

## Effect of Varieties on Potential Nutritive Value of Pistachio Hulls

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### Summary

The aim of this study was to determine the potential nutritive value of pistachio hulls obtained from six different varieties using chemical composition and *in vitro* gas production technique. *In vitro* gas productions of pistachio hulls were determined at 0, 3, 6, 12, 24, 48, 72 and 96 h incubation times and their gas production kinetics were described. There is considerable variation among pistachio hulls obtained from six different varieties in terms of chemical composition and *in vitro* gas production, metabolisable energy (ME) and organic matter digestibility (OMD). Dry matter (DM) contents of pistachio hulls ranged 26.45 to 29.25%. Ash content of pistachio hulls ranged from 8.50 to 19.86%. The crude protein (CP) contents of pistachio hulls ranged 7.27 to 14.99%. The hulls from Kirmizi, Ohadi and Keten Gömleği (KG) had significantly higher CP contents than the others. The NDF and ADF contents of pistachio hulls ranged from 18.25 to 22.49% and 14.32 to 18.29% respectively. The pistachio hulls from Ohadi and Uzun had significantly higher NDF and ADF contents than the others. The CT contents of pistachio hulls ranged from 2.03 to 2.63%. The hulls from Beyaz Ben (BB) had significantly higher CT content than that of KG. The gas production rate ranged from 0.071 to 0.107%. The gas production rate of pistachio hulls from Sultani and KG were significantly higher than the others. The potential gas production of pistachio hulls ranged from 65.92 to 73.46 mL. The potential gas production of pistachio hulls from BB and Ohadi were significantly higher than the others. The ME and OMD contents of pistachio hulls ranged from 9.76 to 11.05 MJ/kg DM and 69.00 to 74.50% respectively. The ME contents of pistachio hulls from BB and Ohadi were significantly higher than those of Kirmizi, Uzun and KG whereas the OMD contents of pistachio hulls from Ohadi were significantly higher than those of pistachio hulls for Kirmizi, Sultani, Uzun and KG. In conclusion, chemical characterization with CP, OMD and ME suggests that the pistachio hulls had moderate level of CP concentration and was quite digestible therefore it can be said that pistachio hulls will provide feedstuffs of an acceptable quality for ruminant animals.

**Keywords:** Chemical composition, Condensed tannin, Digestibility, Nutritive value, *In vitro* gas production, Pistachio hulls

## Varyetenin Antep Fıstığı Dış Kabuğunun Potansiyel Besleme Değerine Etkisi

### Özet

Bu çalışmanın amacı, farklı varyetelerden elde edilen Antep fıstığının dış kabuğunun potansiyel besleme değerini kimyasal kompozisyonu ve *in vitro* gaz üretim teknlığını kullanarak belirlemektir. *In vitro* gaz ölçümleri fermentasyonun başlamasından sonra 3, 6, 12, 24, 48, 72 ve 96 saatlerinde yapılmıştır. Farklı varyetelerden elde edilen Antep fıstığı kabuğunun kompozisyonları, *in vitro* gaz üretimi, metabolik enerji içeriklerinde ve organik madde sindirim dereceleri arasında önemli varyasyonlar vardır. Antep fıstığı kabuklarının kuru madde içeriği %26.45 - %29.25 arasında değişmiştir. Kül içeriği ise %8.50 - %19.86 arasında değişmiştir. Antep fıstığı kabuklarının ham protein içeriği %7.27 - %14.99 arasında değişmiştir. Kirmizi, Ohadi ve keten gömleği varyeteleri en yüksek protein içeriğine sahip olmuştur. Antep fıstığı kabuklarının NDF ve ADF içerikleri sırasıyla %18.25 - %22.49 ve %14.32 - %18.29 arasında değişmiştir. Ohadi ve Uzun varyeteleri en yüksek NDF ve ADF içeriğine sahip olmuştur. Antep fıstığı kabuklarının kondense tanen içerikleri %2.03 - %2.63 arasında değişmiş olup Beyaz Ben varyetesi en yüksek tanen içeriğine sahip olmuştur. Antep fıstığı kabuklarının gaz üretim hızı %0.071 ile %0.107 arasında değişmiş olup en yüksek gaz üretim hızına Sultani ve Keten Gömleği varyeteleri sahip olmuşlardır. Antep fıstığı kabuklarının potansiyel gaz üretim miktarları 65.92 ile 73.46 ml arasında değişmiş olup en yüksek gaz üretim miktarına Beyaz Ben ve Ohadi varyeteleri sahip olmuştur. Antep fıstığı kabuklarının metabolik enerji ve organik madde sindirim dereceleri sırasıyla 9.76 ile 11.05 MJ/kg KM, %69.00 - %74.50 arasında değişmiştir. Beyaz Ben ve Ohadi varyetelerinden elde edilen kabukların metabolik enerji içerikleri Kirmizi, Sultani, Uzun ve Keten Gömleği varyetelerinden elde edilen kabukların metabolik enerjisi içeriğinden yüksek olmasına rağmen Ohadi varyetelerinden elde edilen Kirmizi, Sultani, Uzun ve Keten Gömleği varyetelerinden elde edilen kabuklarının OMD değerinden yüksek bulunmuştur. Sonuç olarak, kimyasal olarak ham protein, OMD ve ME bakımından yapılan karakterizasyon Antep fıstığı kabuklarının orta seviyede ham protein içeriği ve oldukça sindirilebilir olduğundan dolayı ruminantlar için kabul edilebilir kalitede yem sağlayacağı söylenebilir.

