Chemical Composition and Feeding Value of Chopped Date Fronds (CDF) as Affected by Urea and Date Syrup Extract Treatment

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ABSTRACT : In the first of two experiments, chemical composition (Ash, CP and CF contents), nutritive value (*in vitro* organic matter disappearance "IVOMD" and energy content "ME") and nitrogen retention of chopped date fronds (CDF) as affected by chemical treatment (CT) and storage duration (SD) were investigated. The experimental design was a completely randomized block, arranged in a 3 × 4 factorial, with 3 (CT) and 4 (SD) as the main factors using 2 replications/treatment. Three chemical treatments, were used : Control (With zero or no chemical treatment); treatment with 4% urea solution (w/w) and treatment with 4% urea + Date syrup extract (DS). The 4 (SD) were: Control (immediately after opening - without any storage or zero time storage); one month storage period; two months storage period and three months storage period. Both (CT) and (SD) had significant effects ($p < 0.05$) on CP and ash contents of the CDF, however there were no significant effects ($p > 0.05$) due to (CT) and (SD) on CF and nutritive value. High retention value (> 80%) for nitrogen was reported for the treated CDF, immediately after opening the incubated material (zero SD). However, nitrogen retention decreased with increasing (SD) to 67% after one month (SD) but tended to stay at a fairly constant level of 67% until 3 months of storage. In experiment 2, the feeding value of treated CDF was evaluated in comparison to Rhodes grass hay, using growing goats and sheep. A 4 × 2 factorial design was used (Four roughage sources were used : Rhodes grass hay, untreated CDF, urea-treated CDF and CDF treated with urea + DS with sheep and goats as two animal species, using three animals/treatment). Untreated CDF had a similar feeding value to Rhodes grass hay. However treatment of CDF with urea alone or with urea + DS depressed animal performance of both goats and sheep, apparently due to depression of feed intake (appetite). Feeding untreated CDF decreased feeding cost by 29% and cost/kg gain by 23%. CDF showed a good potential as a cheap local roughage and emergency feed for ruminants in the Sultanate.

(**Key Words:** Chemical Composition, Feeding Value, Chopped date Fronds, Rhodes Grass, Urea, Date Syrup Extract)

INTRODUCTION

The most widely available cheap feed resources for ruminants in the tropics are the fibrous and low protein-mineral feeds, which include native pastures, crop residues and agro-industrial by-products. The expensive and often unavailable (or imported) feeds are the sources of amino acids and glucogenic compounds (the protein meals, cereal grains and cereal by-products) (Preston, 1995). The development of efficient feeding systems, based on low quality fibrous feeds, for ruminants in the tropics require : Supplementation of those feeds by the appropriate deficient nutrients or by establishment of efficient rumen fermentation in order to optimize microbial growth and maximize digestibility of fibre component of the fibrous or roughage feeds within the rumen (Jayasuria, 1987) or by supplementation and increase of frequency of feeding and/or rumen manipulation (Chalupa, 1977; Leng, 1991).

In the Sultanate of Oman, like most other tropical countries, the most abundant feed resources are the fibrous feeds comprising natural pastures and range, crop residuces and agro-industrial by-products of which date by-products (particularly date leaves + rachis or date fronds) are the most available (EL Hag, 1995). However, date fronds were reported to be very fibrous and low in protein (EL Hag, 1995). The objective of this research was to improve the nutritive value of date fronds, physically (by chopping and reduction of particle size) and chemically by supplementation with NPN (Urea) and energy (DS) and to assess its feeding value as a roughage source for ruminants in the Sultanate.

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MATERIALS AND METHODS

Treatments

In both trials whole date fronds were chopped by a heavy duty chopping machine into small particles prior to treatment, as described by EL Hag and EL Shargi (1996).

Trial 1. (Preliminary laboratory trial)

The samples of the CDF (One kg each) were treated with : 500 ml tap water only (Control: No urea or zero percent urea); 40 g (4%) of fertilizer grade urea disolved in 500 ml tap water and 40 g (4% urea + DS) fertilizer grade urea disolved in 500 ml Syrup extract (Prepared by soaking 2 kg of Date fruits in one litre of tap water for overnight and then filtered through two layers of cheese cloth. The date syrup extract contained about 14% total solids or sugars). Tap water only (Control), 4% urea solution and the 4% urea + DS respectively, were sprinkled evenly on each sample of one kg CDF (To obtain a moisture level of approximately 33%) and stored at room temperature (30-35℃) in polythene bags in duplicates. The bags were hand pressed to remove air and were well wrapped to create anaerobiasis. The treated samples of CDF were exposed open after three weeks storage period (anaerobically) and duplicate samples were immediately analysed (without any further storge-zero SD) for proximate analysis (AOAC, 1984) and for (IVOMD) according to Tilley and Terry (1963). The remaining treated samples were left open and stored for: one month, two months and three months, respectively (the storage was done aerobically on top of the laboratory bench). In each (SD), proximate analysis and (IVOMD) were also conducted. Accordingly there were three chemical treatments : Control (untreated CDF) ; CDF treated with 4% urea and CDF treated with 4% urea + DS. There were also four SD: Zero SD (fresh-unstored samples, obtained immediately after anaerobic storage) ; one month SD ; two months SD and three months SD. The experimental design used in this study was a completely randomized block in a 3×4 factorial arrangement (3 CT and 4SD as the main factors with 2 replications per treatment). The data was analysed according to Steel and Torri (1980).

