

## Potential Nutritive Value of Honey Locust (*Gleditsia triacanthos*) Pods from Different Growing Sites for Ruminants

A. Kamalak<sup>1\*</sup>, I. Guven<sup>1</sup>, M. Kaplan<sup>2</sup>, M. Boga<sup>3</sup>, A. I. Atalay<sup>1</sup>, and C. O. Ozkan<sup>1</sup>

### ABSTRACT

The nutritive values of honey locust pods obtained from different growing sites were evaluated by chemical composition and *in vitro* gas production techniques. Growing site was found to have a significant ( $P < 0.001$ ) effect on the chemical composition. The CP contents of honey locust pods ranged from 67.2 to 119.9 g kg<sup>-1</sup> DM. Water soluble carbohydrate (WSC) ranged from 122.3 to 152.2 g kg<sup>-1</sup> DM. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents varied with growing site in the range of 299.6 to 414.3 and 195.3 to 262.9 g kg<sup>-1</sup> DM, respectively. Condensed tannin (CT) contents ranged from 27.8 to 148.2 g kg<sup>-1</sup> DM. Polyethylene glycol (PEG) addition significantly ( $P < 0.001$ ) increased gas production and some estimated parameters of honey locust pods obtained from different growing sites. However, honey locust pods obtained from different growing sites showed variable responses to PEG treatment. There were also significant ( $P < 0.001$ ) differences among growing sites in terms of gas production and estimated parameters. Organic matter digestibility (OMD) and metabolizable energy (ME) contents of honey locust pods obtained from different growing sites without PEG supplementation ranged from 58.81 to 65.86% and 8.85 to 9.92 MJ kg<sup>-1</sup> DM respectively. The improvement in gas production, the OMD and ME with PEG emphasized the negative effect of tannins on digestibility. The increase (%) in the estimated OMD and ME contents ranged from 6.30 to 15.81% and 5.61 to 14.94%, respectively.

**Keywords:** Condensed tannin, Digestibility, Growing site, Honey locust pods, Metabolizable energy, PEG.

### INTRODUCTION

Pods of several legume trees or shrubs have been included in livestock diets in many parts of the world during critical periods of the year when quality and quantity of forages are restricted (Batista *et al.*, 2002; Ahmet and El-Hag, 2004; Mahgoup *et al.*, 2005; Silanikove *et al.*, 2006). *Prosopis juliflora* pods included at levels of 200 g kg<sup>-1</sup> in Omani goat diets maximized feed intake, body weight gain and feed conversion (Mahgoup *et al.*, 2005). *Acacia farnesiana* pods included at a level

of 120 g kg<sup>-1</sup> in lambs were accepted with little effect on intake levels of dry matter and diet digestibility (Garcia-Winder *et al.*, 2009). Incorporation of *Faidherbia albida* pods up to 45% had no adverse effects on kids' performance and nutrient digestion (Ibrahim and Tibin, 2003). On the other hand, high levels of condensed tannins in carob (*Ceratonia siliqua*) pods restricted nutrient utilization and decreased voluntary feed intake, crude protein digestibility and animal performance (Silanikove *et al.*, 2006).

Honey locust tree (*Gleditsia triacanthos*) is the one of legume trees producing

<sup>1</sup> Department of Animal Science, Faculty of Agriculture, Kahramanmaraş Sutcu Imam University, Kahramanmaraş, Turkey.

\* Corresponding author, e-mail: akamalak@ksu.edu.tr

<sup>2</sup> Department of Field Crops, Faculty of Agriculture, Erciyes University, Kayseri, Turkey.

<sup>3</sup> Bor Vocational School, Nigde University, Nigde, Turkey.



considerable amounts of pods every growing season. The pods yield can range from 12 to 27 kg per tree per year in young trees (Duke, 1983) to 87 kg per tree per year in adult trees (Papanastasis 1996). Crude protein contents of honey locust pods harvested in July and November ranged from 103 to 134 g kg<sup>-1</sup> DM (Pereria, 2000). It was reported that the intake during the adaptation period was 1 kg DM per sheep (62 kg live weight). However the voluntary consumption period of the intake reached up to 1.8 kg DM of dry pods per day. The digestibility of dry matter and organic matter ranged from 48.6 to 58.5% and 50.0 to 61.0%, respectively (Foroughbakhch *et al.*, 2006).

Honey locust pods produced in Turkey were undervalued mainly because of insufficient knowledge about their potential feeding value. Ammar *et al.* (2005) suggested that chemical composition, in combination with *in vitro* digestibility and ME content, can be considered as useful indicators for preliminary evaluation of the potential nutritive value of previously uninvestigated shrub and tree leaves. Nsahlai *et al.* (1994) indicated that current chemical analysis techniques do not reflect the biological effects of tannin, and therefore the use of *in vitro* techniques has been proposed to supplement the chemical analysis. The gas production technique has been proved to be efficient in determining the nutritive value of feeds containing anti-nutritive factors (Rubanza *et al.*, 2003; Evitayani *et al.*, 2004).