**Anahtar sözcükler:** Kimyasal kompozisyon, Kondense tanen, Sindirim derecesi, Besleme değeri, *In vitro* gaz üretimi, Fıstık dış kabuğu



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## INTRODUCTION

After processing of fruits, vegetables, crops and nuts, considerable amount agricultural byproduct become available and used to meet the energy and protein requirements of livestock animal in most parts of the world especially during the dry season when food shortage occurs<sup>[1]</sup>. There is about 2.212.229 hectares of pistachio garden in Turkey and annual dry pistachio production is 128000 tones<sup>[2]</sup>. Pistachio fruit is well known for its oleaginous and edible seed. The hull of pistachio is constituted by epicarp and mesocarp which adheres tightly the hard inner shell until the pistachio nut is ripe<sup>[3]</sup>. De-hulling of pistachio after harvest produces considerable amount hulls which are dried or ensiled for storage. Several researches showed that dried or ensiled pistachio by product can be used ruminant diets to some extent<sup>[1-6]</sup>. Although there is considerable amount pistachio hull production in Turkey there is no information about chemical composition, digestibility, and metabolic energy contents of pistachio hulls obtained from different varieties. Chemical composition, in combination with *in vitro* gas production, OMD and ME content were widely used to determine the potential nutritive value of feedstuffs which are previously limited or uninvestigated<sup>[7-10]</sup>. The aim of this study was to determine the potential nutritive value of pistachio hulls obtained from six different varieties using chemical composition and *in vitro* gas production technique.

## MATERIAL and METHODS

This experiment was conducted in the laboratory of Department of Animal Science, Faculty of Agriculture, University of Kahramanmaraş Sutcu Imam, Kahramanmaraş, Turkey. Studies performed using *in vitro* experimental model was approved by the Animal Experimentation Ethics Committee of University of Kahramanmaraş Sutcu Imam, Faculty of Agriculture (Protocol No: 2013/01). Pistachio hulls obtained from six different varieties (Beyaz Ben, Kirmizi, Ohadi, Sultani, Uzun and Keten Gömleği) were shade dried and taken to laboratory and milled in a hammer mill through a 1 mm sieve for subsequent analysis.

Dry matter (DM) contents of pistachio hulls 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) contents of pistachio hulls was measured by the Kjeldahl method<sup>[11]</sup>. Crude protein contents of pistachio hulls were calculated as N X 6.25. Neutral detergent fiber (NDF) contents of pistachio hulls was determined by the method van Soest and Wine<sup>[12]</sup> and ADF contents of pistachio hulls were determined by the method of van Soest<sup>[13]</sup>. Condensed tannin contents of pistachio hulls were determined by butanol-HCl method as described by Makkar *et al.*<sup>[14]</sup>. All chemical analysis is carried out in duplicate.

Pistachio hulls milled through a 1 mm sieve were incubated *in vitro* rumen fluid in calibrated glass syringes following the procedures of Menke *et al.*<sup>[15]</sup>.

