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Estimation of Degradability Kinetics, Energy and Organic Matter Digestibility of Date Palm (*Phoenix dactylifera* L.) Leaves Silage by *in vitro* Gas Production Technique

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ABSTRACT

This study was conducted to evaluate of date palm leaves (*Phoenix dactylifera* L.) silage or dry as alternative for ruminants using *in vitro* gas production technique. Rumen liquor was obtained from four Naimey sheep fed on barely and alfalfa hay (slaughter house). The mixture of rumen fluid with buffer 1: 2 v/v, 30 mL were placed into each syringe, containing the samples. The incubation procedure was repeated three times. The gas production was recorded after 3, 6, 9, 12, 24, 48 and 72 h of incubation. Potential Degradability (a+b) and gas production rate (c) were measured. Metabolizable Energy (ME), Net Energy (NE), Organic Matter Digestibility (OMD) and Microbial Protein (MP) were also determined. Crude protein in date palm leaves silage was higher than that in dry form in date palm leaves, the values were 5.80 and 4.83%, respectively. Crude fiber was 34.92 and 32.23% for dry and silage of date palm leaves, respectively. There was no difference in pH between date palm leaves in both forms (dry and silage) and the values were 6.22 and 6.62 for dry date palm leaves and date palm leaves silage, respectively. The present study conclude that date palm leaves could be suitable for ruminants as a source of fiber which used as an energy source for host animal and microbes in the rumen. It can be used in dry form to provide ensiling time as alternative feeds for ruminants.

Key words: Date palm leaves, silage, gas production, alternative feeds, ruminant

INTRODUCTION

The enhancement in feed price encouraged nutritionists to search for cheaper alternative feeds. Kingdom of Saudi Arabia is arid regions characterized by low rainfall have a low primary production and forage quality. Under these environments, it is convenient to use desert plants, shrubs and tree leaves. The date palm (*Phoenix dactylifera* L.) of the natural resources that are drought tolerant and salinity, it is possible to use palm leaves after harvest dates as a type of roughage feed in ruminant diets. In the Arab countries, date palm tree is one of the major fruit crops. The number of date palm trees in terms of consumption and production dates varies from country to country, caused by environmental conditions prevalent, the intention paid to this crop and social conventions. Remainder of the date palm trees after harvest like fronds have a limited

value for ruminant feeding (in natural environments with no or limited alternatives it should be used). Some studies showed the date palm leaves can used as alternative feeds for ruminants. Date palm tree annually produces about 20 kg of leaves and it can be used for animal feeds (Pascual *et al.*, 2000). Bahman *et al.* (1997) suggested that date palm leaves might be an acceptable alternative feeds in mixed diet which contained highly concentrate. Thus, agriculture by-products that can be used for animal feed as alternative feeds such as date palm leaves after harvested the dates in its dry form or in the form of silage. Therefore, the objective of the current study was conducted to evaluate date palm leaves in two forms (dry and silage) as alternative feeds for ruminants using gas production technique.

MATERIALS AND METHODS

Silage of date palm leaves procedure: Date palm leaves were collected after harvested the main yield of dates. Collected date palm leaves were cleaned to remove any foreign substances and cut to 5-10 cm pieces, then mixed with 5% palm molasses (v/w). The mixtures of date palm leaves with palm molasses were placed in three liter plastic bucket by hand, firmly compressed, closed and strapped to prevent air ingress. Each group was prepared as three replicates and plastic bucket were left for fermentation at room temperature for 30 days. Samples of silage were opened after fermentation and used for determining of pH, further analyses.

***In vitro* trial:** *In vitro* gas production technique was conducted according to Menke and Steingass (1988). Rumen liquor was obtained from four sheep fed on barley and alfalfa hay (slaughter house). Buffer solution was prepared according to Onodera and Henderson (1980) and placed in a shaker water bath at 39°C under continuous flushing with CO_2. Approximately 200 mg air dry of dry or silage of date palm leaves samples were placed into syringe (100 mL, three syringes per sample). The mixtures of rumen fluid with buffer 1: 2 v/v, 30 mL were placed into each syringe, containing the samples according to Blummel and Orskov (1993). The incubation procedure was repeated three times. The gas production was recorded after 3, 6, 9, 12, 24, 48 and 72 h of incubation. Cumulative gas production values was fitted to the potential equation:

$$\text{Gas (Y)} = a+b\ (1-\exp^{-ct})$$

where, a is the gas production from the immediately soluble fraction, b is the gas production from the insoluble fraction, a+b is potential Degradability, c is the gas production rate constant for the insoluble fraction (b), t is incubation time, according to the model of Orskov and McDonald (1979).

