Pakistan Journal of Nutrition 10 (9): 838-841, 2011
ISSN 1680-5194

Determining Nutritive Value of Soybean Straw for Ruminants Using Nylon Bags Technique

Naser Maheri-Sis, Bayaz Abdollahi-Ziveh, Ramin Salamatdoustnobar, Alireza Ahmadzadeh, Abolfazl Aghajanzadeh-Golshani and Mehdi Mohebbizadeh
Department of Animal Science, Shabestar Branch, Islamic Azad University, Shabestar, Iran

Abstract: This study was carried out to determine the chemical composition and ruminal degradability of Soybean Straw (SBS). Samples were collected from several soybean grain threshing farms in Moghan, Iran. Chemical composition for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Organic Matter (OM), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) of pooled samples were 89.18, 5.10, 2.85, 96.90, 80.80, 63.20 and 13.00%, respectively. Degradation procedure was performed using nylon bags filled with 5 g of SBS and suspended in the rumen of three fistulated Gezel rams for 0, 2, 4, 8, 16, 24, 48 and 72 h and obtained data were fitted to a non-linear degradation model to calculate ruminal degradation characteristics. Results showed that soluble fraction (a) of SBS were very low, especially in case of DM and OM. Potential degradability (a + b) of SBS for DM, OM and CP were 36.97, 37.74 and 68.07% and for effective degradability (Out flow rate 0.02 h^{-1}) were 21.40, 22.27 and 48.30%, respectively. It is conclude that, SBS have low DM and OM degradability and higher CP degradability in the rumen. Based on chemical composition and degradation characteristics, untreated SBS can be used in the ration of ruminant in limited levels.

Key words: Soybean straw, chemical composition, degradability, nylon bags, ruminants

INTRODUCTION

Ruminant animals play a major role in the livelihood of farmers in the developing countries. They have a unique ability to utilize roughages. Roughages are bulky feeds that are characterized by being high in fiber and low in energy. A cost effective feeding program can be designed around rations utilizing straw as much or most of the roughage source. Good quality straw can make up 75% or more of a wintering cow's diet if supplemented with grain, while a low quality straw might make up only 50% of her diet. Poor quality feed will be consumed at the rate of around 1.25% of the cow's body weight (Saskatchewan Ministry of Agriculture, 2008). Different cereal straws such as wheat straw, barley straw, rice straw as well as some legume straws have been used in ruminant nutrition depends on their availability. Cereal straws are given to cattle, sheep and goats and legume straws are usually reserved for sheep and goat (Abreu and Bruno-Soares, 1998).

Soybean (*Glycine max* L.) is an important legume and oil seed crop in Iran. Soybean production in Iran was higher than 0.2 million ton from the area of 84 thousands ha. The province of Ardebil is 2nd in cultivation and production of soybean in Iran (Ministry of Jihad-e-Agriculture, 2009). Plateau of Moghan (Dasht-e-Moghan) in the north-west of the Ardebil with warm climate is the most important production area of soybean in this province. After soybean grain threshing, large amounts of straw (Fig. 1, 2 and 3) which is composed of stems, leaf and pod husk (Sruamsiri and Silman, 2008) are remaining in the farm. Amount of straw produced is usually more than the seed yield. Some of this straw is fed to livestock; some is left in the farm or burnt. This by-product is one of components of ruminant diets in some small holder farms in areas near the soybean production such as Ardebil province in Iran.

Sruamsiri and Silman (2008) reported that soybean straw contains about 5% crude protein and 3.9 kcal/g DM Gross energy and can be used in cattle nutrition as supplemented roughage. It is notable that due to low palatability of this straw because of its relative hard stem, its utilization in cattle diets should be limited. Mudgal *et al.* (2010) suggested that since soybean straw is superior in nitrogen content compared to wheat straw, it can be replaced with wheat straw in diet of lactating cows.