The aim of this study was to screen honey locust pods obtained from six growing sites in Turkey to (1) quantify chemical compositions and level of condensed tannin

contents of honey locust pods, and (2) assess the effect of tannin activity on feed digestibility and nutrient availability *in vitro* using a polyethylene glycol (PEG) tannin bio-assay.

## MATERIALS AND METHODS

### Honey Locust Pods Samples

Honey locust pods were obtained from six city centers (Adana, Ankara, Gaziantep, Kayseri, Kahramanmaraş, and Osmaniye) in December, 2008 in Turkey. The altitude, mean temperature and rainfall (1975-2008) of growing sites are given in Table 1.

Honey locust pods collected by hand from at least 10 different trees for each city center were pooled and dried at 50-60°C using a forced air oven. Dried honey locust pods samples were ground to pass through a 1 mm sieve for subsequent analysis using a laboratory mill (IKA WERKE MF 10 Basic, Germany).

### Chemical Analysis

Dry matter (DM) was determined by drying the samples at 105°C overnight and ash was determined by igniting the samples in a muffle furnace at 525°C for 8 hours. Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990). Crude protein of dried pods was calculated as  $N \times 6.25$ . Cell wall contents (NDF and ADF) of dried pods were determined using the method described by Van Soest *et al.* (1991). Water soluble carbohydrate of dried

**Table 1.** The altitude, mean temperature and rainfall (1975-2008) of growing sites.

Growing sites	Altitude (m)	Mean temperature (°C)	Rainfall (mm)
Adana	20	17.3	656.7
Ankara	850	11.8	395.2
Gaziantep	706	15.0	706
Kayseri	1054	10.3	394.7
Kahramanmaraş	572	16.6	723.6
Osmaniye	120	18.2	797.1

Pods were determined using the method described by Dubois *et al.* (1956). Condensed tannin of dried pods was determined by butanol-HCl method as described by Makkar *et al.* (1995). All chemical analyses were carried out in triplicate except for NDF and ADF which were carried out in duplicate.

### In Vitro Gas Production

Ground Honey locust pods samples (0.200 g DM) were incubated *in vitro* with diluted rumen fluid (10 ml rumen fluid+20ml culture medium) in calibrated glass syringes of 100 ml in the absence or presence of PEG (1 g, MW, 6000; Sigma, UK), following the procedures of Menke and Steingass (1988). The aim of PEG addition was to determine the adverse effect of CT on the gas production and estimated parameters. All incubations were carried out in triplicate. Rumen fluid was obtained using stomach tube from two lactating and pregnant cows fed a daily ration containing 20 kg maize silage and 10 kg concentrates (%18 CP and 2,750 Kcal ME kg<sup>-1</sup>). The cows had free access to water throughout the experiment. Rumen samples were collected before the morning meal in the thermos flasks and were taken immediately to the laboratory where they were strained through 4 layers of cheesecloth and kept at 39°C.

Gas production was determined at 3, 6, 12, 24, 48, 72 and 96 hours after incubation. Total gas production was corrected for blank gas production. The *in vitro* gas production kinetics was estimated using the exponential model suggested by Orskov and McDonald (1979);

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

where,

$y$  = Gas produced at time 't',

$a$  = Gas production from the quickly soluble fraction (ml),

$b$  = Gas production from the slowly degradable fraction (ml),

$c$  = Gas production rate constant for the slowly degradable fraction (b),

$t$  = Incubation time (hour).

The metabolizable energy (MJ kg<sup>-1</sup> DM) contents of honey locust pods were estimated using equations suggested by Menke and Steingass (1988)

$$ME \text{ (MJ kg}^{-1} \text{ DM)} = 1.06 + 0.157 GP + 0.0084 CP + 0.022 * EE - 0.0081 * XA \quad (2)$$

$GP$  = Net gas production at 24 h incubation time

$CP$  = Crude protein (g kg<sup>-1</sup> DM),

$EE$  = Ether extract (g kg<sup>-1</sup> DM),

$XA$  = Ash content (g kg<sup>-1</sup> DM).

The OMD (%) of honey locust pods were estimated using equations suggested by Menke *et al.* (1979);

$$OMD \text{ (\%)} = 14.88 + 0.889 GP + 0.45 CP + 0.00651 XA, R^2 = 0.92 \quad (3)$$

Where  $GP$  is 24 hours net gas production (ml 200 mg<sup>-1</sup> DM)

$CP$  = Crude protein (%),

$XA$  = Ash content (%).

### Statistical Analysis

Data on chemical composition were subjected to the one way ANOVA using SPSS 10.0 for windows (SPSS, 1999) and were analyzed based on the statistical model:  $Y_{ij} = \mu_{ij} + S_i + e_i$  where,  $Y_{ij}$  is the general mean common for each parameter under investigation.  $S_i$  the  $i$ th effect of growing site on the observed parameters, and  $e_i$  the standard error term.

