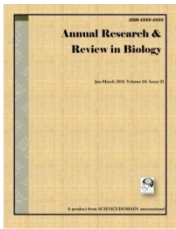

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Chemical Composition, DM and NDF Degradation Kinetics in Rumen of Eleven Different Date Pits

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Authors' contributions

This work was carried out in collaboration between all authors. Author AR designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author AN had the role of supervisor at the study. Authors RV and AT had the role of advisor. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: Study was undertaken to measure chemical composition and degradation kinetics of dry matter and neutral detergent fiber in the rumen for eleven different date pits that where cultivated in different parts of Iran.
Study design: Ruminal degradation kinetics of the pit samples were determined using 3 Holstein steers (450-500kg body weight), fitted with permanent rumen fistulas. Data were fitted using an exponential equation of $P=W+D\ (1-e^{-kd\times(t-T)})$, where P is the potential of degradability, W is the quickly degradable fraction, D is the slowly degradable fraction; k_d is the fractional degradation rate, t is the incubation time (h) and T is the lag time (h).
Place and Duration of Study: The study took place at the Ruminant Nutrition Research Center of Agriculture Faculty of Ferdowsi University of Mashhad which placed at Mashhad urban zone. This study lasted 3 months.
Methodology: Chemical composition, in situ DM and in situ NDF degradation kinetics in rumen of eleven different date pits (Barahi, Kabkab, Kharak, Khasi, Mazafati, mordabsang, Piarom, Rabbi, Estamaran, Shahani and Zahedi) were evaluated.
Results: CP ranged from 5.00 to 6.90% DM and Mazafati pit had highest NDF content

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(78.23% DM) and Mordasang had highest ADF content (59.73% of DM) while Estamaran had lowest NDF and ADF content (68.90 and 50.50% of DM respectively). Mordabsang had the lowest W-fraction$_{DM}$ (0.104h) and Estamaran had the highest D-fraction$_{DM}$ (0.485). In contrast, Estamaran, Khasi, Mazafati and Zahedi had the highest (0.300, 0.301, 0.304 and 0.301 respectively) W-fraction$_{DM}$ and Piarom had lowest (0.323) D-fraction$_{DM}$. The kd$_{DM}$ varied from 0.021/h (Mordasang) to 0.119/h (Estamaran). Piarom had the lowest W-fraction$_{NDF}$ (0.011) and Estamaran had the highest W-fraction$_{NDF}$ (0.046). In contrast, Mazafati had the highest (0.603) and Piarom had lowest (0.394)) D-fraction$_{NDF}$. Among the samples kd$_{NDF}$ varied from 0.021/h (Kharak) to 0.038/h (Estamaran).

Conclusion: In conclusion our results show that pits of these date varieties can be used as fiber source for ruminants and their relatively high EE content may be useful as an energy source.

Keywords: Date; date seed; degradation kinetic; Holstein steers.

1. INTRODUCTION

A major problem that limits livestock production in arid and semi-arid regions is the high cost of animal feed. This is mainly due to an acute shortage in fresh water that limits the utilization of land for the production of food for human and animal consumption [1]. There are some readily available agricultural by-products as potential livestock feeds, especially those from natural plant fauna. Date fruit is a particularly important product in arid and semi-arid regions of the world and plays an important role in the economic and political life of the people in these regions [2]. Based on FAO report [3], Iran was the largest producer of dates in the world. From 2000 to 2007, however, Egypt was the largest producer of dates and Iran was third after Iraq in 2000 and 2001. From 2002 to 2007, Iran had the second rank in date production with Iraq third rank [3]. Date seeds (pits) constitute approximately 10% of the fruit [4]. Pits of date palm (seed) are a waste product of many date fruit processing plants producing pitted dates, date powders, date syrup, date juice, chocolate coated dates and date confectionery. At present, after Maceration and separation of date flesh Date pits are used mainly for animal feeds in the cattle, sheep, camel and poultry industries [5]. Although date pits are produced in considerable amounts, the available information on their nutritive value is scarce. Before utilizing alternative feedstuffs in diets of livestock, it is important to know their chemical composition, availability of their nutrients, their behavior in the digestive tract, and their feeding value for these animals. Among the different components of the feeds for ruminants, the fibrous fraction is of at most importance [6]. Neutral detergent fiber (NDF) is the main component of the feedstuff in ruminant that affects dry matter intake (DMI) of animals of high production. Therefore a study was undertaken to measure chemical composition and degradation kinetics of dry matter and neutral detergent fiber in the rumen for eleven different date pits that cultivated are in different parts of Iran.

2. MATERIALS AND METHODS

2.1 Date Pit Samples

Different date pit samples were collected from different farmers where located in Southern provinces of Iran. Pits of Eleven of the most popular date cultivates in Iran were used in this study: Barahi, Kabkab, Kharak, Khasi, Mazafati, mordabsang (mordasang), Piarom, Rabbi, Estamaran, Shahani and Zahedi.

