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Short communication

Effect of feeding discarded dates on milk yield and composition of *Aradi* goats

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ABSTRACT

The effect of feeding discarded dates (non-edible for human consumption) on milk yield and composition of lactating Aradi does was studied in Saudi Arabia. Ten multiparous Aradi dairy does were equally divided into two groups and they were offered two diets; one as the control diet, including 35% alfalfa hay and 65% concentrate (corn grain, wheat bran, barley and molasses) and the other one as treated diet in which 30% of the total ingredients (basically from cereals) were substituted by discarded dates. Therefore, diets were isonitrogenous (18% CP) and isoenergetic. Milk yield, pH, and acidity of milk, major milk components, nitrogen distribution and minerals in milk were evaluated. No significant differences in yield and acidity of milk were observed between the two diets, while *pH* of milk in the control diet was higher. Milk obtained from does receiving discarded dates was significantly higher in protein and solids-not-fat contents, but the other milk constituents were not different. No significant differences were observed for non-protein nitrogen of milk (NPN). Milk obtained from does fed diet with dates had higher casein nitrogen and non-casein nitrogen than does fed the control diet. Casein number was higher for milk obtained from does fed the diet with dates. For minerals content in the milk, differences in K, Na, Mg, Ca, Fe, and Zn contents between the two dies were not significant, while Mn and Cu were reduced in milk of does receiving dates. In conclusion, feeding isonitrogenous diets including a reasonable dose of discarded dates had no negative effects on milk yield and composition of Aradi goats.

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1. Introduction

Most of the farmers in Saudi Arabia are using all agricultural byproducts such as date byproduct as feedstuffs for their animals. Mahgoub et al. (2005) reported that adding date syrup to the mixed diet needs special care during mixing and pelleting. However, discarded dates have a high amount of sugar with a large quantity of date syrup. To date, information available in the literature about the inclusion of discarded dates in diets of goats is very scarce. Most of the studies dealt with flavor quality in milk from sheep and goats fed date byproducts were mainly focused for carcass characteristic and meat quality and not for fresh milk and milk products (Mahgoub et al., 2005). Therefore, the main objective of the present study was to evaluate the effects of diets including discarded dates on milk yield and composition of Aradi lactating goats under hot climatic conditions.

2. Materials and methods

This experiment was carried out at the Animal Production Research Station, College of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia.

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Table 1
Ingredients used in formulating the experimental diets (%).

Ingredient	Experimental diet	
	Control	Dates
Discarded dates	0	30
Alfalfa hay	35	35
Barley grain	9	0
Wheat bran	8	5.5
Molasses	3	0
Limestone	1.2	1
Corn grain	20.5	0
Soybean meal-44	22.78	27.98
Salt, NaCl	0.25	0.25
Vitamin premix[a]	0.27	0.27

[a] Vitamin premix contains Vit. A 4000,000 IU, Vit. D_3 730,000 IU, Vit. E 3300 mg, Vit. B_1 330 mg, Vit. B_2 1300 mg, Vit. B_6 500 mg, Vit. B_{12} 305 mg, pantothenic acid 3500 mg, niacin 7000 mg, biotin 15 mg, folic acid 350 mg (per kg premix).

2.1. Animals and diets

In November 2005, a total of 10 multiparous lactating Aradi goats of nearly similar weight (62 ± 4.6 kg body weight, 45 ± 3.8 days in milk) were divided into two groups (5 does each) and were offered two diets for a period of eight weeks: (1) control diet; and (2) diet supplemented with dates. Does of control group were fed the diet not containing discarded dates, while does of the second group were fed the diet supplemented by discarded dates. The control diet included 35% alfalfa hay and 65% concentrate (corn grain, wheat bran, barley and molasses), while in treated diet 30% of the total ingredients (basically from concentrate) were substituted by discarded dates. Therefore, diets were isonitrogenous (18% CP) and isoenergetic. Ingredients used in formulating the experimental diets and chemical composition of the ingredients and diets are shown in Tables 1 and 2. All the does kidded during winter and each doe was housed in individual pen located under semi-shed. The two diets were offered to does as TMR pelleted diets of 0.8–1 cm in length and 0.5 cm in diameter. The diets were restricted two times daily at 06:00 AM and 06:00 PM; residual feed was not found. Water and salt licks were available freely. Chemical analyses of the experimental diets and the ingredients used in formulating these diets were carried out according to the AOAC (1990). As expected, all parameters of chemical composition (DM, TDN, CP, CF and DE contents) in the two diets were nearly similar. Foss TECATOR apparatus was used to measure the CP (Model: 2300 Kjeltec) and CF (Model: Fibertec 2010). Total digestible nutrient values (TDN) were calculated based on the TDN content in ingredients, while digestible energy (DE) was calculated according to the formula outlined by Crampton et al. (1957) and Swift (1957) as; DE (Mcal/kg DM) = TDN% × 0.04409.