Data on gas production kinetics, OMD and ME contents of honey locust pods were subjected to the two way ANOVA using SPSS 10.0 for windows (SPSS, 1999), and were analyzed based on the statistical model:  $Y_{ij} = \mu_{ij} + S_i + P_j + (S \times P)_{ij} + e_i$  where,  $Y_{ij}$  is the general observation on *in vitro* gas production kinetics, OMD and ME contents,  $S_i$  the  $i$ th effect of growing site on the observed parameters and  $P_j$  the  $j$ th effect of PEG on the observed parameters. The  $(S \times P)_{ij}$  term represents  $i$ th and  $j$ th interactive effects of growing site and PEG on gas production and *in vitro* digestibility, and  $e_i$  the standard error term common for all observations. Significance differences



between individual means were evaluated using the Duncan's multiple comparison tests when a significant ( $P < 0.05$ ) effect was detected (Duncan, 1955). Standard errors of means were calculated from the residual mean squares in the analysis of variance.

## RESULTS AND DISCUSSION

### Chemical Composition

Chemical compositions of honey locust pods obtained from six cities (Adana, Ankara, Gaziantep, Kayseri, Kahramanmaraş, and Osmaniye) are presented in Table 2. Growing site had a significant ( $P < 0.001$ ) effect on the chemical composition. The CP contents of honey locust pods ranged from 67.2 to 119.9 g kg<sup>-1</sup> DM, WSC from 122.3 to 152.2, NDF from 299.6 to 414.3 g kg<sup>-1</sup> DM, ADF from 195.3 to 262.9 g kg<sup>-1</sup> DM and CT content from 27.8 to 148.2 g kg<sup>-1</sup> DM. The CP contents of honey locust pods were positively ( $r = 0.819$ ,  $P < 0.001$ ) correlated with the altitude whereas the CP contents of honey locust pods were negatively ( $r = -0.854$  and  $-0.759$ ,  $P < 0.001$ ) correlated with temperature and rainfall, respectively.

The CP contents of honey locust pods obtained from Ankara and Kayseri were significantly ( $P < 0.001$ ) higher than those obtained from other sites whereas WSC contents of honey locust pods obtained from Osmaniye were significantly ( $P < 0.001$ )

higher than those obtained from other sites.

The NDF contents of honey locust pods were positively ( $r = 0.681$ ,  $P < 0.015$ ) correlated with the altitude. However, the NDF contents of honey locust pods were negatively ( $r = -0.701$ ,  $P < 0.011$  and  $-0.720$ ,  $P < 0.08$ ) correlated with temperature and rainfall, respectively. The ADF contents of honey locust pods were positively ( $r = 0.738$ ,  $P < 0.006$ ) correlated with the altitude whereas the ADF contents of honey locust pods had negative correlations ( $r = -0.648$ ,  $P < 0.023$  and  $-0.615$ ,  $P < 0.033$ ) with temperature and rainfall, respectively. The NDF contents of honey locust pods obtained from Kayseri and Kahramanmaraş were significantly ( $P < 0.001$ ) higher than those obtained from Adana, Gaziantep and Osmaniye whereas the ADF content of honey locust pods obtained from Ankara was significantly ( $P < 0.001$ ) higher than those obtained from Adana or Osmaniye.

The CT contents of honey locust pods were positively ( $r = 0.931$ ,  $P < 0.001$ ) correlated with the altitude whereas the CT contents of honey locust pods had negative correlations ( $r = -0.971$ ,  $P < 0.001$  and  $-0.881$ ,  $P < 0.001$ ) with temperature and rainfall, respectively. The CT contents of honey locust pods obtained from Kayseri were significantly ( $P < 0.001$ ) higher than those obtained from other sites. On the other hand, the ash content of honey locust pods obtained from Gaziantep was significantly ( $P < 0.001$ ) higher than those obtained from other sampling sites.