2.2 In Situ Rumen Incubation

Ruminal degradation kinetics of the samples were determined using 3 Holstein steers (450-500kg body weight), fitted with permanent rumen fistulas. The animals were fed maize silage ad libitum, and had 24h/d access to fresh water. Concentrate mixture (3 kg/day) was fed twice a day (1.5kg each time). The experiment was conducted in three runs. For each run of the in situ evaluation, the air dried samples were ground to 2-mm particle size in a Foss laboratory mill. Each feed sample (5g) was weighed into nylon bags (pore size of 45µm; bag size of 10×17cm) and incubated in the rumen of each steer for 0, 2, 4, 6, 8,12, 24, 48,72, 96 and 120h. Briefly, for each incubation time, 6 bags (2 bags per steer per incubation time) of each sample were incubated in the rumen. The bags were introduced progressively in the rumen starting with the bags to be incubated for the longest period (120h) and ending with the bags to be incubated for the shortest period (2h). On termination of the incubation period, the bags were taken out from the rumen and the loose material adhering to the outer surface of the bags was washed away by rinsing with tap water. The bags were then washed under the tap water for at least 15min until the washing water was clear. Zero-time wash values were measured by washing three bags per sample as described above without previous incubation in the rumen. The washed bags were oven dried to constant weight at 70ºC. The rumen incubated residues of each sample from the 3 steers were pooled per incubation time, mixed, and analyzed for neutral detergent fiber.

2.3 Calculations

Data were fitted using an exponential equation of $p=W+D\ (1-e^{-kd\times(t-T)})$ [7] where P is the potential of degradability, W is the quickly degradable fraction, D is the slowly degradable fraction; k_d is the fractional degradation rate, t is the incubation time (h) and T is the lag time (h).

The effective degradability of dry matter (ED_{DM}) and neutral detergent fiber (ED_{NDF}) was calculated according to the equation below:

$$ED = W + \left(\frac{kd}{kd + kp}\right) \times D$$

Where W, D and k_d are parameters described above and k_p is passage rate per h.

2.4 Chemical Analysis

Samples of feeds and residues were air dried at 70ºC, ground in a Foss laboratory mill to 1 mm particle size, and analyzed for CP(total N×6.25) (Kjeldahl method, Kjeltec 2300 Autoanalyzer, Foss Tecator AB, Hoganas, Sweden), ether extract (EE) [8], and ash [8]. The procedure of Georing and Van Soest [9] was used in the partitioning of cell-wall components into NDF, ADF and ADL (content of lignin). Hemicellulose was calculated as NDF – ADF and cellulose as ADF – ADL [10]. The DM content was determined by oven drying at 105ºC for 24h.

2.5 Statistics

Data on chemical composition of the samples were summarized by descriptive statistical analysis using Statistical Analysis System Software (SAS). Data on W-fraction, D-fraction, k_d and ED_{DM} and ED_{NDF} of samples were subjected to analysis as a completely randomized design using the General Linear Model (GLM). Duncan's multiple range test was used to compare treatment means at $P<0.05$.

3. RESULTS AND DISCUSSION

3.1 Nutrient Composition

The chemical composition and fiber constituents of date pits are summarized in Table 1. There was no large variation in nutrient composition among the samples. The CP content (g/kg DM) varied from 50 (Khasi) to 69 (Estamaran). The content (g/kg DM) of ADF and NDF varied from 505 and 659 (both for Estamaran) to 597 (mordabsang) and 798 (Shahani) respectively.

In comparison to other feedstuffs, date pit showed it's special nutritional composition. For example, CP, NDF, ADF and ADL amount of corn silage were reported 7.2, 36.8, 21, 2.8%, respectively [11]. In other hand, for wheat straw NDF content were estimated near to date pits (786g/kg DM) [12]. But, the important point is amount of CP and EE in comparison between date pits and wheat straw. Amount of CP in date pit is at least 5% and amount of CP was estimated 3/2%. Amount of EE in this study was at least 82 (g/kg DM) but it was estimated 9 (g/kg DM) for wheat straw [12]. It seems that date pits have better nutritional composition than most of high NDF feedstuff but, they have lesser amount of nutrients than high quality forages same as corn silage or alfalfa.