Trial 2 (feeding trial)

Treatment of CDF

Two lots (100 kg, each) of CDF were treated with 4% urea solution and with 4% urea + DS, exactly as described for the preliminary laboratory trial. The treated materials were also stored anaerobically for three weeks using polythene sheets and then exposed open under shade and fed to sheep and goats, two weeks later. Untreated (control) CDF was used without any soaking or water treatment (used in an intact natural form after chopping). Four roughage types were evaluated in the feeding trial : Untreated (control) CDF ; CDF treated with 4% urea; CDF + urea + DS and Rhodes grass hay (*Chloris guyana*), variety Callide. All the roughage materials were fed *ad libitum* to two groups of growing goats and sheep. Restricted amounts (0.5 kg) of a pelleted commercial concentrate mixture (manufactured by Oman flour mill), containing 14% CP and about 70% TDN was fed to each goat and sheep during the trial.

Animals and experimental design

Twelve growing local (Batina) goats 5-9 months old and mean body weight of 19.8 ± 0.5 kg and twelve growing local Omani sheep of 4-9 months old and mean body weight of 25 ± 1.2 kg were used in this study. Both goats and sheep were divided into four groups of three animals per group, according to body weight. Mean initial body weights of the different groups, respectively were: 19.7 ± 0.9; 19.7 ± 2.4; 20 ± 1.5; 19.7 ± 1.8 and 25.2 ± 2; 25 ± 1.7; 25.2 ± 4.4; 24.8 ± 2.4 kg. The four roughages were randomly allocated to the four groups of animals within each species. The experimental design was essentially a complete random design arranged in a 4×2 factorial (Four roughage sources and two animal species as the main factors with three animals per treatment). Animals were individually housed in pens eqipped with facilities for food and water. Animals were fed freely on the roughage feeds but were restricted on the concentrate diet (each head allowed only 0.5 kg). Animals were allowed free access to trace- mineralized salt lick blocks and clean water throughout the length of the trial which lasted for 70 days. Intake of feeds was recorded every day 08:00 a.m, refusals were measured and refed the following day. The animals were measured biweekly, with feed and water being removed the night preceeding weighing. Costs of feeds and feeding for goats and sheep fed on the different roughages were computed, according to prevailing prices at time of conducting the experiment. Feed intake and animal performance data was analysed as 4×2 factorial accrding to Steel and Torrie (1980).

RESULTS AND DISCUSSION

CDF used in this study was analysed for proximate analysis before and after treatment. Untreated (control) CDF, contained 90% DM, 3% CP, 9.95% ash and 39.5% CF. During storage, both colour and fungal infestation

were carefully observed. The colour of the treated material was changed from yellow to slightly brownish, probably due to the Millard reaction as reported by Herrera-Saldana et al. (1983). However, no fungal infestation was observed on the treated material. CDF treated with urea alone or urea + DS, retained moisture of 61.5 and 66.8 percent (when the material was first open, after three weeks of storage), respectively. Treatment with 4% urea/4% urea + DS, significantly ($p < 0.05$) increased CP content from 3 to 8.4/8.2 percent, respectively. The increase in the content of CP reported in this study was in agreement with results obtained by Badurdeen et al. (1994) and Rasool and Gilani (1995). In this study also significant difference ($p < 0.05$) in the ash content was reported for treated CDF. However, no significant ($p > 0.05$) differences were reported for CF, IVOMD and ME contents of treated CDF (table 1). Lack of significant effects of urea treatment on CF content of CDF, obtained in this study was in agreement to ths findings of Rasool and Gilani (1995). In general values for : CP, CF, IVOMD and ME were very similar and not significantly different ($p > 0.05$) between CDF treated with urea alone or with urea + DS. However CDF treated with urea alone had a significantly ($p < 0.05$) higher content of ash than CDF treated with urea + DS.

Table 1. Effects of urea and DS treatments on crude protein, ash, crude fiber, (IVOMD) and ME (MJ/kg DM) contents of CDF

Chemical treatment	Contents (% DM-basis)*				
	CP	Ash	CF	% IVOMD**	ME (MJ/KG DM)***
Untreated CDF	3.0 ± 0.12[a]	9.95 ± 0.5[ab]	39.5 ± 3.2	23 ± 2.7	3.5 ± 0.4
CDF + 4% urea	8.4 ± 1.0[b]	10.1 ± 0.1[a]	40.6 ± 3.8	27 ± 5.7	4.1 ± 0.8
CDF + 4% urea + DS	8.2 ± 0.8[b]	9.85 ± 0.3[b]	39.1 ± 3.4	25 ± 2.1	3.8 ± 0.3

* All values are reported as means ± SE.

[a,b] Means in the same column with different superscripts differ significantly ($p < 0.05$).