Utilization of the straws in a feeding program depends on its nutritive value. 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

Corresponding Author: Naser Maheri-Sis, Department of Animal Science, Shabestar Branch, Islamic Azad University, Shabestar, Iran

Fig. 1: Soybean straw (Adopted from Sruamsiri and Silman, 2008)

Fig. 2: Soybean pod husk (Adopted from Sruamsiri and Silman, 2008)

Fig. 3: Soybean stems (Adopted from Sruamsiri and Silman, 2008)

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). Bruno-Soares *et al.* (2000) suggested that degradation characteristics of straws in the rumen will provide a useful basis for the evaluation of their nutritive value. However, the available information on the nutritive value of legume straws is scarcer. Information about nutritive value of soybean straw also is lesser than other legume straws.

The aim of this experiment was to determine the nutritive value of Soybean Straw (SBS) including chemical composition and ruminal Dry Matter (DM), Organic Matter (OM) and Crude Protein (CP) degradability using nylon bags (*in situ*) technique.

MATERIALS AND METHODS

Sample collection and chemical analysis: Soybean Straw (SBS) samples were collected from four soybean grain threshing farms in Dasht-e-Moghan, Ardebil province, Iran at summer 2010. Collected samples were pooled and ground for chemical and *in situ* procedures. Dry Matter (DM) was determined by drying the samples at 105°C overnight and ash by igniting the samples in muffle furnace at 525°C for 8 h. Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990). Crude Protein (CP) was calculated as N*6.25. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were determined by procedures outlined by Goering and Van Soest (1970) with modifications described by Van Soest *et al.* (1991); sulfite was omitted from NDF analysis.

***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, 48 and 72 h. After the removal of bags from the rumen, bags were washed in cold water until rinse were clear and dried at 60°C for 48 h (Karsli and Russell, 2002). Then rumen degradation kinetics of DM, OM and CP 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.
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 DM in SBS 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 per hour (Bhargava and Ørskov, 1987) so that the results could be extrapolated to other ruminants that differ in rumen capacity.

RESULTS AND DISCUSSION

As shown in Table 1, chemical composition for DM, CP, EE, OM, NDF, ADF and ADL of SBS were 89.18, 5.10, 2.85, 96.90, 80.80, 63.20 and 13.00%, respectively. The CP content of SBS was higher than those reported by Gupta *et al*. (1973) and Sruamsiri and Silman (2008) and in line with Gupta *et al*. (1978). The NDF and ADF contents were higher than those obtained by Sruamsiri and Silman (2008) and in agreement with Gupta *et al*. (1973) and Gupta *et al*. (1978). Lignin content in current study was lower than findings of Gupta *et al*. (1973) and Gupta *et al*. (1978). The wide range of variation in chemical composition of SBS can be due to different varieties and growing conditions (geographic, seasonal variations, climatic conditions and soil characteristics), impurities, maturity stage and proportion of pods to stems. Pods to stems ratio in turn can be varied by varieties, growing conditions and maturity at harvesting time. Higher pods to stems ratio resulted in higher CP and Lower NDF, ADF and ADL content (Gupta *et al*., 1973; Gupta *et al*., 1978; Sruamsiri and Silman, 2008). Different chemical composition leads to different nutritive value, because chemical composition is one of the most important indices of nutritive value of feeds (Maheri-Sis *et al*., 2008; Aghajanzadeh-Golshani *et al*., 2010).

Ruminal DM, OM and CP degradation of SBS at different incubation times were shown in Table 2. As shown in the Table increasing incubation time lead to increase in degradability of nutrients. Time dependent degradation pattern for DM and OM of SBS was similar but degradability of CP considerably was higher than that of DM and OM. The zero hours incubation time degradability (as index of solubility) for CP was approximately four times greater than DM and OM, which is in turn can be indicated that there is variable amount of Non Protein Nitrogen (NPN) in SBS. Sruamsiri and Silman (2008) reported that 24 h and 48 h *in vitro* digestibility of soybean stem were 4.76 and 6.14% and for soybean pod husk were 27.03 and 45.07%, respectively. It is concluded that higher stems proportion decrease SBS degradability in digestive system of ruminants.