**Table 2.** Chemical composition (g kg<sup>-1</sup> DM) of honey locust pods obtained from six growing sites.

Growing Sites	CP <sup>a</sup>	WSC <sup>b</sup>	EE <sup>c</sup>	NDF <sup>d</sup>	ADF <sup>e</sup>	Ash	CT <sup>f</sup>
Adana	67.2 <sup>a</sup>	122.3 <sup>a</sup>	11.7 <sup>ab</sup>	335.6 <sup>ab</sup>	225.2 <sup>ab</sup>	35.6 <sup>a</sup>	28.4 <sup>a</sup>
Ankara	104.8 <sup>c</sup>	144.3 <sup>d</sup>	6.9 <sup>a</sup>	380.8 <sup>bc</sup>	262.9 <sup>c</sup>	48.0 <sup>d</sup>	118.9 <sup>c</sup>
Gaziantep	82.1 <sup>b</sup>	131.2 <sup>b</sup>	10.0 <sup>ab</sup>	312.0 <sup>a</sup>	238.9 <sup>bc</sup>	51.7 <sup>e</sup>	71.5 <sup>b</sup>
Kayseri	119.9 <sup>d</sup>	146.5 <sup>d</sup>	13.8 <sup>b</sup>	414.3 <sup>c</sup>	251.8 <sup>bc</sup>	41.8 <sup>b</sup>	148.2 <sup>d</sup>
Kahramanmaraş	86.0 <sup>b</sup>	140.1 <sup>c</sup>	7.0 <sup>a</sup>	390.8 <sup>c</sup>	260.5 <sup>bc</sup>	46.4 <sup>c</sup>	61.9 <sup>b</sup>
Osmaniye	87.6 <sup>b</sup>	152.2 <sup>e</sup>	15.9 <sup>b</sup>	299.6 <sup>a</sup>	195.3 <sup>a</sup>	35.3 <sup>a</sup>	27.8 <sup>a</sup>
SEM <sup>g</sup>	2.61	1.19	1.99	11.86	9.15	0.457	8.32
Sig <sup>h</sup>	***	***	***	***	***	***	***

Column means with common superscript did not differ ( $P > 0.05$ ).

<sup>a</sup> Crude protein; <sup>b</sup> Water soluble carbohydrate; <sup>c</sup> Ether extract; <sup>d</sup> Neutral detergent fibre; <sup>e</sup> Acid detergent fibre; <sup>f</sup> Condensed tannin; <sup>g</sup> Standard error of mean; <sup>h</sup> Significance level, \*\*\*  $P < 0.001$

El-Shatnawi and Mohawesh (2000) suggested that ewes require 7-9% CP for maintenance and 10-12% for lactation. It seems to be likely that honey locust pods obtained from Ankara and Kayseri will meet the CP requirements of ewes for maintenance and lactation whereas honey locust pods obtained from Adana, Gaziantep, Kahramanmaras and Osmaniye will meet the CP requirement of ewes for maintenance only since the CP contents of honey locust pods obtained from Adana, Gaziantep, Kahramanmaras and Osmaniye were considerably lower than that required for the lactation of sheep. Therefore, honey locust pods obtained from Adana, Gaziantep, Kahramanmaras and Osmaniye should be supplemented with protein sources to meet the requirement of lactating sheep.

The high level of tannin ( $50 \text{ g kg}^{-1} \text{ DM}$ ) may restrict protein utilization in diets. Tannin may reduce the digestibility of nutrients due to the chemical formations with dietary nutrients such as protein. Tannins in leaves may form a less digestible complex with dietary proteins and may bind and inhibit the action of the endogenous proteins, such as digestive enzymes (Kumar and Singh 1984). Tannin can thus adversely affect the microbial and enzymatic activities (Singleton, 1981; Lohan *et al.*, 1983; Barry and Duncan, 1984; Makkar *et al.*, 1989; Silanikove *et al.*, 1994; 1996). However, in ruminants, dietary condensed tannins ( $20\text{--}30 \text{ g kg}^{-1} \text{ DM}$ ) have been shown to have beneficial effects because they reduce the protein degradation in the rumen by formation of a protein-tannin complex (Barry, 1987).

Honey locust pods obtained from Adana and Osmaniye had low CT contents. Therefore, optimal utilization of CP in honey locust pods obtained from Adana and Osmaniye could not be limited by low levels of condensed tannin due to tannin activity through chemical binding with dietary nutrients. On the other hand CT contents of honey locust pods obtained from Ankara, Gaziantep, Kayseri and Kahramanmaras were considerably high. Therefore, optimal

utilization of CP in honey locust pods obtained from Ankara, Gaziantep, Kayseri and Kahramanmaras may be limited by high levels of condensed tannin due to tannin activity through chemical binding with dietary nutrients. Therefore, supplementation of polyethylene glycol (PEG) or other alkali can be recommended to reduce the possible detrimental effect of tannin in honey locust pods obtained from Ankara, Gaziantep, Kayseri and Kahramanmaras.

The CP content of honey locust obtained from Adana was similar to that obtained by Bruno-Soares and Abreu (2003). The CP content of honey locust obtained from Ankara was comparable with that obtained by Duke (1983).

The NDF contents of honey locust obtained from Gaziantep and Osmaniye were similar to that obtained by Bruno-Soares and Abreu (2003). The ADF contents of honey locust obtained from Adana and Gaziantep were similar to that obtained by Bruno-Soares and Abreu (2003). The CT contents of Gaziantep and Kahramanmaras were similar to that obtained by Bruno-Soares and Abreu (2003) as well.