Energy and microbial protein estimation: The energy values of dry and silage of date palm leaves were calculated from the amount of gas produced at 24 h of incubation with supplementary analysis of crude protein, ash, crud fibre and ether extract (Menke *et al.*, 1979; Menke and Steingass, 1988).

$$\text{ME (MJ kg}^{-1}\text{ DM)} = 2.2+0.136\text{GP}+0.057\text{CP}+0.0029\text{CF}$$

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

where, ME is the metabolizable energy; OMD is organic matter digestibility; GP is 24 h net gas production (mL/200 mg DM); CP is crude protein (%DM); CF is crude fibre (%DM); XA is ash (%DM).

$$NE\ (Mcal/lb) = (2.2+(0.0272*Gas)+(0.057*CP)+(0.149*EE))/14.64$$

where, Gas is 24 h net gas production (mL g^{-1} DM); CP is crude protein (%DM); EE is Ether extract (% DM), then net energy unit converted to be MJ kg^{-1} DM.

Microbial Protein (MP) was calculated as g kg^{-1} OMD according to Czerkawski (1986).

pH measurement: Seventy milliliter of distilled water were added to 35 g of each sample (dry or silage) in glass conical flask soaked at 4°C. The fresh and silage extracts were filtered through 2 layers of gauze and filter paper. The filtrate was stored at -20°C prior to chemical analysis (Shao *et al*., 2007) as described by Li *et al*. (2012). pH values were measured using a digital pH-meter.

Chemical analysis: The dry and silage samples of date palm leaves were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and ash according to AOAC (1995).

Statistical analysis: All data were analyzed using SPSS packet software was used (SPSS, 2002).

RESULTS AND DISCUSSION

The chemical composition and pH of date palm leaves in two forms (dry and silage) are shown in Table 1. Crude protein in date palm leaves silage was higher than that in dry form, the values were 5.80 and 4.83%, respectively. The increase of crude protein in silage compared to dry date palm leaves probably due to the increase in dry matter of date palm leaves silage (Table 1). Ziaei and Sharifi Hosseini (2009) found that supplementation of palm leaves with energy supplementary had no significant effect on crude protein content of silages. The crude protein of date palm leaves is usually low, about 5-7% DM (Arhab *et al*., 2006; Genin *et al*., 2004; Medjekal *et al*., 2011; Elhag and Elkhanjari, 1992) and this figures are agreement with the figures of crude protein in the present study (4.83-5.80%). Higher figures have been reported by Al-Yousef *et al*. (1993) and Ziaei and Sharifi Hosseini (2009) and the values of their reported are 10.6 and 16.5% DM, respectively. Crude fiber was 34.92 and 32.23% for dry and silage of date palm leaves, respectively. The lower crude fiber in ensiled date palm leaves was probably due to cell wall degradation by cellulolytic clostridia or acid hydrolysis (McDonald *et al*., 1991; Baytok *et al*., 2005). The chemical composition in this study and other studies is clear that date palm residues are low in protein and high in fiber and therefore it is suitable for ruminants as a source of fiber. There was no difference in pH between date palm leaves in both forms (dry and silage) and the values were

Table 1: Chemical composition (% of DM basis) and pH of date palm leaves

	Date palm leaves	
Item	Dry	Silage
Ash	10.03	10.78
Organic matter	89.97	89.22
Crude protein	4.83	5.8
Ether extract	3.5	3.32
Crude fiber	34.92	32.23
NFE	46.72	47.87
pH	6.22±0.01	6.62±0.02

NFE: Nitrogen free extract

Table 2: Parameters of gas production produced from date palm leaves during 72 h iucubation (Mean±SD)

Items	a+b (mL)	c (mL h^{-1})
Date palm leaves		
Dry	30.13±1.62 NS	0.03±0.003 NS
Silage	31.12±3.07	0.03±0.004

Cumulative gas production data were fitted to the model of Ørskov and McDonald (1979), Gas (Y) = a+b (1-exp^{-ct}), where; a is the gas production from the immediately soluble fraction, b is the gas production from the insoluble fraction, a+b is potential Degradability, c the gas production rate constant for the insoluble fraction (b), t is incubation time, NS: No significant differeuce within a column

