2002). Then rumen degradation kinetics of Organic Matter was calculated using the nonlinear model proposed by Ørskov and McDonald (1979):

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

where,

P = Percentage of degradability for response variables at t.

Table 1: Chemical composition of sunflower meal

Component	%
DM	95.88
Crude protein	(%DM)30
NDF	(%DM) 45.08

NDF: Neutral detergent fiber; DM: dry matter

Table 2: Ruminal degradation (%) of sunflower meal at different incubation times

Incubation time (h)	OMD
0	24.297
2	35.520
4	40.684
8	57.470
16	63.403
24	72.590
48	78.210

The zero h Organic Matter degradation was 24.297%; The 2, 4, 8, 16, 24, 48 h Organic Matter degradation were 35.52, 40.684, 57.47, 63.43, 72.59 and 78.21% respectively

Table 3: Ruminal degradation parameters and effective degradability of sunflower meal

Items	OMD
a (%)	25.081
b (%)	52.546
a + b (%)	77.627
c/h	0.0987
ED % Out flow rate 0.02/h	68.766
ED % Out flow rate 0.05/h	59.933
ED % Out flow rate 0.08/h	54.10

a: Washout fraction as measured by washing loss from nylon bags; b: Potentially degradable fraction; c: Rate of degradation of fraction b (h); ED: Effective Degradability; OM: Organic Matter

t = Time relative to incubation (h)
a = Highly soluble and readily degradable fraction (%)
b = Insoluble and slowly degradable fraction (%)
c = Rate constant for degradation (h^{-1})
e = 2.7182 (Natural logarithm base)

Following determination of these parameters, the effective degradability of Organic Matter in sunflower meal was calculated using equation described by Ørskov and McDonald (1979):

$$ED = a + (b*c) / (c + k)$$

where,

ED = Effective degradability for response variables (%)
a = Highly soluble and readily degradable fraction (%)
b = Insoluble and slowly degradable fraction (%)
c = Rate constant for degradation (h^{-1})
k = Rate constant of passage (h^{-1})

When calculating effective degradability, rate constant of passage was assumed to be 0.02, 0.05 and 0.08 h (Bhargava and Ørskov, 1987) so that the results could be extrapolated to other ruminants that differ in rumen capacity (Maheri-Sis *et al*., 2011).

RESULTS AND DISCUSSION

Chemical composition: The chemical composition of sunflower meal is shown in Table 1.

The CP content in sunflower meal was 30%. The dry matter and Neutral detergent fiber contents were 95.88 and 45.08%, respectively.

There are many factors affecting chemical composition and mineral content of concentrate feedstuffs such as stage of growth, maturity, species or drying method, growth environment and soil types (Underwood and Suttle, 1999; Kiyani Nahand *et al*., 2010).

***In situ* degradation procedures:** Ruminal Organic Matter degradation of sunflower meal at different incubation times were shown in Table 2.

In situ Organic Matter degradability characteristic of sunflower meal was shown in Table 3.The Organic Matter degradability from the soluble fraction (a), potentially degradable fraction (b) and Potential degradability (a+b) were, 25.081, 52.546 and 77.627%, respectively and the rate degradability (c) was 0.0987/h respectively estimated.

The total degradability of the sample is given by a+b which obviously cannot exceed 100. It follows that 100 - (a+b) represents the fraction which will appear to be undegradable in the rumen. If 'a' is positive, then there is a component which is degraded rapidly and/or a component which is soluble, or fine enough to escape from the bags simply by soaking and washing. Whether 'a' represents rapid degradation, or simply washing losses, can be determined with control bags which are simply soaked in water and then washed and dried in the normal way. When a negative value for 'a' is obtained this means that there has to be an initiation period for degradation to start (Kiyani Nahand *et al*., 2011).

Effective Degradability (ED) of the examined nutrient components were calculated using the outflow rates of 0.02, 0.05 and 0.08/h, according to Ørskov *et al*. (1980):

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

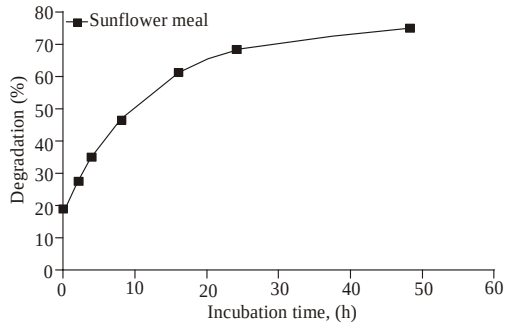

Fig. 1: Ruminal organic matter degradation of sunflower meal was at different incubation times

where, ED is effective degradability and 'a', 'b' and 'c' are the constants as described earlier in the non-linear equation above and 'k' the rumen fractional outflow rates (Maheri-Sis *et al*., 2011; Kiyani Nahand *et al*., 2011).

Effective rumen degradable organic matter at a different rate was determine, Effective Degradability (ED) of Organic Matter decreased with increase in outflow rates OMD decreased of 68.776 (k = 0.02) to 54.10% (k = 0.08) in the sunflower meal.

Effective Degradability (ED) of Organic Matter in outflow rates of (k = 0.02) was 59.933% in the sunflower meal. Mupangwa *et al*. (1997) observed ED of DM to decrease as the outflow rate (kiyani Nahand *et al*., 2011). Ruminal Organic Matter degradation of sunflower meal at different incubation times were shown in Fig. 1.

CONCLUSION

Chemical composition and *in situ* degradability can be considered as useful indicators for the preliminary evaluation of the likely nutritive value of food industrial by-product. The results of this study based on chemical composition and organic matter degradation indicated that sunflower meal could be a valuable food industrial by-product in ruminant nutrition. Due to the high degradation of organic matter and the high protein contents, the sunflower meal by-product have a potential primarily as protein supplements to diets low in protein.

ABBREVIATIONS

OMD: Organic matter digestibility
CP : Crude protein;
a : Washout fraction as measured by washing loss from nylon bags
b : Potentially degradable fraction
c : Rate of degradation of fraction b (h)
ED : Effective Degradability
NDF : Neutral Detergent Fiber

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