As can be seen from Table 2, there are considerable variations in chemical composition of honey locust among growing sites where the honey locust pods were collected. The variation among sites may be associated with differences in climatic conditions and soil types in growing sites where the honey locust pods were collected.

### ***In Vitro* Gas Production**

The *in vitro* gas production of honey locust pods in the absence or presence of PEG is presented in Figure 1. At all incubation times, gas productions in the presence of PEG were considerably higher than those obtained in the absence of PEG irrespective of honey locust pods type. However, honey locust pods from different growing sites showed variable responses on increase in gas production. Honey locust

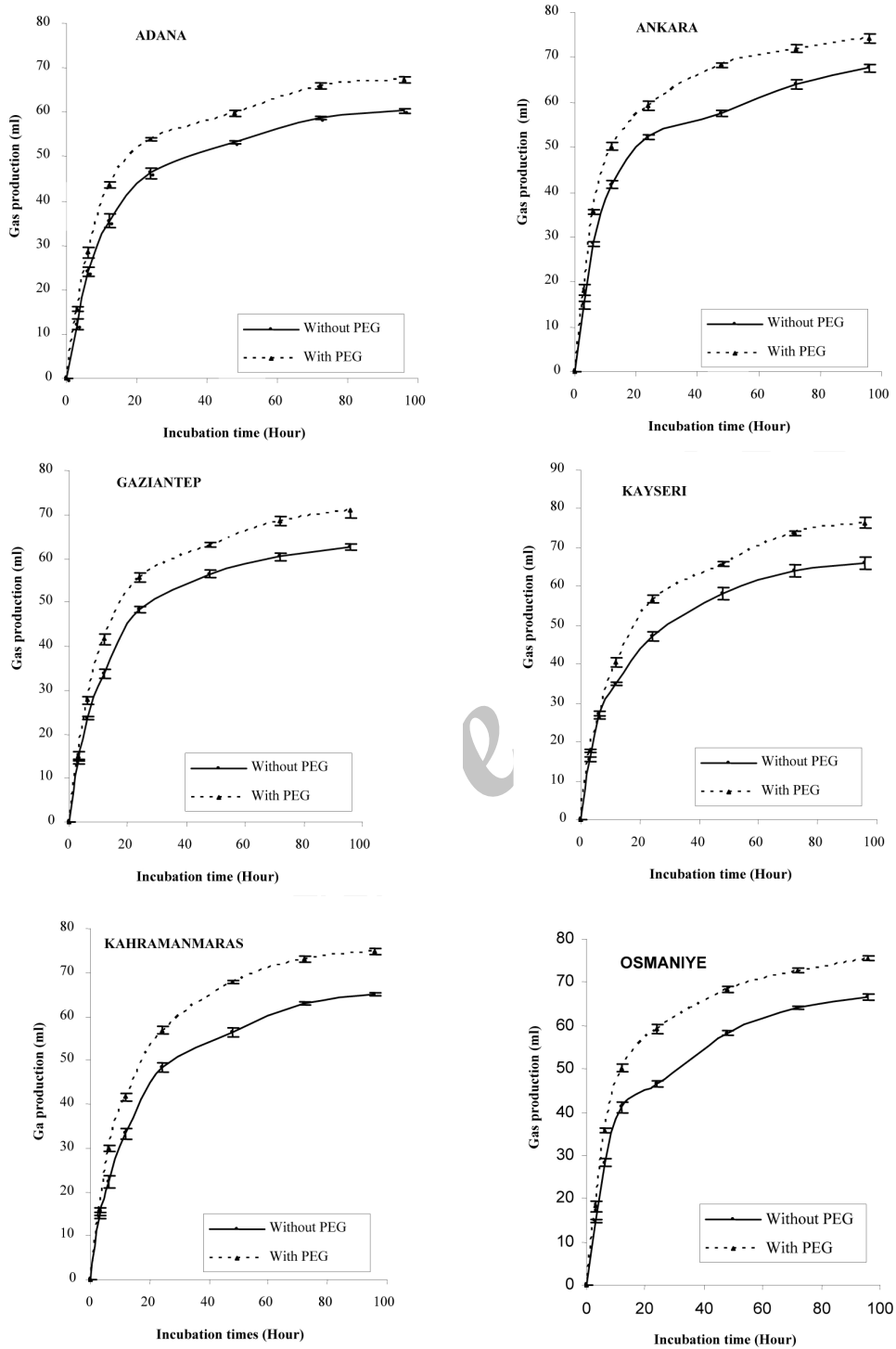


Figure 1. Effect of growing site and polyethylene glycol (PEG) on the gas production of honey locust pods.

Pods obtained from Kayseri and Kahramanmaras had the highest increase in the gas production at 96 h incubation time.

The gas production kinetics of honey locust pods incubated in the presence or absence of PEG are presented in Table 3. Growing site and PEG supplementation had a significant effect ( $P < 0.001$ ) on the gas production kinetics coefficients such as *c*, *a* and *b*.