Rumen fluid was obtained from one year old and approximately 50 kg of three fistulated Awassi ram after one week adjustment period of a diet. Fistulated Awassi ram fed twice daily with a diet containing alfalfa hay (60%) and concentrate (40%). Rumen fluid was collected before morning feeding and squeezed through four layers of cheesecloth. The rumen fluid was flushed with CO<sub>2</sub>. The rumen fluid was added to buffered mineral solution in the ratio of 1:2 respectively. Approximately 0.200 gram dry weight of Pistachio hulls samples was weighed in triplicate into calibrated glass syringes of 100 ml. The syringes were prewarmed at 39°C before the injection of 30 ml rumen fluid-buffer mixture into each syringe followed by incubation in a water bath at 39°C. Gas production was recorded at 3, 6, 12, 24, 48, 72 and 96 h after incubation and corrected for blank incubation. Cumulative gas production data of Pistachio hulls were fitted to non-linear exponential model as: Y = A (1 – exp<sup>-ct</sup>)<sup>[16]</sup>.

Where Y is gas production at time't', A is the potential gas production (ml/200 mg DM), c is the gas production rate constant (h<sup>-1</sup>) and t is the incubation time (h).

ME (MJ/kg DM) values of pistachio hulls were estimated using equation of Menke *et al.*<sup>[15]</sup> as follows:

$$\text{ME (MJ/kg DM)} = 2.20 + 0.136 \text{ GP} + 0.057 \text{ CP},$$

where, GP = 24 h net gas production (ml/0.200 g); CP = Crude protein (%).

Organic matter digestibility (%) values of pistachio hulls were calculated using equation of Menke *et al.*<sup>[14]</sup> as follows:

$$\text{OMD (\%)} = 14.88 + 0.889 \text{ GP} + 0.45 \text{ CP} + 0.0651 \text{ XA}$$

where XA: ash content (%).

One-way analysis of variance (ANOVA) was carried out to determine the effect of variety on the chemical composition, gas production kinetics, ME and OMD of pistachio hulls. Significance between individual means was identified using the Tukey's multiple range tests<sup>[17]</sup>. Mean differences were considered significant at P<0.05.

## RESULTS

The effect of variety on the chemical composition of pistachio hulls is presented in *Table 1*. The variety has significant effect on the chemical composition of pistachio hulls. The DM contents of pistachio hulls ranged from 26.45 to 29.25%. The CP contents of pistachio hulls ranged 7.27 to 14.99%. The hulls from Kirmizi, Ohadi and KG had significantly higher CP contents than the others. The NDF and ADF contents ranged from 18.25 to 22.49% and 14.32

to 18.29% respectively. The hulls from Ohadi and Uzun had significantly higher NDF and ADF contents than the others. The ash contents of pistachio hulls were ranged 8.50 to 19.86%. The hulls from Uzun had significantly higher ash content than that of Sultani. The CT contents of hulls ranged from 2.03 to 2.63%. The hulls from BB had significantly higher CT content than that of KG.

The effect of variety on gas production of pistachio hulls at different time intervals is presented in Fig. 1. At 3, 6 and 12 hours incubation the gas production for Kirmizi and Uzun were significantly lower than the others. At 24, 48 and 72 h incubation times, the gas production for Kirmizi, Uzun and KG were significantly higher than the others. At 72 h incubation times the gas productions for BB and Ohadi were significantly higher than the others.

The effect of variety on gas production kinetics, ME, OMD of pistachio hulls is presented in Table 2. The variety had a significant effect on gas production kinetics, ME, OMD of pistachio hulls. The gas production rate ranged from 0.071 to 0.107%. The gas production rate of pistachio hulls from Sultani and KG were significantly higher than the others. The potential gas production of pistachio hulls ranged from 65.92 to 73.46 ml. The potential gas production of pistachio hulls from BB and Ohadi were significantly higher than the others.

