An investigation on determining the nutritive value of oak nuts

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ABSTRACT: This study was conducted to determine the nutritive values of shelled, unshelled oak nuts and their shells. For the estimation of dry matter (DM), organic matter (OM) and crude protein (CP), degradability characteristics, digestibilities, energy values and tannin contents of these feedstuffs the nylon bag technique, cellulose feed system and enzyme methods were used. In spite of the fact that *in situ* dry matter, organic matter and crude protein degradabilities of shelled and unshelled oak nuts were high, the degradabilities of shells were found lower. Degradability characteristics (*a, b, a + b*) and effective degradabilities were high in unshelled and shelled oak nuts and low in shells. The differences between the oak nut shells and the other two groups were significant for DM and OM degradabilities ($P < 0.01$). Pepsin digestible N contents were lower in shelled and unshelled oak nuts and high in shells. Unshelled and shelled oak nuts were significantly different from the oak nut shells for digestibility of DM and OM. Energy values were highest in unshelled oak nuts and lowest in shells. Oak nuts can be used as a forage source in regions with their high natural production.

Keywords: *Quercus pubescens*; degradability; tannin; digestibilities; energy values

One of the most important problems in animal husbandry is that the animals could not be fed adequately. Roughages used in animal nutrition are cheap and also stimulate rumen growth, maintain normal ruminal physiology and provide nutriments. In Turkey roughage production is insufficient and cannot meet the requirements of the animal husbandry sector. Studies stated that only 50% of the roughage requirements could be met (Buyukburc, 1996; Tan and Serin, 1998). Among the reasons of this case are inadequacy of areas allocated to forage production and destruction of ranges and pastures. Furthermore, it is not possible to obtain high quality products in adequate amounts from the areas in which roughages are produced (Comakli *et al*., 2000).

The inadequacy of roughage production urges animal producers (farmers) to seek alternative feed sources. The total area on which oak nuts have been raised is nearly 6.5 million ha in Turkey. Of this area 750 000 ha are groves and the remainder is sink and brushwood. There are 18 oak-nut tree species in Turkey (Ozer and Bul, 1998).

Oak nuts as fruits of the oak tree have been used for a long time, the hulled oak nuts in is mainly which in termy at nitrogen free extract (NFE). It also contains tannin (5–8%) and stric acid. While bitter substances are generally found in hulls, the oak nuts with high bitter substance concentrations may contain these substances in the inner parts of oak nuts. These substances cause constipation.

While the oak nuts are generally suitable for sheep, goat and pig nutrition, they can also be used in ox, horse, rabbit and poultry nutrition (Akyildiz, 1986).

If the outer hulls of dry oak nuts are removed, digestibility of oak nuts increases. Oak nuts can be given with other feeds, in a mixed form to cause the animals to accustom to oak nuts.

Ergul (1997) reported that the high crude fibre content in hulls had a negative role in consumption and digestion processes, and thus the remaining the hulls the increases the nutritive value of oak nuts.

Oak nuts have high levels of carbohydrates, medium levels of crude fibre and low levels of protein. While the main part of carbohydrates is composed of starch, the remaining part is sugar (3–7%) and soluble nutrients (5–8%) (Ergul, 1997).

The nutritive value of oak nuts was reported by Akyildiz (1967, 1986), Bulgurlu (1980), Ergul (1997) (Table 1). In determining the nutritive value of feed it is essential to determine digestibility and energy value in addition to the nutrient content of this feed. The objective of this study is to determine the nutrient content of oak nuts.

MATERIAL AND METHODS

Material

Three 2 years old Karayaka rams weighing nearly 50 kg, fitted with rumen cannulae were used. Rumen cannulated rams were fed grass hay and a concentrate designed to meet the DM requirements during the experiment.

Oak nuts used as a feed were collected from Samsun, Amasya and Sinop. In our study the species *Quercus pubescens* was used as feed material. The oak nuts collected in different areas were allocated to three groups (shelled, unshelled and shell).