Although in the absence of PEG, gas production rate of honey locust pods obtained from Ankara was significantly higher than those obtained from Adana, Gaziantep, Kayseri and Kahramanmaras, in the presence of PEG it was only significantly higher than those obtained from Kayseri and Kahramanmaras.

In the absence of PEG supplementation, gas production from quickly soluble fraction of honey locust pods obtained from Kayseri was significantly ( $P < 0.001$ ) higher than those obtained from the other sites whereas in the presence of PEG, it was only significantly higher ( $P < 0.001$ ) than those obtained from Adana, Ankara, Gaziantep and Osmaniye.

In the absence and presence of PEG

supplementation, the potential gas production (*a+b*) of honey locust pods from Adana was significantly ( $P < 0.001$ ) lower than those obtained from other sites.

The estimated OMD and ME contents of honey locust pods incubated in the presence and absence of PEG are given in Table 4.

There were significant ( $P < 0.001$ ) differences in the estimated OMD and ME contents of honey locust incubated in the presence or absence of PEG among growing sites. The growing site and PEG supplementation had significant ( $P < 0.001$ ) effects on the estimated OMD and ME contents.

In the absence of PEG, the estimated OMD and ME contents of honey locust pods from Ankara were significantly ( $P < 0.001$ ) higher than those obtained from the other sites. In the presence of PEG, the estimated OMD of honey locust obtained from Ankara was significantly higher than Adana, Gaziantep, Kayseri, Kahramanmaras and Osmaniye whereas the estimated OMD of honey locust obtained from Ankara was significantly higher than those obtained from Adana, Gaziantep, Kayseri and Kahramanmaras.

**Table 3.** The effect of polyethylene glycol and growing site on the gas production kinetics of honey locust pods.

Growing sites	<i>c</i>		<i>a</i>		<i>b</i>		<i>a+b</i>	
	PEG		PEG		PEG		PEG	
	-	+	-	+	-	+	-	+
Adana	7.43 <sup>b</sup>	8.7 <sup>c</sup>	1.12 <sup>a</sup>	0.84 <sup>a</sup>	56.7 <sup>a</sup>	63.4 <sup>a</sup>	57.8 <sup>a</sup>	64.3 <sup>a</sup>
Ankara	8.4 <sup>c</sup>	9.8 <sup>c</sup>	1.20 <sup>a</sup>	1.02 <sup>a</sup>	61.9 <sup>c</sup>	69.7 <sup>bc</sup>	63.2 <sup>c</sup>	70.7 <sup>bc</sup>
Gaziantep	6.7 <sup>ab</sup>	8.2 <sup>b</sup>	1.82 <sup>ab</sup>	1.34 <sup>ab</sup>	58.9 <sup>ab</sup>	67.58 <sup>b</sup>	60.2 <sup>b</sup>	68.9 <sup>b</sup>
Kayseri	6.23 <sup>a</sup>	6.1 <sup>a</sup>	3.57 <sup>c</sup>	2.94 <sup>c</sup>	60.1 <sup>bc</sup>	70.7 <sup>c</sup>	63.6 <sup>c</sup>	73.6 <sup>c</sup>
Kahramanmaras	5.96 <sup>a</sup>	6.8 <sup>ab</sup>	2.29 <sup>b</sup>	2.1b <sup>c</sup>	60.8 <sup>bc</sup>	70.5 <sup>c</sup>	63.1 <sup>c</sup>	72.7 <sup>c</sup>
Osmaniye	7.5b <sup>c</sup>	9.6 <sup>c</sup>	2.48 <sup>b</sup>	1.22 <sup>ab</sup>	60.3 <sup>bc</sup>	70.2 <sup>c</sup>	62.8 <sup>bc</sup>	71.4 <sup>bc</sup>
SEM	0.281	0.469	0.258	0.338	0.645	0.770	0.708	0.900
Sig	***	***	***	***	***	***	***	***
Site	***		***		***		***	
PEG	***		***		***		***	
Site X PEG	*		NS		**		*	

Column means with common superscript did not differ ( $P > 0.05$ ).

PEG= Polyethylene glycol; -= Without PEG; += With PEG; *a*= The gas production from the rapid soluble fraction (ml); *b*= The gas production from the insoluble fraction (ml); *c*= The gas production rate (ml h<sup>-1</sup>) for the slowly degradable fraction (b); *a+b*= potential gas production (ml); SEM= Standard error of mean; Sig= Significance level; \*\*\*  $P < 0.001$ , \*\*  $P < 0.01$ , \*  $P < 0.05$ , NS= Non-significant.



**Table 4.** The effect of polyethylene glycol and growing site on the organic matter digestibility (OMD) and metabolizable energy (ME) of honey locust pods.