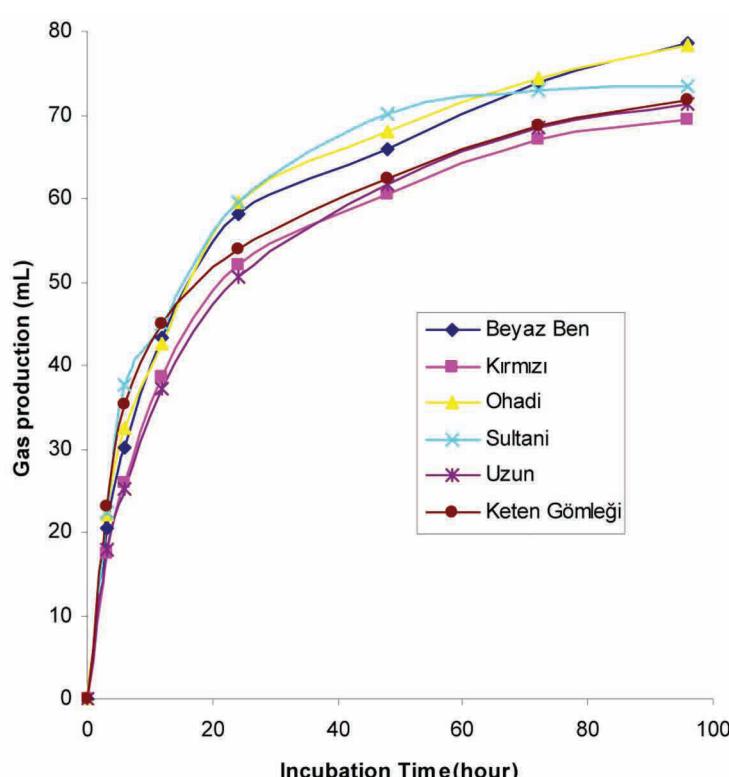
The ME and OMD contents of pistachio hulls ranged from 9.76 to 11.05 MJ/kg DM and 69.00 to 74.50% respectively. The ME contents of pistachio hulls from BB and Ohadi were significantly higher than those of Kirmizi, Uzun and KG whereas the OMD contents of pistachio

**Table 1.** The effect of variety on the chemical composition of pistachio hulls (on a dry matter basis)

**Tablo 1.** Çeşidin Antep fistiği dış kabuğunun kimyasal kompozisyonuna etkisi (kuru madde bazında)

Nutrient Composition	Variety						SEM	Sig.
	BB	Kirmizi	Ohadi	Sultani	Uzun	KG		
DM	26.45 <sup>c</sup>	26.73 <sup>c</sup>	29.25 <sup>a</sup>	28.54 <sup>ab</sup>	28.98 <sup>ab</sup>	26.85 <sup>b</sup>	0.549	**
Ash	16.66 <sup>ab</sup>	18.62 <sup>ab</sup>	11.38 <sup>ab</sup>	8.50 <sup>b</sup>	19.86 <sup>a</sup>	15.44 <sup>ab</sup>	3.070	*
CP	11.06 <sup>c</sup>	14.99 <sup>a</sup>	13.30 <sup>b</sup>	7.27 <sup>d</sup>	10.77 <sup>c</sup>	14.49 <sup>b</sup>	0.357	***
NDF	18.25 <sup>b</sup>	19.03 <sup>b</sup>	22.13 <sup>a</sup>	18.51 <sup>b</sup>	22.49 <sup>a</sup>	18.84 <sup>b</sup>	0.225	***
ADF	15.15 <sup>b</sup>	14.32 <sup>b</sup>	18.29 <sup>a</sup>	15.38 <sup>b</sup>	18.02 <sup>a</sup>	14.47 <sup>b</sup>	0.479	***
CT	2.63 <sup>a</sup>	2.34 <sup>ab</sup>	2.37 <sup>ab</sup>	2.07 <sup>ab</sup>	2.55 <sup>ab</sup>	2.03 <sup>b</sup>	0.183	**

<sup>a,b,c</sup> Row means with common superscripts do not differ ( $P<0.05$ ), SEM - standard error mean, Sig. - significance level, DM - Dry matter %, CP - Crude protein, NDF - Neutral detergent fiber, ADF - Acid detergent fiber, CT - Condensed tannin, BB - Beyaz Ben, KG - Keten Gömleği, \* $P<0.05$ , \*\* $P<0.01$ , \*\*\* $P<0.001$



**Fig 1.** The effect of variety on gas production of pistachio hulls

**Şekil 1.** Çeşidin Antep fistığı dış kabuğunun gaz üretimine etkisi

**Table 2.** The effect of variety on the gas production kinetics, metabolisable energy and organic matter digestibility of pistachio hulls**Tablo 2.** Çeşidin Antep fistiği dış kabuğunun gaz üretim par/ametrelerine, metabolik enerji ve sindirim derecesine etkisi