In the *in situ* trial, nylon bags (8.0 × 14.5 cm) with the 40μm pore size were used. Sample size/surface area was 12.9 mg/cm^2 in this study. Nylon bags were located in the ventral sac (free movement). In the *in vitro* trial, the enzyme cellulase obtained from the micro-organism *Trichoderma viridea*, hemicellulase from the micro-organism *Aspergillus niger*, α-amylase from the porcine pancreas, and the enzyme pepsin were used.

Method

The *in situ* degradability and degradability characteristics of oak nuts were measured using the nylon bag technique by Orskov and McDonald (1979).

Three bags for each feed in each of the rams were incubated for 2, 4, 8, 16, 24, 48 and 72 hours. Triplicate bags containing about 5 g DM were introduced into the rumen and incubated for 2, 4, 8, 16, 24, 48 and 72 hours. After incubation, bags were rinsed in running tap water to remove adhering digesta and then washed twice in a pool of water (30°C) for 5 min to remove rumen fluid. They were dried at 65°C for 72 hours. In a forced-drought oven, they were allowed to air equilibrate and weighed.

Table 1. Nutritive value of oak nuts (%)

Feed	DM	CP	EE	CF	NFE	Ash	Reference
Fresh fruit	54.4	1.5	2.3	13.5	35.9	0.8	Akyildiz, 1986
Unshelled	44.3	1.3	1.5	4.1	36.8	0.6	
Fresh shelled	60.3	3.5	2.0	6.4	46.8	1.6	Akyildiz, 1967
Fresh unshelled	59.4	3.9	2.0	2.4	49.4	1.7	
Dry shelled	86.9	6.2	3.7	12.6	61.8	2.6	
Fresh unshelled	59.4	3.9	2.0	2.4	49.4	1.7	Bulgurlu, 1980
Fresh shelled	60.3	3.5	2.0	6.4	46.8	1.6	
Dry unshelled	85.3	6.0	4.0	4.4	68.8	0.1	
Dry shelled	86.9	6.2	3.7	12.6	61.8	2.6	
Fresh shelled	62.9	4.1	3.1	8.9	45.3	1.5	Ergul, 1997
Fresh unshelled	59.4	3.9	2.0	2.4	49.4	1.7	
Dry shelled	81.5	7.5	4.0	9.0	59.0	2.0	

DM = dry matter, CP = crude protein, EE = ether extract, CF = crude fibre, NFE = N free extract

After incubation, DM, OM and CP degradabilities for each bag, for each incubation period and for each ram were calculated separately from formulas suggested by Susmel *et al*. (1990):

$$\text{DMD (\%)} = \frac{[(S_1 - T_2) \times \text{DM\%}] - [(S_2 - T_1) \times 100]}{(S_1 - T_2) \times \text{DM\%}} \times 100$$

$$\text{OMD (\%)} = \frac{[(S_1 - T_2) \times \text{OM\%}] - [(S_2 - T_1) \times 100]}{(S_1 - T_2) \times \text{OM\%}} \times 100$$

where: S_1 = sample amount before incubation in nylon bag
S_2 = sample amount after incubation in nylon bag
T_1 = weight of nylon bag (80°C, 24 hours)
T_2 = air dry weight of nylon bag (room temperature, 24 hours)

$$\text{CPD (\%)} = \frac{\text{BICP am.} - \text{AICP am.}}{\text{BICP am.}} \times 100$$

where: BICP am. = CP amount before incubation
AICP am. = CP amount after incubation

Effective DM, OM and CP degradabilities were determined according to McDonald (1981). The degradability data obtained from each ram for OM and CP were interpolated with the non-linear model:

$$P\ (\%) = a + b\ [1 - e^{-(cxt)}]$$

$$\text{ED (\%)} = a + [bc/(c + k)](1 - e^{-(c + k)\ xt})$$

where: P = degradability at time (t)
a = the rapidly soluble fraction (i.e. zero time intercept)
b = the potentially degradable fraction
c = the rate constant of degradation of b and t is the time of rumen incubation
k = the rate of rumen outflow

Effective degradability (ED) was calculated with the estimated for k = 0.04, 0.06 and 0.08.

