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Determination of dry matter and crude protein degradation of gamma-irradiated soybean meal

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Key words: Soybean meal, gamma-irradiation and nylon bags.

Abstract

In order to determine of nutritive value of soybean meal treated with gamma-irradiation using in situ technique, this study was carried out. In this study three fistulated wetheres (47.5±2.75 kg) were used in *in situ* method. Ruminal DM and CP disappearances were measured 0, 4, 6, 8, 12, 16, 24, 36, 48, 72 and 96 h. Dry matter degradability of untreated soybean meal at 96h was 75.57% that was higher than soybean meal treated with gamma-irradiation and there were significant differences (P<0.05). Crude Protein degradability of untreated soybean meal at 0h was 9.56% that was higher than soybean meal treated with gamma-irradiation and there were significant differences (P<0.05).

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Introduction

Feeds when ingested by ruminant animals are subjected to microbial degradation in the rumen. The end products of the degradation process, i.e. ammonia, amino acids, peptides and volatile fatty acids, are utilized for the synthesis of microbial biomass. The feed escaping rumen degradation, endogenous protein and the microbial biomass entering the duodenum are used to supply energy and protein for the ruminant tissues. Therefore, the nutritional value of a feed depends on its nutrient contents, the extent of rumen degradation and the digestibility of undegraded feed components, especially protein, passing to the small intestine (Ruba and Chaudhry, 2008). The inadequacies of feeding ruminants based simply on quantity alone has long been recognized. Manipulating the degree to which specific nutrients are made available to ruminal microorganisms and the amount that escapes ruminal fermentation has elicited animal performance response (Nocek, 1988). Highly productive ruminants have a low efficiency in protein utilization because of high ruminal losses, mainly as ammonia, due to excessive protein degradation by ruminal microorganisms. Most protein concentrates are extensively degraded. Consequently, developing protection methods against ruminal protein degradation is of great interest. Protein denaturation can slow the actions - of ruminal microorganisms and is a traditional protection method.

Gamma-irradiation has been recognized as a reliable and safe method to improve the nutritive value of foods (Diehl, 2002; Siddhuraju *et al.*, 2002). Recently, treatment of soybean meal and canola meal with gamma-irradiation was successful in reducing degradation of CP by rumen microorganisms and increasing intestinal CP digestibility (Shawrang *et al.*, 2007, 2008). Moreover, gamma-irradiation was effective in reducing phytic acid in broad bean and velvet seed (Al-Kaiesy *et al.*, 2003; Bhat *et al.*, 2007).
Fermentation characteristics of feedstuffs in rumen fluid can be studied using *in vivo*, *in situ* and *in vitro* techniques (Taghizadeh *et al.*, 2008). The Dacron polyester or nylon bag technique has been used widely for estimating ruminal nutrient degradation because it is a relatively simple, low-cost method compared with methods in volving intestinally annulated animal (Marshall *et al.*, 1997). The *in situ* nylon-bag technique is widely used to characterize the disappearance of feeds from the rumen. Nylon-bag technique provides a useful means to estimate rates of disappearance and potential degradability of feedstuffs and feed constituents (Taghizadeh *et al.*, 2008)

The objectives of this study were to determine the nutritive value of soybean meal treated with gamma-irradiation using in situ technique.

Materials and methods

Animals and feeding

Three yearling (Gizil) wethers (47.5±2.75 kg) were used. At least 30d before initiation of the experiment, each wether was surgically fitted with a ruminal cannula. The wethers were housed in tie stalls under controlled environmental conditions with continuous lighting and constant temperature (24 to 26°C). All whether were fed a diet containing of 60% hay and 40% concentrate (NRC, 1989).

Sample collection

Soybean meal samples were collected from at least 10 different areas of mass. All 10 samples were thoroughly mixed, and a composite sample (100g) was taken. All samples were dried in an oven at 100°C until a constant weight was achieved. Samples were then ground to pass thought a 2-mm screen in Wiley mill (model 4, Arthur H. Thomas Co., Philadelphia, PA).

Treating with gamma radiation

Before doing this process, the moisture content of the sample was given orally to 25%. Then samples were irradiated at room temperature and atmospheric air, with doses of 0, 25, 50 and 75 kGy in Iranian Atomic Energy Organization's Nuclear Research Center for Agriculture and Medicine. Radiation was conducted with an average rate of 0.36 Gy per seconds, using in vitro irradiation system model PX-30. In this

radiation system, cobalt-60 is used as the source of gamma radiation.

