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RUMINAL DEGRADATION CHARACTERISTICS OF LENTIL BY-PRODUCTS

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Mercimek yan ürünlerinin rumende yıkılabilme özellikleri

Özet: *Çeşitli mercimek yan ürünlerinde (yemlik mercimek, iyi kaliteli mercimek kepeği, kötü kaliteli mercimek kepeği), kuru madde (KM), organik madde (OM), azot (N), nötral deterjan fiber (NDF) ve asit deterjan fiber (ADF)'in rumende yıkılabilirlikleri in situ naylon torba tekniği ile belirlendi.*

Araştırmada rumen kanülü takılmış, ortalama 40 kg ağırlığında olan 3 baş Ankara keçi tekesi kullanıldı. Hayvanlar iyi kaliteli kıyılmış kuru çayır otu ile beslendiler.

Yemlik mercimekte KM, OM, NDF ve ADF'nin yıkılabilirliği, diğer mercimek yan ürünlerinden daha yüksek bulundu. Yemlik mercimek, iyi ve kötü kaliteli mercimek kepeği kuru maddesinin rumende maksimum potansiyel yıkılabilen değerleri sırasıyla % 87.58, 67.55 ve 51.85 olarak belirlendi.

Mercimek yan ürünlerinin, özellikle yemlik mercimeğin, rumende çözünebilen ve yıkılabilen azotun fazla miktarda olduğu gözlendi. Bu durum, mercimek yan ürünlerinin, rumen fonksiyonu için çözünebilen ve yıkılabilen azot sağlayarak düşük düzeyde azot kapsayan kaba yemleri tamamlayıcı olarak kullanılabileceğini göstermektedir.

Anahtar kelimeler: Mercimek yan ürünleri, in situ yıkılabilirlik, naylon torba tekniği, Ankara keçisi

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Summary: *Rumen degradability of dry matter (DM), organic matter (OM), nitrogen (N), neutral detergent fibre (NDF) and acid detergent fibre (ADF) in various lentil by-products (feed grade lentil, good quality lentil bran, poor quality lentil bran) was estimated by in situ nylon bag technique.*

Three ruminally cannulated Angora bucks weighing about 40 kg were used. They were fed a good quality chopped grass hay.

The maximum potential degradability of DM, OM, N, NDF and ADF was higher in feed grade lentil than others. The rumen potential degradation values of DM in feed grade lentil, good and poor quality lentil bran was 87.58, 67.55 and 51.85 %, respectively.

It is found that lentil by-products, especially feed grade lentil, had a greater amount of ruminally soluble and degradable N. It suggests that lentil by-products may complement low N concentration roughages by providing soluble and degradable N for rumen function.

Key words : Lentil by-products, in situ degradability, nylon bag technique, Angora buck

Introduction

The nylon-bag technique proposed by ørskov and McDonald (9) for assessing the rumen degradability of nitrogen (N) in ruminant feeds has been widely used for evaluating mixed feeds(12), forages (6), grains and grain mixtures (5) and various protein rich sources (3, 10). This method can also be applied to study the ruminal degradation of dry matter (DM), organic matter (OM) and fibre fractions (7, 11).

After processing lentil, 12–15 % of by-products are obtained. Nutrient content of by-products changes according to their hull content.

In developing countries, the majority of animals are maintained solely on low quality roughages over prolonged periods. Based on the observations of Negi et al.(6), the rumen degradable nitrogen available to a 400 kg cow consuming 5 kg of wheat or rice straw or grass hay would be of the order of 14.1, 11.8 and 9.8 g, respectively. The organic matter in wheat straw, rice straw and grass hay was 89, 82 and 92 % of DM and OM degraded in the rumen would be 0.97, 1.43 and 1.03 kg, suggesting a potential for microbial nitrogen yield of 29.1, 42.9 and 30.9 g, respectively (6). When the available rumen

degradable nitrogen is lower than the potential for conversion to microbial nitrogen, protein supplementation is required to improve the utilization of these roughages.