Ruminal degradation parameters and effective degradability of soybean straw were presented in Table 3. As illustrated in the Table 3, SBS have a very low immediately degradable fraction (a) especially in case of DM and OM. Solubility of CP (5.80%) in SBS was higher that of DM (0.47%) and OM (0.57). Potential degradability (a + b) of CP (68.07%) also was higher than that of DM (36.97%) and OM (37.74%). Effective degradability of SBS did decreased by increasing out flow rate. Higher effective degradability obtained for CP. In case of maintenance level feeding (Out flow rate 0.02 h^{-1}) effective degradability of DM, OM and CP were 21.40, 22.27 and 48.30%, respectively.

Digestibility experiment of Gupta *et al*. (1973) based on lignin ratio technique, showed that DM and CP digestibility of ungrounded SBS (35.9 and 49.7%) was

Table 1: Chemical composition of soybean straw (%)

DM	CP	EE	OM	NDF	ADF	ADL
89.18	5.10	2.85	96.90	80.80	63.20	13.00

DM: Dry Matter, CP: Crude Protein, EE: Ether Extract, OM: Organic Matter, ADF: Acid Detergent Fiber, NDF: Neutral Detergent Fiber and ADL: Acid Detergent Lignin

Table 2: Ruminal degradation (%) of soybean straw at different incubation times

Incubation time (h)	DM	OM	CP
0	1.10	1.10	4.90
2	2.10	2.40	11.80
4	3.30	3.67	16.60
8	7.90	8.57	24.20
16	12.40	12.93	33.00
24	19.70	20.60	49.53
48	25.60	26.67	59.16
72	32.30	33.37	65.42

DM = Dry Matter, OM = Organic Matter, CP = Crude Protein

Table 3: Ruminal degradation parameters and effective degradability of soybean straw

Items	DM	OM	CP
a (%)	0.470	0.570	5.800
b (%)	36.500	37.170	62.270
a + b (%)	36.970	37.740	68.070
c (h^{-1})	0.027	0.028	0.043
Lag time (h)	0.700	0.500	0.000
ED (%) Out flow rate 0.02 h^{-1}	21.400	22.270	48.300
ED (%) Out flow rate 0.05 h^{-1}	13.270	13.900	34.600
ED (%) Out flow rate 0.08 h^{-1}	9.660	10.200	27.600

a: Washout fraction as measured by washing loss from nylon bags; b: Potentially degradable fraction; c: Rate of degradation of fraction b (h^{-1}); ED: Effective Degradability, DM = Dry Matter, OM = Organic Matter, CP = Crude Protein

lower than grounded form (44.4 and 51.2%). Gupta *et al.* (1978) indicated that DM and CP digestibility of SBS were in range of 42.9-49.80% and 56.9-62.3%, respectively. They are concluded that wide range of variation in nutrients digestibility of SBS may be due to variation in pod to stems ration as well as varieties and maturity stage of harvested soybeans. These studies support our finding that digestibility of CP was greater than that of DM in SBS. Sruamsiri and Silman (2008) reported that total tract apparent digestibility of soybean pod husk was 53.81, 59.69 and 42.385 for DM, OM and CP, respectively. Low degradability of SBS indicated that this by-product can not support rumen microorganism's growth due to lower soluble carbohydrates as available energy source. Variable results from different studies may be caused by different chemical composition, leaves and pod to stems proportion, method of feedstuffs evaluation, varieties, maturity and impurities.

Conclusion: Results of current study indicated that soybean straw soluble fraction was very low as well as other ruminal degradation parameters. However its protein content and degradability is in acceptable range. It can be suggest that in further studies soybean straw should be treated by different methods especially for preparing fermentable energy source (such as molasses) in order to improve nutritive value and dry matter intake. It seems that soybean straw without any treatment only can be included in low levels in ruminant's diets.