In vitro digestibility of DM and OM was determining according to Alcicek and Wagener (1995) as follows:

$$\text{DMD (\%)} = \frac{S_1\ (T_1 - \text{To})}{S_1} \times 100$$

$$\text{OMD (\%)} = \frac{(T_1 - T_2)}{(S_1 - A_1)} \times 100$$

where: S_1 = sample amount (as DM)
T_0 = weight of crucible (105°C, 48 hours)
T_1 = dry sample (105°C, 24 hours) + T_0
T_2 = ashed sample (550°C, 4 hours) + T_0
A_1 = crude ash amount of sample, g

Total energy (TE), digestible energy (DE), metabolisable energy (ME), net energy lactation (NEL), net energy fat (NEF) and net energy maintenance (NEM) values were calculated according to the enzyme method (Jarrige, 1989; Malossini et al., 1993). Calculated values were converted to MJ/kg DM.

TE (kcal/kg DM) = 5.99 CP + 6.71 EE + 4.28 CF + 4.73 NFE

DE (kcal/kg DM) = (TEXOMD)/100

ME (kcal/kg DM) = [(86.82–0.0099 CF–0.0196 CP) DE]/100

q = ME/TE

NE_L (kcal/kg DM) = k × ME, (k = 0.60 + 0.24 (q–0.57))

NE_F (kcal/kg DM) = k × ME, (k = 0.78 q + 0.006)

NE_M (kcal/kg DM) = k × ME, (k = 0.287 q + 0.554)

In the pepsin digestion method, triplicate samples of 0.5 g of oak nuts (shelled, unshelled and shells) plus 50 ml of 0.1% pepsin in 0.01 N HCl were placed in 100 ml centrifuge tubes and incubated in a water bath at 40°C for 24 hours. Digestion was stopped by the addition of 10 ml of 10% trichloroacetic acid (TCA). The mixture was squeezed through Whatman 541 paper and washed with 3% TCA (Mir *et al*., 1984) and the N content was estimated by Kjeldahl procedure (AOAC, 1984).

Gallotannin in feeds was determined according to the method proposed by Bate-Smith (1977). Proanthocyanidine was determined according to the method proposed by Bate-Smith (1975) and total phenolic matter was determined according to the method proposed by Gurses and Artik (1987).

Analyses OM, CP, EE, Ash of feeds and residues in the nylon bags were determined according to AOAC (1984), CF was determined by the method of Lepper (Bulgurlu and Ergul, 1978).

Statistical analyses

Data obtained from the *in situ* and pepsin digestion trials were analysed as a randomised plot design. Analysis of variance was performed according to an ANOVA model, using the one-way procedure of the MSTAT-84 package. Differences between means were tested by Duncan's Multiple Comparison Test as detailed by Duzgunes *et al*. (1987).

RESULTS AND DISCUSSION

Chemical composition of the oak nuts (shelled, unshelled and shells) used in the experiment is given in Table 2.

Nitrogen-free extract content in shelled oak nuts and unshelled oak nuts was higher than in oak nut shells. Although the OM, CP, EE, Ash and NFE contents of oak nuts (shelled and unshelled) were similar to those reported by Akyildiz (1986), Bulgurlu (1980) and Ergul (1997), the CF content was lower than that found by Ergul (1997), Bulgurlu (1980) and Akyildiz (1986).

In the oak nut shell all the nutrients were low except crude fibre, and the crude fibre content was high.

Tannin content in oak nuts

Proanthocyanidine, gallotannin and total phenolics contents in oak nuts (shelled, unshelled and shell) are given in Table 3.