Table 1. Chemical and fiber composition of date pit samples (%DM)

Sample	CP	ASH	EE	NDF	ADF	ADL	Cellulose	Hemicellulose
Barahi	6.27	1.00	11.80	76.87	57.77	12.31	19.1	45.46
Estamara	6.90	2.60	10.20	68.90	50.50	11.83	18.4	38.67
Kabkab	6.10	1.27	10.07	74.47	55.52	13.27	18.95	42.25
Kharak	6.67	1.53	8.22	69.70	56.34	10.14	13.36	46.2
Khasi	5.00	1.13	9.93	72.83	55.02	12.71	17.81	42.31
Mazafati	5.47	1.07	10.50	78.23	53.03	13.35	25.2	39.68
Mordabsangn	6.57	0.97	7.03	77.67	59.73	13.11	17.94	46.62
Piarom	5.73	1.17	8.13	77.87	57.87	12.86	20.00	45.01
Rabbi	6.53	1.20	13.97	78.01	56.27	12.74	21.74	43.53
Shahani	6.43	0.90	9.60	79.77	57.60	13.28	22.17	44.32
Zahedi	5.98	1.40	11.52	70.50	55.53	13.10	14.97	42.43

3.2 In Situ Ruminal Drymatter Degradability Characteristics of Date Samples

The in situ DM degradation kinetics and ED_{DM} of the samples are presented in Table 2. There was a large variation ($P<0.001$) in W-fractions, D-fractions, kd, T and ED_{DM} among the samples. Mordabsang had the lowest W-fraction (0.104^h) and Estamaran had the highest D-fraction (0.485). In contrast, Estamaran, Khasi, Mazafati and Zahedi had the highest (0.300, 0.301, 0.304 and 0.301 respectively) W-fraction and Piarom had lowest (0.323) D-fraction. The kd varied from 0.021/h (Mordasang) to 0.119/h (Estamaran). Also lag time (T) varied from 0.10 (Mordabsang) to 4.54 (Kharak). The ED_{DM} values decreased consistently with increasing rumen outflow rates, and ranged from 0.193 to 0.622 at a rumen outflow rate of 0.06/h (Table 2). At the three rumen outflow rates, Estamaran had the highest and Mordabsang had the lowest ED_{DM} values (Table 2). The result of effective degradability of dry matter in this study was averaged 40.75% (ranged from 19.3% to 62.2%) compared to wheat straw (passage rate of 0.06 per hour) with effective degradability of 36.3% [12]. This wide range of differences in dry matter degradation can resulted from differences in varieties nutritional composition.

Table 2. In situ ruminal dry matter degradation kinetics and effective degradability of samples

Samples	Degradation kinetics[1]				Effective degradability (ED)[2]		
	W	D	k_d	T	ED_{DM} 1	ED_{DM} 2	ED_{DM} 3
Barahi	0.143^{g}	0.357^{d}	0.032^{i}	1.60^{f}	0.325^{i}	0.266^{j}	0.236^{j}
Estamaran	0.300^{a}	0.485^{a}	0.119^{a}	0.54^{h}	0.687^{a}	0.622^{a}	0.576^{a}
Kabkab	0.282^{b}	0.339^{e}	0.093^{c}	2.47^{bc}	0.536^{e}	0.486^{e}	0.452^{e}
Kharak	0.273^{c}	0.309^{g}	0.071^{f}	4.54^{a}	0.488^{f}	0.439^{f}	0.408^{f}
Khasi	0.301^{a}	0.429^{b}	0.089^{d}	2.22^{d}	0.620^{c}	0.556^{c}	0.513^{c}
Mazafati	0.304^{a}	0.438^{b}	0.106^{b}	1.10^{g}	0.640^{b}	0.578^{b}	0.535^{b}
mordasang	0.104^{h}	0.354^{d}	0.021^{j}	0.10^{i}	0.246^{j}	0.193^{k}	0.169^{k}
Piarom	0.168^{f}	0.323^{f}	0.050^{h}	1.98^{e}	0.368^{h}	0.313^{i}	0.282^{i}
Rabbi	0.243^{d}	0.352^{d}	0.072^{f}	2.33^{cd}	0.487^{f}	0.430^{g}	0.395^{g}
Shahani	0.183^{e}	0.368^{c}	0.058^{g}	1.30^{g}	0.418^{g}	0.357^{h}	0.321^{h}
Zahedi	0.301^{a}	0.370^{c}	0.079^{e}	2.58^{b}	0.568^{d}	0.510^{d}	0.472^{d}
SEM[3]	0.0021	0.0019	0.0009	0.0430	0.0040	0.0040	0.0038

Means within the same column with differing superscript (a–k) are different (P<0.05).
[1] W is the quickly degradable fraction, D is the slowly degradable fraction; kd is the fractional degradation rate, t is the incubation time (h) and T is the lag time.
[2] The ED_{DM} was calculated by using three passage rates: 0.03/h (ED_{DM}1), 0.06/h(ED_{DM}2) and 0.09/h (ED_{DM}3).
[3] Standard error of the mean.