ACKNOWLEDGMENT

This article adopted from M.Sc. thesis in animal science, Shabestar Branch, Islamic Azad University. We would like to acknowledge Mr. Ali Noshadi for their assistance. Authors thanks from Animal Research Centre of Islamic Azad University, Shabestar Branch, Iran.

REFERENCES

Aghajanzadeh-Golshani, A., N. Maheri-Sis, A. Mirzaei-Aghsaghali and A.R. Baradaran-Hasanzadeh, 2010. Comparison of nutritional value of tomato pomace and brewers grain for ruminants using *in vitro* gas production technique. Asian J. Anim. Vet. Adv., 5: 43-51.

Abreu, J.M.F. and A.M. Bruno-Soares, 1998. Characterization and utilization of rice legume and rape straw. Options Mediterraneennes - Serie B, 17: 39-51.

AOAC, 1990. Official Method of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA., pp: 66-88.

Bhargava, P.K. and E.R. Ørskov, 1987. Manual for the use of nylon bag technique in the evaluation of feedstuffs. Rowett Research Institute, Aberdeen, Scotland, UK.

Bruno-Soares, A.M., J.M.F. Abreu, C.V.M. Guedes and A.A. Dias-da-Silva, 2000. Chemical composition, DM and NDF degradation kinetics in rumen of seven legume straws. Anim. Feed Sci. Technol., 83: 75-80.

Chumpawadee, S., C. Anut and C. Piyanate, 2007. Chemical compositions and nutritional evaluation of energy feeds for ruminant using *in vitro* gas production technique. Pak. J. Nutr., 6: 607-612.

Goering, H.K. and P.J. Van Soest, 1970. Forage fibre analysis (Apparatus, Reagents, Procedures and Some applications). Agricultural Handbook 379. Agricultural Research Services, USDA, Washington, DC.

Gupta, B.S., D.E. Johnson and F.C. Hinds, 1978. Soybean straw intake and nutrient digestibility by sheep. J. Anim. Sci., 46: 1086-1090.

Gupta, B.S., D.E. Johnson, F.C. Hinds and H.C. Minor, 1973. Forage potential of soybean straw. Agron. J., 65: 538-541.

Karsli, M.A. and J.R. Russell, 2002. Prediction of the voluntary intake and digestibility of forage-based diets from chemical composition and ruminal degradation characteristics. Turk. J. Vet. Anim. Sci., 26: 249-255.

Maheri-Sis, N., M. Chamani, A.A. Sadeghi, A. Mirza-Aghazadeh and A. Aghajanzadeh-Golshani, 2008. Nutritional evaluation of kabuli and desi type chickpeas (*Cicer arietinum* L.) for ruminants using *in vitro* gas production technique. Afr. J. Biotechnol., 7: 2946-2951.

Ministry of Jihad-e-Agriculture, 2009. Statistics book of animal and agricultural products. Ministry of Jihad-e-Agriculture, Iran. 114 pages (in Persian). ISBN: 978-964-467-042.

Mudgal, V., R.P.S. Baghel and S. Srivastava, 2010. Effect of feeding soybean straw on intake and milk production of lactating crossbred cows. J. Hortic. Lett., 1: 06-07.

Ørskov, E.R., F.D. DeB Hovell and F. Mould, 1980. The use of the nylon bag technique for the evaluation of feedstuffs. Trop. Anim. Prod., 5: 195-213.

Ørskov, E.R. and I. McDonald, 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agric. Sci., 92: 499-503.

Saskatchewan Ministry of Agriculture, 2008. Straw, a roughage source for ruminants. Production Fact Sheet, Saskatchewan ministry of agriculture. http://www.agriculture.gov.sk.ca/Default.aspx?DN=13d85902-ba4c-4170-a2c0-7f4486ea031d.

Sruamsiri, S. and P. Silman, 2008. Nutritive composition of soybean by-products and nutrient digestibility of soybean pod husk. Mj. Int. J. Sci. Tech., 2: 568-576.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.