At present no published information about the degradability of nutrients of lentil by-products in the rumen of Angora goats or other ruminants is available. Such information may be used for computing a balanced ration. Therefore the aim of this experiment was to measure the rumen degradability of dry matter, organic matter, nitrogen, neutral-detergent fibre (NDF) and acid-detergent fibre (ADF) in three types of lentil by-products.

Material and Methods

Feeds: Three types of lentil by-products were studied: feed grade lentil, good quality lentil bran and poor quality lentil bran.

Chemical analyses: Proximate analyses were performed according to the Association of Official Analytical Chemists (1). The samples were also analysed for NDF (4) and ADF (13).

In situ degradability: In situ degradability of each lentil by-products was measured using the nylon bag technique of Ørskov and McDonald(9). Three mature Angora bucks weighing about 40 kg were used. The animals were fitted with permanent rumen cannulae. The animals were housed in individual pens and water was freely available. They were fed a good quality chopped hay (11.20 % crude protein, 8.6 MJ metabolic energy / kg) ad libitum.

Nylon bags were of the type described by Ørskov, Hovell and Mould(8). Nylon bags (90x140 mm) with a pore size of 20-40μm were used. The sample size was approximately 5 g and the material was ground through a laboratory mill with a 3 mm screen. The samples were incubated in the rumen of each of three Angora bucks, with incubation periods of 4, 8, 16, 24, 48, 72 and 96 h. On withdrawal from the rumen, bags were vigorously shaken in a bucket of cold water. Then the bags with contents rinsed under running water until the wash water is clear. The bag material was cleaned by rubbing between the finger and thumb. They were then dried to a constant weight at 65°C for 48 h, allowed to air-equilibrate and then weighed. The solubility or washing loss was determined by soaking samples of each material in water at 37-39°C for 1 h followed by the washing procedure above. Each measurement was carried out in dublicate.

The DM, OM, N, NDF and ADF contents were determined in both incubated material and residues (1, 4, 13).

Calculation of degradability characteristics of DM, OM, N, NDF and ADF: The DM degradability was calculated after correcting both incubated feeds and residues for residual moisture.

The degradability data obtained from Angora bucks for DM, OM, N, NDF and ADF were interpolated with the first-order model of (9):

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

where: p is the actual degradation after time t, a is the rapidly soluble or degradable fraction, b is the potentially degradable (fermentable) fraction, c is the constant rate of degradation of b, t is the time of degradation.

Effective degradability of DM, OM, N, NDF and ADF was calculated according to the equation of (9):

$$p_e = a + (bc)/(c + k)$$

where: p_e is the effective degradation, k is the fractional ruminal outflow rate, and a, b and c are as defined above. A hypothetical fractional ruminal outflow rate of 0.05 per h was used for estimation of effective degradability (2).

Results

The chemical composition of the lentil by-products are shown in Table 1. The rumen degradability characteristics and effective degradabilities of DM, OM, N, NDF and ADF are given in Table 2 and 3. As seen in Table 1, feed grade lentil was high in crude protein and poor quality lentil bran had high amounts of crude fibre due to the high content of bran.

Table 1. The chemical composition of lentil by-products, % (on a dry matter basis)
Tablo 1. Mercimek yan ürünlerinin kimyasal bileşimi, % (kuru maddede)

Nutrient	Feed grade lentil	Good quality lentil bran	Poor quality lentil bran
Dry matter	90.36	91.07	90.10
Organic matter	95.84	94.42	95.62
Crude protein	24.35	18.27	15.02
Ether extract	1.72	0.58	1.09
Crude fibre	19.36	24.80	32.19
Nitrogen free extract	50.41	50.77	47.32
Neutral detergent fibre	49.66	48.64	60.60
Acid detergent fibre	31.88	36.43	48.06

The percentage disappearance of lentil by-products form nylon bags incubated in the rumen for DM, OM, N, NDE and ADF is shown in Figure 1, 2 and 3.