As seen in Table 3, proanthocyanidine contents in oak nuts (shelled, unshelled and shell) were 1.084,

Table 2. Chemical composition of oak nuts used in the experiment (%)

Feeds	DM	OM	CP	EE	CF	Ash	NFE
Fresh, unshelled	54.97	53.51	3.56	3.82	1.11	1.46	45.01
Air dry, unshelled	85.32	83.06	5.53	5.94	1.73	2.27	69.86
100% DM	–	97.34	6.48	6.96	2.02	2.66	81.87
Fresh, shell	54.90	53.71	1.98	0.57	21.39	1.18	29.77
Air dry, shell	88.02	86.12	3.17	0.92	34.30	1.89	47.73
100% DM	–	97.84	3.60	1.04	38.96	2.14	54.22
Fresh, shelled	54.68	53.07	3.37	2.71	4.99	1.61	41.99
Air dry, shelled	87.87	85.29	5.41	4.36	8.03	2.58	67.49
100% DM	–	97.06	6.15	4.96	9.13	2.93	76.80

DM = dry matter, OM = organic matter, CP = crude protein, EE = ether extract, CF = crude fibre, NFE = N free extract

Table 3. Proanthocyanidine, gallotannin, total phenolics contents and their SEM values in oak nuts

Feeds	Proanthocyanidine (547 nm)	Gallotannin (550 nm)	Total phenolics (760 nm)
Unshelled (%)	1.08^a	2.73^a	15.02^a
Shell (%)	8.16^b	13.46^b	24.05^b
Shelled (%)	4.65^c	11.42^b	22.13^b
SEM	0.26	0.76	0.34
F	444.67**	599.00**	424.55**
CV (%)	2.32	2.91	3.24

SEM = standard error of the mean, *CV* = coefficient of variation

$^{**}P < 0.01$; ^{a,b,c}means in the same column with different superscripts ($P > 0.05$)

8.160 and 4.656%, respectively. The lowest value of proanthocyanidine content was obtained for shelled oak nuts (4.656). The highest value was obtained for the shell (8.160). There were significant differences between feed groups ($P < 0.01$). Bulgurlu (1980) reported that oak nuts contained 6–8% of tannin acid and some bitter substances.

The amount of proanthocyanidine (condensed tannin) especially in the shell is between the limits advised by Bulgurlu (1980).

Kocaoglu and Yalcin (1996) reported that phylavon or proanthocyanidines were found in forage crops, in oak nut species and when they were included at a rate of 5–11% in ruminant rations, digestibilities of nutrients and feed intake decreased; and it was also reported that the optimum level of tannin concentration in the ration was 2.2%.

Gallotannin content in unshelled oak nuts (2.73%) was lower than in shelled oak nuts (11.43%) and shell (13.46%). The highest gallotannin content was found in oak nut shells. The unshelled oak nuts were different from the other groups ($P < 0.01$).

The highest total phenolics content was found in the shell (24.05%) and the lowest in unshelled oak nuts (15.02%). The differences between the unshelled group and the other two groups were significant ($P < 0.01$). These results are consistent with Akyildiz (1986), who reported that these compounds are found in the shells. Akyildiz (1986) reported that for the removal of this bitterness from

Table 4. DMD, OMD, CPD and their SEM values for oak nuts

	Incubation periods (h)						
	2	4	8	16	24	48	72
DMD							
Unshelled (%)	41.51^a	44.97^a	51.20^a	61.37^a	69.11^a	83.13^a	89.65^a
Shell (%)	4.35^b	4.81^b	5.66^b	7.12^b	8.30^b	10.68^b	11.99^b
Shelled (%)	45.99^a	48.53^a	53.12^a	60.64^a	66.41^a	77.06^a	82.26^a
SEM	8.37	8.89	9.85	11.43	12.62	14.72	15.67
F	202.96**	193.40**	149.85**	114.14**	116.68**	242.10**	564.49**
CV (%)	66.98	66.49	65.84	65.07	64.49	63.29	62.61
OMD							
Unshelled (%)	40.31^a	44.59^a	52.11^a	63.82^a	72.14^a	85.29^a	90.04^a
Shell (%)	4.46^b	4.77^b	5.36^b	6.38^b	7.24^b	9.06^c	10.14^c
Shelled (%)	45.92^a	48.08^a	52.04^a	58.71^a	64.01^a	74.34^b	79.72^b
SEM	8.24	8.81	9.88	11.65	12.96	15.08	15.88
F	209.37**	200.78**	185.78**	179.09**	193.50**	336.75**	731.21**
CV (%)	66.78	66.47	66.35	66.44	66.40	65.69	64.86
CPD							
Unshelled (%)	23.64^b	27.07^b	33.26^b	43.33^b	50.98^a	64.72^a	71.03^a
Shell (%)	0.27^c	0.42^c	0.68^c	1.08^c	1.36^b	1.77^b	1.91^b
Shelled (%)	34.61^a	37.59^a	42.79^a	50.80^a	56.54^a	66.26a	70.79^a
SEM	6.47	7.04	8.09	9.81	11.10	13.44	14.60
F	66.34**	111.42**	201.74**	303.04**	550.37**	1262.10**	178.21**
CV (%)	81.33	79.52	77.51	75.70	74.97	74.41	74.66