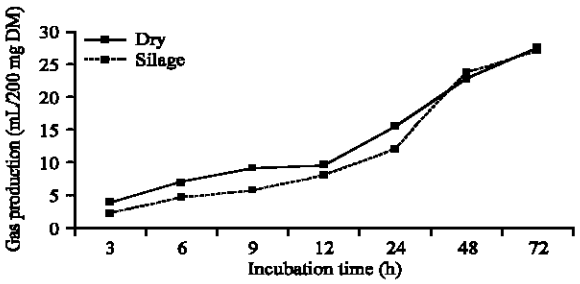

Fig. 1: Cumulative gas produced (mL/200 mg DM) at different incubation times of date palm leaves

6.22 and 6.62 for dry date palm leaves and date palm leaves silage, respectively (Table 1). For a good silage grade, the pH must be lower than 4.0, except if the DM content is higher than 30% (Dulphy and Demarquilly, 1981; Vanbelle *et al*., 1981; Demarquilly and Andrieu, 1988).

Figure 1 shows the cumulative gas produced at different incubation times of date palm leaves in both forms (dry and silage). The values of gas production extent at 72 h were 27.50 and 27.17, respectively. There were no significant differences ($p>0.05$) between dry and silage of date palm leaves in potential Degradability (a+b) (Table 2). The values were 30.13 and 31.12 mL for dry and silage of date palm leaves, respectively. The gas production rate (c) of date palm leaves in both forms is presented in Table 2. The values were 0.03 and 0.03 mL h^{-1}, for dry and silage of date palm leaves, respectively. Gas production technique has been widely used to assess the nutritive value of feedstuff, the types of wastes (vegetables, fruits or crops) and tropical plants (El-Waziry *et al*., 2005, 2007; El-Waziry, 2007; Razligi *et al*., 2011; Getachew *et al*., 1998).

The predicted metabolizable energy (ME, MJ kg^{-1} DM), net energy (NE, MJ kg^{-1} DM), organic matter digestibility (OMD, %) from gas production and microbial protein (MP, g kg^{-1} OMD) are presented in Table 3. The OMD was higher ($p<0.05$) in dry date palm leaves than that of silage. The values were 34.96 and 27.49% for dry date palm leaves and date palm leaves silage, respectively (Table 3). The increase of OMD in dry form of date palm leaves probably due to the decrease of ash content compared to silage form of date palm leaves. The predicted ME which calculated from gas production at 24 h incubation was 4.07 and 5.01 MJ kg^{-1} DM for date palm leaves silage and dry date palm leaves (Table 3), respectively. There was no significant difference between two forms of date palm leaves (dry and silage) in NE (Table 3). The value of NE was higher in dry form compared to silage form of date palm leaves (3.53 and 2.84 MJ kg^{-1} DM). The energy obtained from dry form of date palm leaves compared to silage form probably due to the high content of crude fiber and ether extract (Table 1). Elhag and Elkhanjari (1992) reported that

Table 3: Predicted of metabolizable energy (ME), net energy (NE), organic matter digestibility (OMD) and microbial protein (MP) in vitro from date palm leaves during 72 h incubation (Mean±SD)

Items	ME (MJ kg^{-1} DM)	NE (MJ kg^{-1} DM)	OMD (%)	(MP g kg^{-1} OMD*)
Date palm leaves				
Fresh	5.01±0.31[a]	3.53±0.19[a]	34.96±2.98[a]	42.17±3.59[a]
Silage	4.07±0.41[b]	2.84±0.35[a]	27.49±3.40[b]	33.16±4.11[b]

[a,b]Means within a column bearing different superscripts differ ($p<0.05$), *Calculated according to Czerkawski (1986)

the similar results of ME with dry date palm leaves in *in vivo* trail. The same manner of ME, NE and OMD was found with MP, the values were 42.17 and 33.16 g kg^{-1} OMD for dry and silage forms of date palm leaves, respectively (Table 3). The high value of MP for dry form compared to silage form may due to the high values of OMD, ME and NE, therefore dry date palm leaves is suitable for ruminants as a source of energy which contributes for microbial protein synthesis.

CONCLUSION

The present study conclude that date palm leaves could be suitable for ruminants as a source of fiber which used as an energy source for host animal and microbes in the rumen. The study also shows the date palm leaves in dry form is better than that in the form of silage due to chemical composition and organic matter digestibility and energy, therefore it can be used in dry form to provide ensiling time as alternative feeds for ruminants.

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