Table 2. The rumen degradability characteristics and effective degradabilities of dry matter, organic matter and nitrogen*

Tablo 2. Kuru madde, organik madde ve azotun rumende yıkılabilme özellikleri ve etkin yıkılabilirlikleri*

	Washing loss (%)	a (%)	b (%)	c (fraction per h)	a+b (%)	Residual s.d. (%)	P_e (%)
Dry matter							
Feed grade lentil	24.28	32.47	55.11	0.0211	87.58	2.60	48.8
Good quality lentil bran	24.73	40.08	27.47	0.0183	67.55	1.80	47.5
Poor quality lentil bran	17.20	17.42	34.43	0.0292	51.85	0.95	30.1
Organic matter							
Feed grade lentil	24.00	31.44	55.66	0.0217	87.10	2.87	48.3
Good quality lentil bran	23.99	39.88	29.44	0.0165	69.32	1.93	47.2
Poor quality lentil bran	17.02	16.30	34.81	0.0304	51.11	0.92	29.5
Nitrogen							
Feed grade lentil	30.80	35.58	53.06	0.0555	88.64	3.21	63.5
Good quality lentil bran	31.61	55.48	30.60	0.0127	86.08	1.93	61.7
Poor quality lentil bran	20.30	27.51	39.52	0.0353	67.03	1.57	43.9

*: a, b, c are constants in the equation of $p = a + b\ (1-e^{-ct})$
a+b is the maximum potential degradability (asymptote, total potential)
P_e is the effective degradability, $p_e = a + (bc)/(c+k)$. $(k = 0.05/h)$.

Table 3. The rumen degradability characteristics and effective degradabilities of neutral detergent fibre and acid detergent fibre*

Tablo 3. Nötral deterjan fiber ve asit deterjan fiberin rumende yıkılabilme özellikleri ve etkin yıkılabilirlikleri*

	Washing loss (%)	a (%)	b (%)	c (fraction per h)	a+b (%)	Residual s.d. (%)	P_e (%)
Neutral detergent fibre							
Feed grade lentil	11.23	9.69	73.25	0.0181	82.94	3.52	29.2
Good quality lentil bran	21.22	20.94	31.41	0.0127	52.35	1.58	27.3
Poor quality lentil bran	4.42	2.43	31.95	0.0372	34.38	1.86	16.1
Acid detergent fibre							
Feed grade lentil	8.81	6.72	74.94	0.0100	81.66	1.68	19.2
Good quality lentil bran	7.89	8.20	26.14	0.0155	34.34	1.52	14.4
Poor quality lentil bran	3.00	-0.24	26.74	0.0354	26.50	1.65	10.8

*: a, b, c are constants in the equation of $p = a + b\ (1-e^{-ct})$
a+b is the maximum potential degradability (asymptote, total potential)
p_e is the effective degradability, $p_e = a + (bc)/(c+k)$, $(k = 0.05/h)$.

Discussion

The equation $p = a + b\ (1-e^{-ct})$ fitted the data well since the residual standard deviation mostly was proportionately less than 3.52 (Table 2 and 3).

There were large differences in washing loss and degradation characteristics between lentil by-products.

Dry matter disappearance from bags not inserted into the rumen (washing loss) was 24.28 % for feed grade lentil, 24.73 % for good quality lentil bran and 17.20 % for poor quality lentil bran.

Good quality lentil bran had higher soluble fraction of DM, OM, N and NDF than that of others. These constituents from good quality lentil bran was more slowly digested into dispersible constituents, as indicated by smaller b fractions and their much slower rate of degradation and as shown in Fig. 1, 2 and 3.

Poor quality lentil bran had a lower ruminal degradation of DM, OM, N, NDF and ADF than did feed grade lentil and good quality lentil bran. Feed grade lentil had a lower ruminal degradation of DM, OM, N, NDF and ADF up to 16 h incubation than did good quality lentil bran. But after 16 h, the degradation increased higher than that of good quality lentil bran (Fig. 1-3).