SEM = standard error of the mean, *CV* = coefficient of variation
**$P < 0.01$; ^{a,b,c}means in the same column with different superscripts ($P > 0.05$)

oak nut shells they must be put into water for two-three days.

In situ rumen degradability and degradability characteristics

The DM, OM and CP degradabilities (DMD, OMD, CPD) of oak nuts are given in Table 4. As seen in Table 4, the highest DMD of oak nuts (shelled, unshelled and shell) was obtained after 72 hours incubation period. DMDs of oak nuts (shelled, unshelled and shell) in 72 hours were found to be 89.65, 11.99 and 82.26%, respectively. The lowest degradability was obtained for the shell. DMD values for the three feeds were significantly different ($P < 0.01$).

The lowest OMDs of all the incubation periods were obtained for oak nut shells (10.14%). The highest OMDs were found for unshelled oak nuts (90.04%). The OMD value of shelled oak nuts was between unshelled and shell. OMD values between feeds were different ($P < 0.01$).

The highest CF content of oak nut shells might be caused by a decrease in OMD.

Likewise, the lowest CF content of unshelled oak nuts might be caused by an increase in OMD.

The highest CPDs were obtained for the shelled oak nuts (71.03%), and the lowest CPD was obtained for the oak nut shell (1.91%). There were significant differences between the shell and the other groups ($P < 0.01$).

The DMD, OMD and CPD characteristics of oak nuts are given Table 5. As seen in Table 5, while the highest *a* value (rapidly soluble fraction), *b* value

Table 5. DMD, OMD, CPD characteristics and their SEM values for oak nuts

	a (%)	*b* (%)	*a* + *b* (%)	*c* (%/h)	Effective degradability (%)		
					k = 0.04	*k* = 0.06	*k* = 0.08
DMD							
Unshelled (%)	37.81^{a}	58.32^{a}	96.12^{a}	3.28^{a}	63.70^{a}	58.15^{a}	54.60^{a}
Shell (%)	3.87^{b}	9.82^{b}	13.70^{b}	2.41^{a}	7.65^{b}	6.75^{b}	6.25^{b}
Shelled (%)	43.26^{a}	44.87^{a}	88.14^{a}	3.29^{a}	62.50^{a}	58.35^{a}	55.65^{a}
SEM	7.82	9.31	16.65	0.40	11.73	10.90	10.34
F	170.15**	38.70**	237.87**	0.38	222.68**	188.27**	180.41**
CV (%)	67.71	60.57	61.79	33.51	64.40	64.99	65.25
OMD							
Unshelled (%)	35.66^{ab}	57.07^{a}	92.73^{a}	4.24^{a}	65.05^{a}	59.30^{a}	55.50^{a}
Shell (%)	4.13^{bc}	7.73^{bc}	11.86^{c}	2.14^{a}	6.85^{b}	6.15^{b}	5.80^{b}
Shelled (%)	43.62^{a}	42.62^{b}	86.25^{ab}	2.82^{a}	60.80^{a}	56.90^{a}	54.45^{a}
SEM	7.65	9.33	16.41	0.45	11.88	10.99	10.40
F	212.19**	101.84**	1496.74**	4.66	257.05**	226.72**	212.33**
CV (%)	63.21	63.82	63.21	35.83	65.79	66.03	66.04
CPD							
Unshelled (%)	19.95^{a}	56.95^{ac}	76.90^{a}	3.50^{a}	45.60^{b}	40.10^{a}	36.60^{ab}
Shell (%)	0.10^{b}	1.90^{b}	2.00^{b}	4.60^{a}	1.10^{c}	0.90^{c}	0.80^{c}
Shelled (%)	31.35^{c}	45.23^{c}	76.58^{a}	3.95^{a}	52.00^{a}	47.85^{b}	45.10^{a}
SEM	5.89	10.986	16.03	0.62	10.12	9.20	8.60
F	35.29**	19.61*	42.94**	0.17	2681.40**	650.30**	362.05**
CV (%)	84.29	77.57	76.90	37.90	75.37	76.08	76.61