The does have single or twin kids and they were given the diets gradually 14 days before the initiation of the experiment to be adapted for such experimental diets. Then, the diets were offered to the does for a period of 6 weeks and milk yield was recorded daily.

2.2. Management of kids and milk samples collection

Two-week old kids were separated from their dams and after milking and taking the samples, the kids were fed the milk using the suckling bottles. One day before the end of each week of lactation, kids were separated from their does in the evening and the does were machine milked for the remaining milk after kids' suckling. On the last day of each week (milking and sampling day), does were totally machine milked in morning and evening and milk yield was recorded in grams for each doe. Then, 30 ml milk samples were collected and immediately frozen (−20 °C) to be chemically analyzed thereafter.

2.3. Chemical analyses of milk

The *pH* of milk was measured immediately after milking with an Orion *pH* meter (Orion Research Inc., Cambridge, MA, UK). Milk samples were analyzed for fat, protein, lactose, ash and titratable acidity according to procedures outlined in AOAC (1990). Fat was determined by the Gerber method, protein by the micro-Kjeldahl method, while lactose was determined by subtraction. A nitrogen conversion factor of 6.38 was used to calculate protein contents of milk samples and various fractions. Milk samples were fractionated for total nitrogen (TN) and non-casein nitrogen (NCN), while non-protein nitrogen (NPN) was determined in the supernatants as outlined by Cerbulis and Farrell (1975).

2.4. Mineral analyses of milk

For determining minerals in milk, the ash was dissolved in 20% HCl. The final diluted solution for calcium and magnesium determination contained 1% lanthanum to overcome phosphate interference. All minerals, except phosphorus, were determined by Pye Unicam Atomic Absorption Spectrophotometer. Phosphorus was determined spectrophotometrically (Milton Roy Spectronic 21D, USA). All milk samples were duplicated in their analyses. All the reagents used were of analytical grade.

2.5. Statistical model of analysis

Data were analyzed by adopting *ANOVA* for complete randomized design using GLM procedure of SAS program (1996). Milk yield and composition parameters were analyzed using the following linear model:

$$Y_{ijklm} = \mu + D_i + A_{ij} + T_k + W_l + DT_{ik} + DW_{il} + TW_{kl} + DTW_{ikl} + E_{ijklm}$$

where Y_{ijklm} = observation on *ijklm*th trait; μ = overall mean; D_i = effect of *i*th diet [i = 1, 2; 1 = diet without dates, 2 = diet with 30% dates]; A_{ij} = random effect of *j*th doe within *i*th diet; T_k = effect of *k*th time of milking [k = 1, 2; 1 = morning, 2 = evening]; W_l = effect of *l*th week of lactation; DT_{ik}, DW_{il} and TW_{kl} = effect of two-order interactions of $D_i \times T_k$, $D_i \times W_l$ and $T_k \times W_l$, respectively; DTW_{ikl} = effect of three-order interaction of D_i, T_k and W_l; E_{ijklm} = random error.

All the data to be measured as percentages were subjected to an arc-sin transformation to approximate normal distribution before being analyzed.

3. Results and discussion

Sources of variation and least-square means for milk yield and components in Aradi goats are presented in Table 3. Since most of the interactions effects were not significant, only some of them were presented in the table of results.

Table 2
Chemical composition of the ingredients and diets (on DM basis, %).

Item	Alfalfa hay	Wheat bran	Barley grain	Corn grain	Soybean meal	Molasses	Discarded dates	Control diet	Dates diet
DM	90.9	89.0	88.6	88.0	89.0	90.0	88.0	89.61	89.50
Ash	7.8	6.6	2.7	1.5	6.9	11.4	10.4		
CP	17.0	17.4	13.0	8.5	44.0	8.5	3.8	18.37	18.22
EE	3.4	4.3	2.0	4.1	1.3	0.2	3.4		
CF	30.1	11.3	5.7	2.5	6.5	0.5	2.8	12.62	12.49
NFE	41.7	60.4	76.6	83.4	41.3	79.4	79.5		
TDN	56.6	70.5	85.9	87	88	77	84.0	65.49	65.55
Ca	1.19	0.14	0.05	0.02	0.33	0.17	0.17	0.87	0.85
P	0.24	1.27	0.38	0.35	0.71	0.03	0.03	0.41	0.32
DE (kcal/kg)							2882	2884	

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Table 3
Sources of variation and least-square means for milk yield, pH, acidity, milk components and minerals components (mg/100 gm) in Aradi goats.