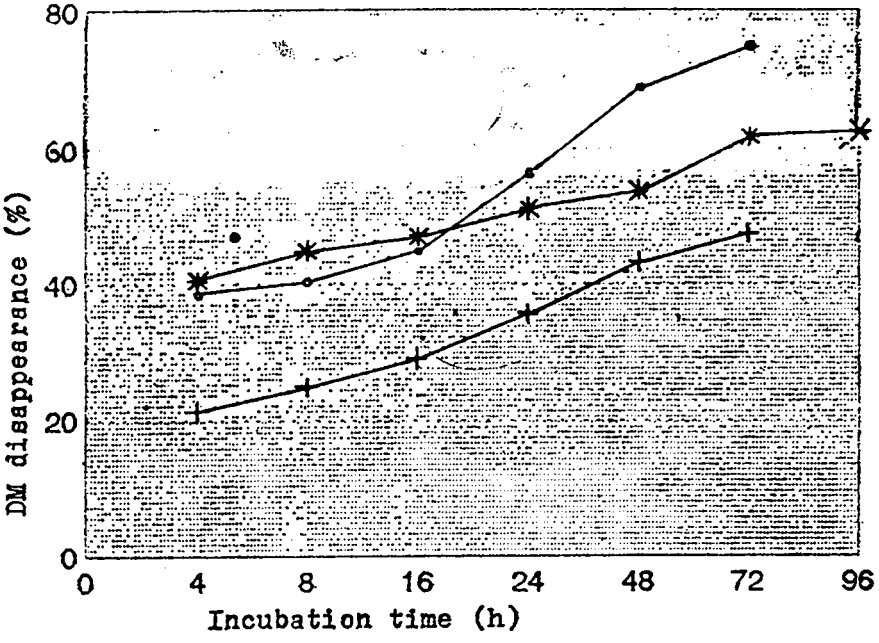

Fig. 1. Dry matter disappearance of lentil by-products incubated in situ (observed values) —o—: feed grade lentil, *: good quality lentil bran, + : poor quality lentil bran

Şekil 1. Mercimek yan ürünlerinin in situ kuru madde yıkılabilirlikleri (bulunan değerler). -o- yemlik mercimek,*: iyi kaliteli mercimek kepeği, + : kötü kaliteli mercimek kepeği