SEM = standard error of the mean, *CV* = coefficient of variation

**$P < 0.01$; $^{a, b, c}$means in the same column with different superscripts ($P > 0.05$)

(potentially degradable fraction), *a* + *b* value (total degradable DMD) were found (as; 43.26, 44.87 and 88.14%, respectively) for the shelled oak nuts, the lowest values were shown for the shell (3.87, 9.82 and 13.70%, respectively). Although there were not any significant differences between the unshelled oak nuts and shelled oak nuts, these groups were significantly different from the shell ($P < 0.01$).

There were no differences between the feeds in terms of *c* value (rate constant of *b*).

The highest effective DMDs (EDMD) were obtained from the unshelled oak nuts. The lowest effective DMD was obtained for the shell. EDMD for the shell was significantly different from the shelled oak nuts and the unshelled ones.

Although the highest *a* value for OMD of oak nuts was found for shelled oak nuts, the highest *b* and *a* + *b* values for OMD were found for unshelled oak nuts. While the unshelled oak nuts and the shelled ones were not different, the oak nut shell was different from the other groups ($P < 0.01$). The differences in terms of *c* were not significant ($P > 0.05$).

The highest EOMD was found for the unshelled oak nuts and the lowest for the oak nut shell. The differences between the oak nut shell and the other two groups were significant ($P < 0.01$).

While the lowest *a* value of CPD was found for the shelled oak nuts, the highest value was found for the shells of oak nuts. *b* and *a* + *b* values of OMD were lower in the oak nut shell than in the other groups. The characteristics of CPD (*a*, *b*, *a* + *b*) for the oak nut shell were found different from the shelled oak nuts and unshelled ones ($P < 0.01$). However the *c* value of OMD was not found different between the feeds.

On the other hand, the highest CPDs between the feeds were obtained from the shelled oak nuts and the lowest CPD was found for the oak nut shell. The differences between the feeds were significant ($P < 0.01$).

In vitro digestibility

In vitro DM digestibilities (IVDMD), *in vitro* OM digestibilities (IVOMD) and pepsin digestible N contents of oak nuts are given in Table 6.

As seen in Table 6, the highest IVDMD was found for the unshelled oak nuts (44.64%), the lowest IVDMD was found for the oak nut shell (5.26%). Unshelled and shelled oak nuts were significantly different from the oak nut shells.

The highest IVOMD was found for the unshelled oak nuts (44.67%), the lowest IVOMD was found for the oak nut shell (5.75%). Oak nut shells were significantly different from the other groups ($P < 0.01$).

The decrease in IVDMD and IVOMD of the unshelled oak nuts is due to its high carbohydrate content and low cellulose content.

The results obtained in the present experiment are supported by Bulgurlu (1980), who reported that seed digestibilities increased when their shells were removed.

Pepsin digestible N content was the highest for the oak nut shell (96.62%) and the lowest pepsin digestion N content was found for the unshelled oak nuts (14.92%). Oak nut shells were significantly different from shelled and unshelled oak nuts.

These results indicate that the shells have the high by-pass value although DMD, OMD and CPD of the shells decreased, but pepsin digestible N content of the shell increased.

The unshelled oak nuts had higher and lower values of pepsin solubility. These results indicate that this feed N component was degraded by the rumen microorganisms at the result, it can be said that the unshelled oak nuts decrease the by-pass value. The shelled oak nuts were also between the oak nut shell and the unshelled oak nuts.