Growing sites	OMD			ME		
	PEG		% increase	PEG		% increase
	-	+		-	+	
Adana	58.81 <sup>a</sup>	64.35 <sup>a</sup>	9.94 <sup>ab</sup>	8.85 <sup>a</sup>	10.05 <sup>a</sup>	13.54 <sup>a</sup>
Ankara	65.86 <sup>c</sup>	69.56 <sup>d</sup>	6.30 <sup>a</sup>	9.92 <sup>d</sup>	10.98 <sup>c</sup>	10.60 <sup>a</sup>
Gaziantep	61.22 <sup>b</sup>	66.59 <sup>b</sup>	9.25 <sup>a</sup>	9.12 <sup>b</sup>	10.28 <sup>ab</sup>	12.62 <sup>a</sup>
Kayseri	61.87 <sup>b</sup>	67.04 <sup>bc</sup>	9.46 <sup>a</sup>	9.43 <sup>c</sup>	10.91 <sup>c</sup>	15.66 <sup>a</sup>
Kahramanmaras	61.53 <sup>b</sup>	67.42 <sup>bc</sup>	10.20 <sup>ab</sup>	9.15 <sup>b</sup>	10.47 <sup>b</sup>	14.40 <sup>a</sup>
Osmaniye	60.04 <sup>ab</sup>	69.01 <sup>cd</sup>	15.81 <sup>b</sup>	9.19 <sup>bc</sup>	11.14 <sup>c</sup>	21.25 <sup>b</sup>
SEM	0.715	0.656	1.80	0.123	0.117	2.143
Sig	***	***	***	***	***	***
Site	***			***		
PEG	***			***		
Site X PEG	***			***		

Column means with common superscript did not differ ( $P > 0.05$ ).

PEG= Polyethylene glycol; -= Without PEG; += With PEG; OMD= Organic matter digestibility (%); ME= Metabolizable energy (MJ kg<sup>-1</sup> DM); SEM= Standard error of mean; Sig= Significance level \*\*\*  $P < 0.001$ ; NS= Non-significant.

Honey locusts from different growing sites showed variable responses to increase in OMD and ME. The increase in the estimated OMD and ME contents due to PEG supplementation ranged from 6.30 to 15.81% and 10.60 to 21.25%, respectively.

Correlation coefficient (r) for the relationship between chemical composition and gas production at 24 hours of incubation and some estimated parameters are presented in Table 5.

Gas production kinetics such as *a*, *b*, *a+b* were positively correlated with CP and WSC. Estimated ME and OMD were also positively correlated with CP content of honey locust pods.

The increase in the *in vitro* gas production and estimated parameters with PEG emphasizes the negative effect of tannins on digestibility. Makkar *et al.* (1995) suggested that PEG, a non-nutritive synthetic polymer, has a high affinity to tannins and makes tannins inert by forming tannin PEG complexes. In addition, The PEG can also liberate protein from the preformed tannin-protein complexes (Barry *et al.*, 1986). Therefore, some studies have clearly shown that PEG supplementation increased gas and volatile fatty acid production (Getachew *et al.*, 2002; Seresinhe and Iben, 2003; Karabulut *et al.*, 2007).

Makkar *et al.* (1995) and Getachew *et al.*

**Table 5.** Correlation coefficient (r) values between chemical composition and gas production at 24 h of incubation and some estimated parameters

Parameters	Chemical constituents						
	CP	WSC	EE	NDF	ADF	Ash	CT
Gas <sub>24h</sub>	0.357	0.207	-0.683**	0.315	0.602**	0.614**	0.464
<i>c</i>	-0.080	0.041	-0.039	-0.313	-0.214	-0.163	-0.103
<i>a</i>	0.608**	0.575*	0.488*	0.365	-0.013	-0.116	0.407
<i>b</i>	0.628**	0.754**	-0.306	0.399	0.389	0.376	0.474*
<i>a+b</i>	0.764**	0.854**	-0.054	0.476*	0.315	0.262	0.556*
ME	0.578*	0.366	-0.583*	0.461	0.648**	0.596*	0.646**
OMD	0.611**	0.389	-0.561*	0.480	0.651**	0.591**	0.674**

\*\*  $P < 0.01$ , \*  $P < 0.05$



(2000) clearly demonstrated the negative effects of tannin on digestibility of *Acacia* spp. and *Dichrostachys* spp. The increase in the gas production, their kinetics, OMD and ME in the presence of PEG is possibly due to an increase in the available nutrients especially carbohydrates and nitrogen, to rumen micro-organisms., McSweeney *et al.* (1999) demonstrated that supplementation of PEG caused a significant and marked increase in the rate and extent of ammonia production. It was also shown that supplementation of PEG at a level of 25 or 50 g per day to goat fed lentiks leaves and concentrate markedly increased *in vivo* DM, OMD and protein digestibility (McSweeney *et al.*, 1999). However, the honey locust pods obtained from different growing sites here, did not give the same response for PEG supplementation possibly due to differences in the tannin structure and function of honey locust pods. It was reported that leaves of tree also gave different responses for PEG supplementation. The reason why tree leaves give different responses can be the differences in chemical composition of tannins, the variation in tannin anti-nutritive activity between foliage species, the nature of tannin and chemical structure (Dalzell and Kerven, 1998) and degree of polymerization (Schofield *et al.*, 2001). In a similar way, possible differences in chemical composition and variation in anti-nutritive activity of condensed tannin in honey locust pods may have resulted in the different response for PEG supplementation. It has been reported that the effect of PEG also depends on the level of proteins in the diet. The higher the level of proteins the lesser is the effect of PEG supplementation (Makkar and Becker, 1996).