Parameters	Variety						SEM	Sig.
	BB	Kırmızı	Ohadi	Sultani	Uzun	KG		
C	0.077 <sup>b</sup>	0.074 <sup>b</sup>	0.081 <sup>b</sup>	0.098 <sup>a</sup>	0.071 <sup>b</sup>	0.107 <sup>a</sup>	0.005	***
A	73.11 <sup>a</sup>	66.01 <sup>c</sup>	73.46 <sup>a</sup>	70.96 <sup>b</sup>	67.39 <sup>c</sup>	65.92 <sup>c</sup>	0.538	***
ME	10.74 <sup>a</sup>	10.11 <sup>cd</sup>	11.05 <sup>a</sup>	10.70 <sup>ab</sup>	9.76 <sup>d</sup>	10.34 <sup>bc</sup>	0.108	***
OMD	72.65 <sup>ab</sup>	69.00 <sup>c</sup>	74.50 <sup>a</sup>	71.60 <sup>b</sup>	71.60 <sup>b</sup>	70.26 <sup>bc</sup>	0.711	***

<sup>a,b,c</sup> Row means with common superscripts do not differ ( $P<0.05$ ), SEM - standard error mean, Sig. - significance level, C - gas production rate (%), A - potential gas production (mL), ME - Metabolisable energy (MJ/kg DM), OMD - Organic matter digestibility %, \*\*\*  $P<0.001$

hulls from Ohadi were significantly higher than those of pistachio hulls for Kırmızı, Sultani, Uzun and KG.

## DISCUSSION

There are significant variations among varieties in terms of chemical compositions of pistachio hulls. The NDF, ADF and CP contents obtained in the current study were considerably lower than those reported by Gholizadeh *et al.*<sup>[6]</sup> who reported that NDF and ADF, CP contents were 25, 20 and 16.6% respectively. On the other hand, except for Uzun and Sultani, ash contents of pistachio hulls obtained in the current study were considerably higher than those reported by Gholizadeh *et al.*<sup>[6]</sup> who reported that ash content was 12.7%. The differences between two studies are possibly associated differences in variety, growing conditions, kernel maturity and de-hulling process applied.

Except for Sultani, the crude protein contents of pistachio hulls are comparable with those proposed as the minimum requirements for lactation (12% of DM) and growth (11.3% of DM) in ruminants<sup>[18]</sup>. Therefore pistachio hulls investigated in the current experiment have the potential for ruminant animals to meet the protein requirements during the critical periods when there is a shortage of high quality forages. However, Kumar and Singh<sup>[19]</sup> suggested that CP in diet may be restricted due to high levels of condensed tannin (50 g/kg DM) owing to excessive formation of tannin-protein complexes, e.g. with endogenous protein, which pass through the animal largely undigested. On the other hand Barry<sup>[20]</sup> suggested that CT which is lower than 2-3% may have beneficial effects to ruminants due to reduction in protein degradation as a result of the formation of protein-tannin complexes in the rumen. However, in the current experiment, the condensed tannin levels of pistachio hulls were lower than those considered detrimental to ruminant animals.

There are significant variation among pistachio varieties in terms of in vitro gas production and estimated parameters such as OMD and ME contents of hulls. The variation in gas production and estimated parameters among pistachio

varieties can be attributed to compositional differences of pistachio hulls, especially cell wall, CP contents and some other anti-nutritive factors such as CT. Babayemi *et al.*<sup>[21]</sup> indicated that there are many factors that may determine the amount of gas to be produced during the fermentation, depending on the nature and level of cell content, the presence of secondary metabolites in feedstuffs. Blummel and Orskov<sup>[22]</sup> suggested that in vitro gas production is associated with volatile fatty acid (VFA) production following fermentation of substrate so the more fermentation of a substrate the greater the gas production, although the fermentation end products do correlate more closely with gas production.

Organic matter digestibility of pistachio hulls obtained in the current study were considerably higher than those reported by Noghabi and Rauzbehan<sup>[23]</sup> who reported that OMD of pistachio hulls ranged from 52.6 to 65.6% and polyethylene glycol (PEG) supplementation significantly increased in vitro OMD of pistachio hulls.

Although there is considerable amount pistachio hull production in Turkey, there is no information about the biomass production of pistachio hulls as a feed source for ruminant animals. It would be more useful if further studies should be focused on the biomass production potential of pistachio hulls in Turkey.

In conclusion, chemical characterization with CP, OMD and ME suggests that the pistachio hulls moderately high CP concentration and was quite digestible therefore pistachio hulls provide feedstuffs of an acceptable quality for ruminant animals.

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