Milk trait	Diet (*D*)		Milking time (*T*)		Sampling week (*W*)	Interactions		R.S.D.
	Control	Dates	AM	PM		*D* × *T*	*D* × *W*	
Milk yield (g)	1094^{a}	1273^{a}	1768^{a}	598^{b}	**	NS	NS	491
pH	6.65^{a}	6.58^{a}	6.61^{a}	6.62^{a}	**	NS	*	0.072
Acidity (%)	0.15^{a}	0.16^{a}	0.16^{a}	0.15^{a}	NS	NS	NS	0.025
Fat %	3.90^{a}	4.00^{a}	2.86^{a}	5.04^{b}	NS	NS	*	0.937
Protein (%)	2.85^{a}	3.05^{b}	3.02^{a}	2.89^{b}	NS	*	NS	0.142
NPN (%)$^{+}$	8.24^{a}	7.81^{a}	7.84^{a}	8.15^{a}	***	NS	***	1.41
NCN (%)$^{+}$	17.97^{a}	18.03^{a}	17.48^{a}	18.77^{a}	NS	NS	NS	3.24
CN (%)$^{+}$	73.78^{a}	74.16^{a}	74.67^{a}	73.07^{a}	***	NS	*	5.28
Lactose	4.17^{a}	4.27^{a}	4.23^{a}	4.22^{a}	NS	NS	NS	0.571
Solids not fat (%)	7.85^{a}	8.14^{b}	8.08^{a}	7.91^{a}	NS	NS	NS	0.536
Total solids (%)	11.75^{a}	12.10^{a}	10.93^{a}	12.95^{b}	NS	NS	NS	1.086
Ash (%)	0.82^{a}	0.81^{a}	0.82^{a}	0.80^{b}	**	NS	NS	0.027
K (mg)	154^{a}	148^{a}	154^{a}	147^{a}	NS	NS	NS	13
Na (mg)	55^{a}	61^{a}	57^{a}	59^{a}	NS	NS	NS	14
P (mg)	29^{a}	36^{a}	31^{a}	34^{a}	*	NS	NS	14
Mg (mg)	16^{a}	14^{a}	17^{a}	13^{a}	NS	NS	NS	11
Ca (mg)	137.3^{a}	110.6^{a}	131.9^{a}	115.9^{a}	**	NS	**	61.9
Fe (mg)	0.244^{a}	0.251^{a}	0.242^{a}	0.253^{a}	***	NS	NS	0.17
Mn (mg)	0.025^{a}	0.017^{b}	0.020^{a}	0.025^{a}	NS	NS	**	0.008
Zn (mg)	0.382^{a}	0.400^{a}	0.388^{a}	0.393^{a}	***	NS	NS	0.060
Cu (mg)	0.104^{a}	0.067^{b}	0.081^{a}	0.089^{a}	***	NS	NS	0.074

R.S.D. = residual standard deviation; ^{a,b}Values having different superscripts within each row are significantly different ($p < 0.05$); $^{+}$figures as a percentage of total nitrogen in milk; NS = non-significant ($p > 0.05$); $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; NPN = non-protein nitrogen; NCN = non-casein nitrogen; CN = casein nitrogen.

3.1. Milk yield, pH and acidity of milk

Differences in least square means of milk yield, pH and acidity of milk for Aradi goats in the two diets and times of milking were mostly non-significant (Table 3). The daily milk yield averaged 1094 ± 108 and 1273 ± 89 g for does fed control and 30% dates diets, respectively; the difference between the two diets was not significant. From the producers' point of view, these results for milk yield were moderate under hot climate, which may be an encouraging factor for the goat producers in the Arabian Gulf countries to raise Aradi goats in this area using diets including discarded dates. Dosari et al. (1996) showed that Al-Aradi goat is the best local breed in Saudi Arabia for milk production. Data of milk yield for Aradi goats in the present study, made under a hot range of temperatures (35–45 °C), was comparable with that reported for tropical dairy goats raised in the Arabian Gulf and other Asian regions (Devendra, 1991), whereas the data was much lower than that reported for Alpine, Nubian and Saanen goats (Haenlein, 1996, 2007; Bava et al., 2001; Serradilla, 2001; Muller et al., 2002), not necessarily obtained in hot climate areas. Sawaya et al. (1984b) in Saudi Arabia reported that milk production of Aradi goats was relatively low (60–150 kg/year) and they concluded that these goats can produce milk steadily even during periods of drought and, therefore they are greatly appreciated by desert dwellers.