In the current study carob (*Ceratonia siliqua*) pods were chosen as a comparative feed since there is limited information about honey locust pods and honey locust pods were similar and comparable to carob (*Ceratonia siliqua*) pods in terms of chemical characteristics. Priolo *et al.* (2000) showed the adverse effects of tannin on

lambs fed with carob (*Ceratonia siliqua*) pulp based diets. Supplementing the lambs fed with carob (*Ceratonia siliqua*) based diets with PEG increased dry matter, crude protein and NDF digestibility. The adverse effects of tannin on kids fed with carob (*Ceratonia siliqua*) based diets were also demonstrated by Silanikova *et al.* (2006). Supplementing the kids fed these diets with PEG also increased feed intake, crude protein digestibility and growth performance.

## CONCLUSIONS

Considerable variation in the potential nutritive value of honey locust pods among growing sites was observed. The improvement in gas production, digestibility and metabolizable energy contents of honey locust pods due to addition of PEG suggest the negative effect of condensed tannin on digestibility and represent recovered feed nutrients. However, before large scale implementation of PEG supplementation, further investigations are recommended to determine the effect of CT on feed intake, animal performance and profitability of supplementation. The results of the present study may be valuable to farmers since they provide information concerning the chemical composition, OMD and ME contents of honey locust pods growing in different sites so that farmers can make full use of honey locust pods.

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## ارزش بالقوه غذایی نیام های درخت لیلکی (*Gleditsia triacanthos*) به دست آمده از رویشگاههای مختلف برای نشخوارکنندگان

۱. کمالک، ی. گون، م. کاپلان، م. بوگا، ا. ی. آتالای، و س. و. اوزکان

### چکیده

ارزش غذایی نیام‌های درخت لیلکی به دست آمده از رویشگاه‌های مختلف با روش‌های ترکیب شیمیایی و تولید گاز اینویتر و ارزیابی شد. اثر رویشگاه بر ترکیب شیمیایی معنی دار بود ( $P < 0.001$ ). مقدار CP نیام‌های درخت لیلکی بین ۶۷/۲ و ۱۱۹/۹ g/kg DM متغیر بود. میزان کربوهیدرات‌های محلول در آب (WSC) بین ۱۲۲/۳ و ۱۵۲/۲ g/kg DM تغییر می‌کرد. مقادیر فیبرشونده خنثی (NDF) و فیبرشونده اسیدی (ADF) با رویشگاه به ترتیب به میزان ۲۹۹/۶ تا ۴۱۴/۳ و ۱۹۵/۳ تا ۲۶۲/۹ g/kg DM تغییر داشت. مقدار تانن متراکم (CT) از ۲۷/۸ تا ۱۴۸/۲ g/kg DM متغیر بود. افزودن پلی اتیلن گلیکول (PEG) به‌طور معنی داری ( $P < 0.001$ ) تولید گاز و برخی از پارامترهای برآورد شده نیام‌های درخت لیلکی به دست آمده از رویشگاه‌های مختلف را افزایش داد. با این وجود، نیام‌های درخت لیلکی به دست آمده از رویشگاه‌های مختلف پاسخ‌های متفاوتی نسبت به تیمار PEG از خود نشان دادند. همچنین رویشگاه‌های مختلف از نظر تولید گاز و پارامترهای برآورد شده به‌طور معنی داری ( $P < 0.001$ ) متفاوت بودند. میزان قابلیت هضم ماده آلی (OMD) و انرژی قابل سوخت و ساز (ME) نیام‌های درخت لیلکی به دست آمده از رویشگاه‌های مختلف بدون ماده مکمل PEG به ترتیب بین ۵۸/۸۱ تا ۶۵/۸۶٪ و ۸/۸۵ تا ۹/۹۲ MJ/kg DM متغیر بودند. بهبود تولید گاز، OMD و ME با افزودن PEG حاکی از اثر منفی تانن بر قابلیت هضم می‌باشد. میزان افزایش (%) در مقادیر برآورد شده OMD و ME به ترتیب بین ۶/۳۰ تا ۱۵/۸۱٪ و ۶/۳۰ تا ۱۴/۹۴٪ تغییر می‌کرد.