Table 1. In situ DM disappearance (% of DM).

Soybean meal	Incubation time (h)							
	0	8	16	24	36	48	72	96
Untreated	29.31[a]	49.51[a]	60.94[a]	64.51[a]	68.80[a]	71.70[a]	73.56[a]	75.57[a]
25 kGy	28.25[a]	48.62[ab]	60.11[ab]	64.28[a]	67.69[a]	70.14[b]	72.03[b]	73.99[b]
50 kGy	26.70[b]	47.78[bc]	58.73[b]	62.84[b]	66.18[b]	69.62[b]	71.36[b]	72.71[c]
75 kGy	25.18[c]	47.02[c]	57.06[c]	60.94[c]	64.96[b]	68.49[c]	70.35[c]	71.97[c]
SEM	0.3215	0.3542	0.3735	0.3245	0.3292	0.2671	0.2528	0.2355

[a,b,c]: Means within a column with different subscripts differ ($p<0.05$).

Table 2. In situ CP disappearance (% of DM).

Soybean meal	Incubation time (h)							
	0	8	16	24	36	48	72	96
Untreated	9.37a	34.40a	46.63a	49.27a	55.46a	56.93a	60.03a	61.98a
25 kGy	7.83b	33.03b	45.39b	49.32a	53.15b	55.89b	58.78b	60.90b
50 kGy	7.05c	32.26c	43.92c	47.74b	51.55c	54.59b	57.02c	59.54c
75 kGy	5.76d	30.00d	41.76d	45.41c	49.60d	53.49d	55.80d	57.77d
SEM	0.1736	0.2391	0.2768	0.2092	0.1892	0.2082	0.1668	0.2826

[a,b,c]: Means within a column with different subscripts differ ($p<0.05$).

In situ degradation

In situ methods procedures was determined using Nocek (1988), the ground samples (5g) were placed in Dacron bags (5.5×10 cm;47-µm pore size) and were sealed with waterproof glue. Each feed sample was incubated in 6 replicates (2 replicates for each whether) in the rumen. Nylon bags were suspended in the rumen in a polyester mesh bag (25×40 cm;3mm pore size) and were removed from the rumen at the same time so that all bags could be washed simultaneously. The nylon bags were then removed from the mesh bag and washing until the rinse water remained clear. Samples were then dried in an oven at 55˚C until a constant weight was achieved before determination of DM and CP disappearance. The DM and CP degradation data was fitted to the exponential equation $P = a+b(1 - e^{-ct})$ (Ørskov and Mc Donald, 1979), where P: is the disappearance of nutrients during time t, a: the soluble nutrients fraction which is rapidly washed out of the bags and assumed to be completely degradable, b: the proportion of insoluble nutrients which is potentially degradable by microorganisms, c: is the degradation rate of fraction b per hour and t is time of incubation.

Calculations and statistical analysis

Data were analyzed as a completely randomized design using a general linear model (GLM) procedure of SAS (1999), with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered.

Results and discussion

In situ ruminal degradability

The degradability parameters of DM and CP are shown in Table 1 and 2. According to the reported results, untreated soybean meal showed high ruminal DM disappearance in all of the incubation times there were significant differences ($P < 0.05$). At the 0h of ruminal incubation, the untreated soybean meal (29.31%) and treated with 75 kGy (25.18%) showed higher and lower ruminal DM disappearance respectively, and there were significant differences ($P < 0.05$). According to the reported results, untreated

soybean meal showed high ruminal CP disappearance in all of the incubation times there were significant differences ($P < 0.05$). The use of gamma radiation and electrons in order to improve the nutritional value of food, based on increases digestibility and with change the site of digestion reviewed by Taghinezhad *et al.*, (2009). Levels above 10 kGy of irradiation can disable the anti nutritional compounds such as tannins, gossypol, protease inhibitors, lectins, phytic acid, non-starch polysaccharides and oligosaccharides, without changing the nutritional quality of food. Ion beams constitute form of gel for proteins, with creation crosslink with proteins bind together (Lee *et al.*, 2005). Ties caused to resistant microbes and enzymes, enzyme digestion and reducing microbial access to substrate and thereby increasing the rumen bypass protein in the intestine.

Conclusion

According to the study, soybean meal can be processed by gamma irradiation, to protect the protein in it and increase the bypass protein.

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