3.3 In Situ Ruminal NDF Degradability Characteristics of Samples

The in situ NDF degradation kinetics and ED_{NDF} of the samples are presented in Table 3. Piarom had the lowest W-fraction (0.011) and Estamaran had the highest W-fraction (0.046). In contrast, Mazafati had the highest (0.603) and Piarom had lowest (0.394)) D-fraction. The kd varied from 0.021/h (Kharak) to 0.038/h (Estamaran). Mazafati had the lowest lag time (T) (0.021) followed by Khasi (0.038) and there was no significant difference between other samples. The ED_{NDF} values decreased consistently with increasing rumen outflow rates, and ranged from 0.091 to 0.265 at a rumen outflow rate of 0.06/h (Table 3). At the three rumen outflow rates, Estamaran had the highest and Barahi had the lowest ED_{DM} values (Table 3).

There is a growing need to generate an accurate database on the degradation kinetics of the local feeds. The results of this study present a comprehensive database on the ruminal dry matter and NDF degradation kinetics of several date pits commonly used as a fiber source in Iran. There are reports about using date pit in fattened sheep diet [13], Broiler starter and finisher diets [14] and fish diets [15] but as far as authors know there is no published data available on ruminal degradation kinetics of date pit. Chemical composition of date pit used in cited studies are in the range of chemical composition of date pit samples in present study. However slight differences mostly because of differences in cultivate characteristics, soil, environment condition and botanical effects are anticipated. Bruno-Soares et al. [16] tested seven legume straws and in their study extent of degradation for DM and NDF by the nylon-bag technique varied between 45.4 and 63.2%, and 36.6 and 57.1%, respectively. Some of the samples in present study (i.e. Estamaran) have shown similar characteristics and according to their fiber content and degradation kinetics of DM and NDF they possibly can be used instead of legume straws in diets. However straws if chopped properly offer considerable amounts of physical effective fiber. Date pit is used in grinded form for the ruminant's diets and there is a serious doubt that it can fulfill the physical benefits of straws. There is wide difference in degradation characteristics between varieties as it was shown in Table 2 and Table 3. It can occur because of differences in time of harvesting date fruits and variety differences. For example, some studies showed differences in crude fat, crude fiber, ash and tannins content in different time of harvesting fruits [17].

Table 3. In situ ruminal NDF degradation kinetics and effective degradability of samples

Samples	Degradation kinetics[1]				Effective degradability (ED)[2]		
	W	D	k_d	T	ED_{NDF} 1	ED_{NDF} 2	ED_{NDF} 3
arahi	0.013^{i}	0.450^{e}	0.014^{h}	1.600^{a}	0.145^{j}	0.091^{j}	0.069^{j}
Estamaran	0.046^{a}	0.570^{b}	0.038^{a}	1.600^{a}	0.361^{a}	0.265^{a}	0.213^{a}
Kabkab	0.031^{d}	0.502^{d}	0.023^{e}	1.600^{a}	0.249^{e}	0.170^{e}	0.133^{e}
Kharak	0.019^{g}	0.455^{e}	0.021^{f}	1.600^{a}	0.207^{g}	0.137^{g}	0.105^{g}
Khasi	0.042^{b}	0.539^{c}	0.024^{e}	1.433^{b}	0.279^{c}	0.194^{c}	0.154^{c}
Mazafati	0.020^{f}	0.603^{a}	0.032^{b}	0.600^{c}	0.330^{b}	0.229^{b}	0.177^{b}
mordsang	0.007^{j}	0.457^{e}	0.014^{h}	1.600^{a}	0.124^{k}	0.076^{k}	0.056^{k}
Piarom	0.011^{i}	0.394^{f}	0.019^{g}	1.600^{a}	0.164^{i}	0.106^{i}	0.080^{i}
Rabbi	0.023^{e}	0.447^{e}	0.026^{d}	1.600^{a}	0.231^{f}	0.159^{f}	0.124^{f}
Shahani	0.015^{h}	0.460^{e}	0.020^{g}	1.600^{a}	0.193^{h}	0.126^{h}	0.096^{h}
Zahedi	0.037^{c}	0.502^{d}	0.028^{c}	1.600^{a}	0.267^{d}	0.188^{d}	0.150^{d}
SEM[3]	0.0004	0.0027	0.0003	0.0430	0.0022	0.0017	0.0014

Means within the same column with differing superscript (a–k) are different (P<0.05).
[1] W is the quickly degradable fraction, D is the slowly degradable fraction; kd is the fractional degradation rate, t is the incubation time (h) and T is the lag time.
[2] The ED_{NDF} was calculated by using three passage rates: 0.03/h (ED_{NDF}1), 0.06/h(ED_{NDF}2) and 0.09/h (ED_{NDF}3).
[3] Standard error of the mean.

4. CONCLUSION

In conclusion our results show that pits of some date varieties can be used as fiber source for ruminants and their relatively high EE content may be beneficiary as an energy source.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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