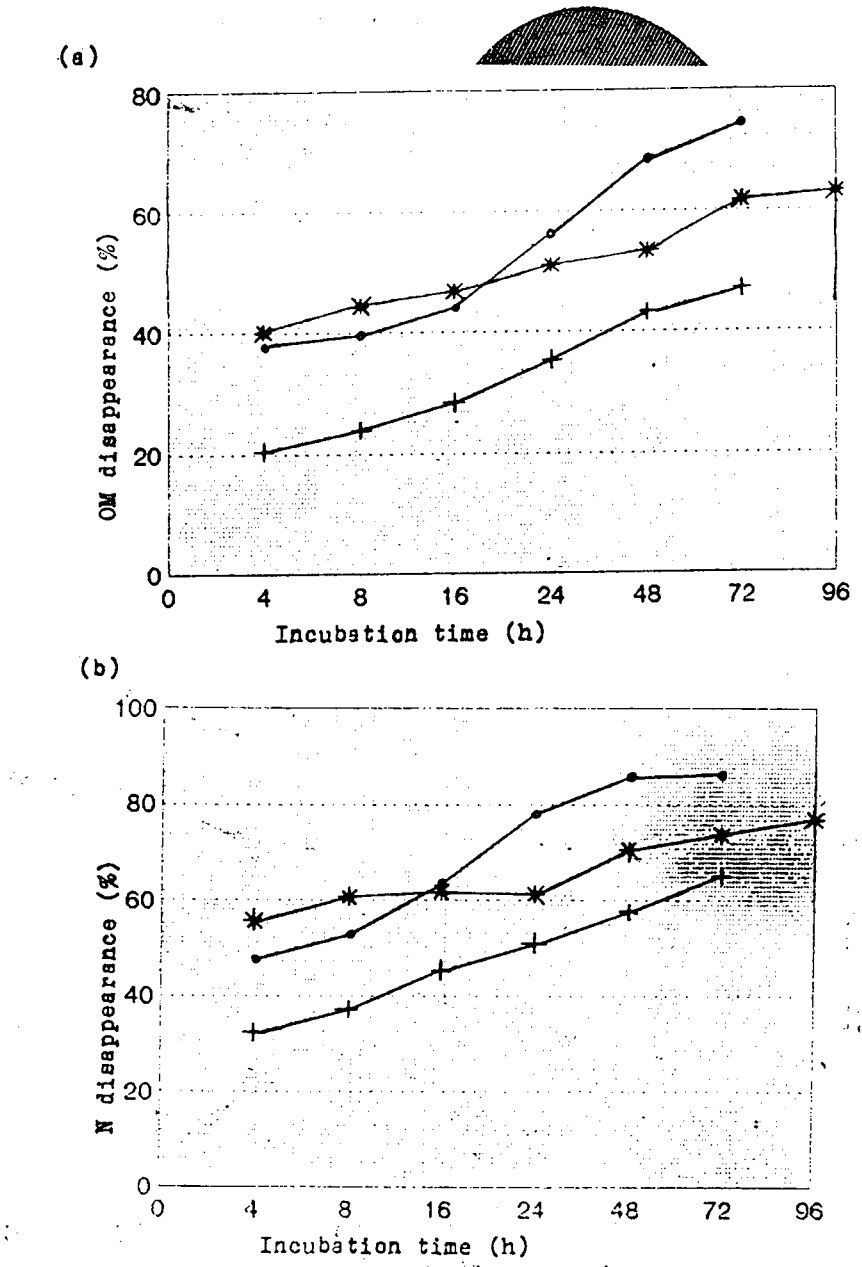

Fig. 2. The percentage disappearance of lentil by-products from nylon bags incubated in the rumen (observed values) for organic matter (a), nitrogen (b)
—o—: feed grade lentil, *: good quality lentil bran, + : poor quality lentil bran
Şekil 2. Mercimek yan ürünlerindeki organik madde (a) ve azotun (b) rumende naylon torba ile belirlenen yüzde yıkılabilirlik değerleri (bulunan değerler). -o-: yemlik mercimek, *: iyi kaliteli mercimek kepeği, + : kötü kaliteli mercimek kepeği