The difference in titratable acidity of milk between the two diets was not significant (Table 3). *pH* of milk obtained from does fed the control diet was higher than from those does fed diet with dates. However, pH and titratable acidity of milk recorded in this study are corresponding closely to that for Aradi goats obtained by Sawaya et al. (1984b).

Significant interaction effect was detected between diet and time of milking for *pH* in milk (Table 3). Bava et al. (2001) in Italy reported non-significant interaction effect between diet and period of lactation for milk yield and composition in Saanen goats throughout lactation.

3.2. Gross composition of milk

Milk obtained from does fed diet with dates was significantly higher in protein and solids-not-fat contents than does fed diet without dates, but was comparable for other constituents (Table 3). In dairy cows, milk protein content is usually related with the non-fiber carbohydrates content of the diet (NFC) or easily fermentable carbohydrates (sugar, starch) other than NDF; diets with low NFC (<30%) give low values of protein content. In contrast, diets with high NFC (35–45%) give higher milk protein contents. If feeding dates increased the NFC of the diet, this could justify the higher protein content in the milk. Bahman et al. (1997) reported that using date palm leaves in lactating cows did not affect milk yield and composition. Fat and total solids percentages reported here for Aradi goats were higher and protein was lower than that reported by Sawaya et al. (1984b) for the same breed. Results in this study are generally comparable to those data published for goats raised in the tropics as well as for goats in other parts of the world (Jenness, 1980; Analla et al., 1996; Bava et al., 2001). However, changing milk composition depends on many factors and the most important of which is the composition of the diet (Sanz Sampelayo et al., 1998). Results reviewed in this concept are conflicting since some authors reported that feeding had no significant effects on milk composition (Bava et al., 2001), while others reported significant effects (Ilahi et al., 1999).

Significant interaction effect ($p < 0.05$) was found only between diet and sampling week for fat concentration in milk (Table 3).

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3.3. Nitrogen distribution in milk

There was no significant difference in non-protein nitrogen (NPN) for milk obtained from the two diets (Table 3). The NPN content was about 8.4% of the total nitrogen in milk. This result is comparable with that reported by Mehaia and Al-Kanhal (1989) for Aradi goats. With respect to non-casein nitrogen (NCN) and casein nitrogen (CN), does fed diet with dates showed higher content than does fed the control diet ($p < 0.05$), in accordance with the differences observed in CP content.

The percentage of total nitrogen (TN) in milk as casein nitrogen is called the casein number, and it characterizes the suitability of milk for cheese production, i.e. yield of the cheese depends directly on the amount of casein in milk. Casein numbers for goat's milk in the present study averaged 73.8 and 74.2 for milk obtained from does fed diet without dates and with dates, respectively (Table 3). The results obtained with discarded dates are favorable for dairy goats' processors since casein is the principal protein component for fermented milk and cheese. Results for casein number in milk of the present study are similar to those reported by Jenness (1980), while higher casein numbers in the range of 77–79 have been reported by Mehaia and Al-Kanhal (1989) and Bava et al. (2001).

Interaction effects for diet by week of lactation were significant for CN and NPN (Table 3). Bava et al. (2001) reported non-significant interaction effect between diet and lactation week on milk composition for Saanen goats.

3.4. Milk minerals

Differences in minerals concentrations in milk in terms of K, Na, P, Mg, Ca, Fe, and Zn between the two diets were not significant (Table 3), whereas contents of Mn and Cu in milk obtained from does fed control diet were higher than that from does fed diet with dates. However, minerals content in milk varies greatly with the variations of minerals in the diets used (Jenness, 1980).

The content of calcium as a major mineral in milk (Table 3) was higher than that reported for Aradi goat by Sawaya et al. (1984a). Results of this study are generally similar to the data published for the other breeds of goats (Jenness, 1980; Sawaya et al., 1984a), except that phosphorous was lower in the current study than the range of 61–153 mg/100 ml reported in these literatures.

With respect to trace elements in milk (Table 3), Fe and Zn contents were not significantly different in the two diets used. Iron and zinc contents in the milk were higher than the values reported by Sawaya et al. (1984a). The amounts of iron, manganese, zinc and copper were comparable with those concentrations of goat's milk reported by Jenness (1980).

Most of the interactions effects given in Table 3 were not significant for the majority of milk minerals.

4. Conclusions

- Dates excluded from human consumption could be beneficially used as an ingredient in the diets of small ruminants taking into account the right proportion of dates added and balancing correctly the CP content of the diet.
- Using discarded dates in feeding of small ruminants could be sounded in hot climate countries particularly for Aradi dairy goats in the Arabian Gulf area.

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