Table 6. IVDMD, IVOMD and pepsin digestible N contents in oak nuts (%)

Feeds	IVDMD	IVOMD	Pepsin digestible N
Unshelled	44.64 ± 1.63^{a}	44.67 ± 3.04^{a}	14.92 ± 1.39^{b}
Shell	5.26 ± 3.63^{b}	5.75 ± 3.27^{b}	96.62 ± 2.97^{c}
Shelled	37.58 ± 2.13^{ac}	39.54 ± 1.87^{a}	46.15 ± 3.06^{a}

The same letter in means in the column shows insignificant differences

$^{a, b, c}$means in the same column with different superscripts ($P > 0.01$)

Table 7. TE, DE, ME, NE_L, NE_F and NE_M values of oak nuts (MJ/kg DM)

Feeds	TE	DE	ME	NE_L	NE_F	NE_M
Unshelled	19.02	8.50	7.25	4.02	2.20	4.81
Shell	18.91	1.08	0.89	0.42	0.04	0.51
Shelled	18.68	7.39	6.13	3.40	1.67	4.07

Energy value

Total energy (TE), digestible energy (DE), metabolisable energy (ME), net energy lactation (NE_L), net energy fat (NE_F) and net energy maintenance (NE_M) values of the oak nuts (shelled, unshelled and shell) are given in Table 7.

The highest TE value was found for the unshelled oak nuts (19.02 MJ/kg DM), followed by the shell and the shelled ones. There were not any significant differences between the feeds (shell, shelled and unshelled). The highest DE value was obtained for the unshelled oak nuts (8.50 MJ/kg DM) and the lowest DE value was obtained for the shell (1.08 MJ/kg DM). There were significant differences between the feeds (shelled, unshelled and shell) ($P < 0.01$).

The highest ME, NE_L, NE_F and NE_M value were found for the unshelled oak nuts and the lowest values were obtained from the shell. There were differences between the feeds ($P < 0.01$).

These results indicate that these feeds have lower by-pass protein values.

IVDMD and IVOMD of the shelled oak nuts and the unshelled ones were higher than in the oak nut shell. This case is also reflected by energy value.

In the light of the results of this experiment it can be said that the shelled oak nuts and the unshelled ones can be used as forages. The highest and the lowest amounts of oak nuts that can be used in ruminant rations are uncertain and more detailed feeding studies must be carried out on this problem.

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ABSTRAKT

Stanovení nutriční hodnoty žaludů metodou *in situ*

V práci byla stanovena nutriční hodnota vyloupaných a nevyloupaných žaludů a jejich skořápek. Ke stanovení sušiny, organické hmoty a charakteristik degradace dusíkatých látek, stravitelnosti, energetické hodnoty a obsahu taninu byly použity metody nylonových sáčků (*in situ*), složek buněčných stěn za použití predikčních rovnic a enzymatické metody (*in vitro*). Degradace sušiny, organické hmoty a dusíkatých látek byla u vyloupaných a nevyloupaných žaludů vysoká, u skořápek byla nižší. Charakteristiky degradace (*a*, *b*, *a* + *b*) a využitelné degradace vykazovaly u nevyloupaných a vyloupaných žaludů vysoké hodnoty, u skořápek byly hodnoty nižší. Při degradaci DM a OM byly zjištěny významné rozdíly mezi skořápkou žaludů a dvěma zbývajícími skupinami ($P < 0,01$). Obsahy stravitelného N stanovené *in vitro* byly u vyloupaných a nevyloupaných žaludů nižší, naopak u skořápek vysoké. Nevyloupané a vyloupané žaludy se významně lišily od skořápek žaludů ve stravitelnosti DM a OM. Nejvyšší energetické hodnoty byly zaznamenány u nevyloupaných žaludů a nejnižší u skořápek. Žaludy lze používat jako krmivo v oblastech s jejich vysokou přirozenou produkcí.

Klíčová slova: *Quercus pubescens*; degradace; tanin; stravitelnost; energetická hodnota

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