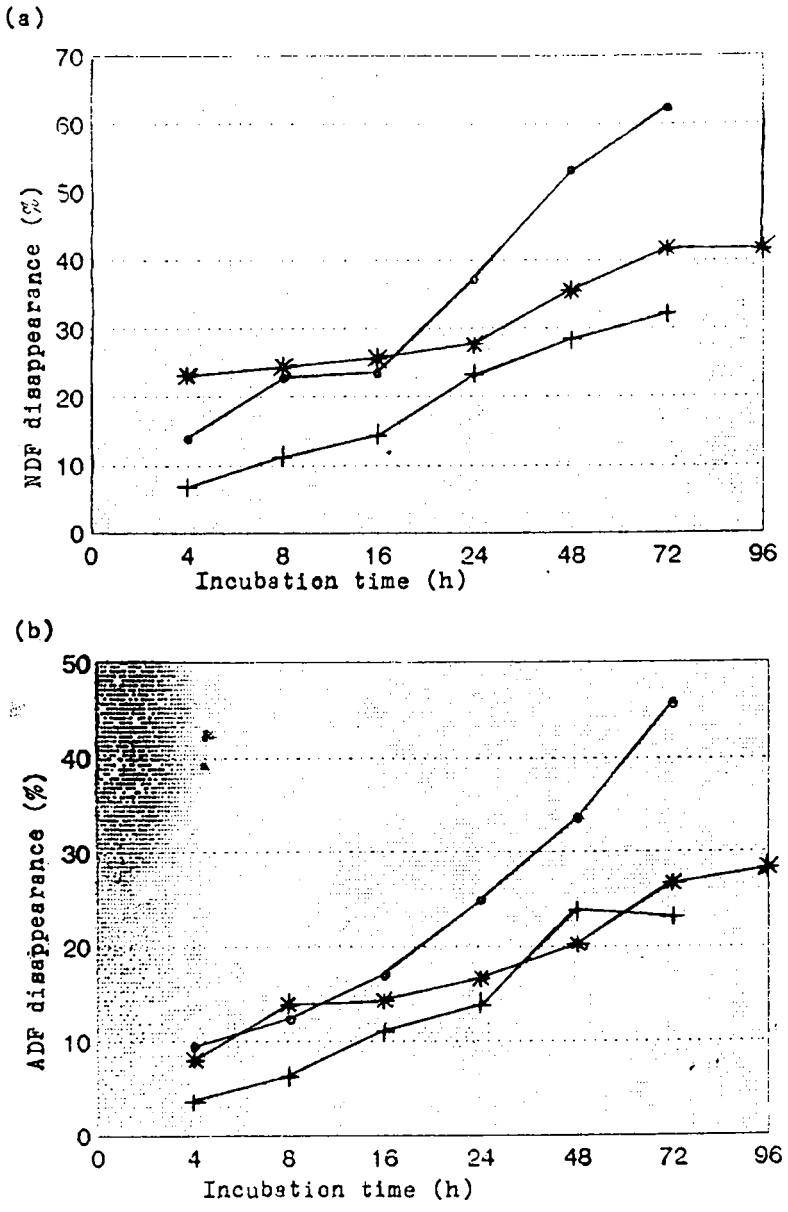

Fig. 3. The percentage disappearance of lentil by-products from nylon bags incubated in the rumen (observed values) for neutral detergent fibre (a), acid detergent fibre (b) —o—:feed grade lentil, *: good quality lentil bran, + : poor quality lentil bran

Şekil 3. Mercimek yan ürünlerindeki nötral deterjan fiber (a) ve asit deterjan fiberin (b) rumende naylon torba ile belirlenen yüzde yıkılabilirlik değerleri (bulunan değerler). -o- : yemlik mercimek, *: iyi kaliteli mercimek kepeği, + : kötü kaliteli mercimek kepeği

The rumen maximum potential degradation values of feed grade lentil, good quality lentil bran and poor quality lentil bran were 87.58, 67.55 and 51.85 % for DM, 87.10, 69.32 and 51.11 % for OM, respectively. The effective degradabilities of DM in these lentil by -products at the assumed rumen outflow rate of 0.05/h were 48.8, 47.5 and 30.1 %, respectively. Apparently as a ruminant feed, feed grade lentil and good quality lentil bran had higher potential than other.

The maximum potential degradability of N in feed grade lentil, good quality lentil bran and poor quality lentil bran was 88.64, 86.08 and 67.03 %, respectively. The rate constants for the degradation of N in good quality lentil bran was 64-77 % lower than poor quality lentil bran and feed grade lentil. The effective degradability of N at a rumen outflow rate of 0.05/h in feed grade lentil, good quality lentil bran and poor quality lentil bran was 63.5, 61.7 and 43.9 %, respectively. It followed that the lentil by -- products contained a significant soluble and degradable nitrogen to contribute to the requirement of rumen microorganisms.

The maximum potential degradability of NDF in feed grade lentil, good quality lentil bran and poor quality lentil bran, was found to be 82.94, 52.35 and 34.38 %, respectively. It was found that curves of NDF disappearance for lentil by - products was closely parallel to the curves of DM disappearance. Varg and Hoover (14) reported that curves of DM and NDF disappearance paralleled each other after approximately 4 h in situ for grains and forages.

The maximum potential degradability of ADF in feed grade lentil, good quality lentil bran and poor quality lentil bran was 81.66, 34.34 and 26.98 %, respectively.

Data obtained in this experiment indicate that the potential degradability of DM, OM, N, NDF and ADF was higher in feed grade lentil than others.

In Turkey, the majority of animals are maintained mainly on low quality roughages especially cereal straw over prolonged periods. In this case as the available rumen degradable nitrogen from these roughages is much lower than the potential for conversion to microbial nitrogen, the utilization of these low quality roughages is improved by supplementation with lentil by-products.

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