** IVOMD was determined by Tilley and Terry method (1963).

*** ME was calculated using (IVOMD), by the following equation as described by MAFF (1980):

$$\text{ME (MJ/KG DM)} = (0.152\ \text{CP} + 0.342\ \text{EE} + 0.128\ \text{CF} + 0.159\ \text{NFE}) \times \frac{\text{(D-Value)}}{100 - \text{TA}}$$

Where as TA = % total ash and D-Value = % IVOMD.

Percent retention of nitrogen in the CDF, as affected by chemical treatment and storage duration is summarized in table 2. It was observed that, following anaerobic storage and immediately after uncovering of the CDF samples, about 86.9% and 81.5% of urea nitrogen were retained in the CDF treated with urea alone and urea + DS, respectively. It was shown that with increasing storage duration (Post-opening of the anaerobically stored material) some losses occured in the amount of the retained urea nitrogen, particularly after on month of

Table 2. Retention and loss in nitrogen contents of CDF as affected by chemical treatment and storage duration

Chemical treatment	% N added	Storage duration							
		Fresh unstored CDF samples* (immediately after anaerobic storage)		One month after anaerobic storage*		Two months after anaerobic storage*		Three months after anaerobic storage*	
		% N content	% N retained	% N content	% N retained	% N content	% N retained	% N content	% N retained
CDF + urea	1.84	1.6	86.9	1.26	68.5	1.25	67.9	1.28	69.6
CDF + urea + DS	1.84	1.5	81.5	1.36	73.9	1.2	65.2	1.2	65.2

% DM of CDF + urea only and CDF + urea + DS, immediately after opening (following anaerobic storage) ; one month storage after opening; two months storage after opening and three months storage after opening, respectively were: 61.5 vs. 66.8; 88.4 vs. 87.7; 89.8 vs. 90.0 and 90.3 vs. 90.6.

storage. However following one month of storage, the losses tended to decrease and stayed at a fairly constant level of about two thirds of the amont of the originally added urea nitrogen. In general, retention values for urea nitrogen in both treated CDF samples were very similar but with relatively higher values for urea treated CDF samples. Those retention values for urea nitrogen obtained for CDF in this study, were in agreement to values reported by Rasool and Gilani (1995) for wheat straw also treated with 4% urea.

Effects of storage duration on: CP, CF, ash IVOMD and ME contents of CDF are presented in table 3. Only CP and ash contents were significantly ($p < 0.05$) affected by SD. They both tended to decrease with increasing length of SD. Eventhough CP decreased with increasing lengh of SD, yet it was still retained at a relatively high and constant value (about 67% of the amont of the urea added) for a period of three months of SD. It was unexplainable as to why ash was significantly decreased with SD. It was good that both IVOMD and ME contents (nutritive value) were not significantly ($p > 0.05$) affected by SD. This implicates that urea treated CDF can be fed until three months of SD (maximum SD evaluated in this study) without any significant effects on its nutritive value and consequently on animal performance, although slight losses of nitrogen are anticipated. The proximate composition and ME contents of the four roughages and the commercial concentrate diet fed to sheep and goats are shown in table 4. It was clear that treated CDF contained very high CP values, almost 200% of the (control) untreated CDF. Those CP values were even higher than the value of the CP reported for Rhodes grass hay. It was obvious that urea treatment improved and rectified the deficiency of the nitrogen in

Table 3. Effect of storage duration on CP, CF, ash, % IVOMD and ME contents of treated CDF

Item*	Storage duration			
	Fresh, unstored CDF (immediately after anaerobic storage)	One month (after anaerobic storage)	Two months (after anaerobic storage)	Three months (after anaerobic storage)
(%) CP	7.5 ± 1.0[a]	6.4 ± 0.8[b]	6.2 ± 0.8[b]	6.2 ± 0.5[b]
(%) CF	40.4 ± 3.9	37.0 ± 1.5	40.0 ± 1.0	39.7 ± 0.5
(%) ash	10.3 ± 0.3[a]	9.7 ± 0.3[b]	9.9 ± 0.1[c]	9.96 ± 0.3[c]
(%) IVOMD	25.3 ± 5.0	25.3 ± 5.0	24.6 ± 3.7	24.7 ± 1.0
ME (MJ/kg DM)	3.8 ± 0.7	3.8 ± 0.7	3.7 ± 0.5	3.7 ± 0.2

* All values are reported as means ± SE.

[a,b,c] Means in the same row with different superscripts differ significantly ($p < 0.05$).

Table 4. Chemical composition (% DM-basis) and ME content of the different feeds offered to goats and sheep during the feeding trial

Item	Feed				
	CDF (control-untreated)	CDF + urea	CDF + urea + DS	Rhodes grass hay	Concentrate feed
DM	90	87	88.0	90.6	89.0
Ash	9.4	10.0	9.6	10.4	9.2
OM	90.6	90.0	90.4	89.6	90.8
CP	3.0	9.0	8.5	7.0	14.0
EE	0.8	1.0	1.2	1.6	3.0
CF	41.0	40.0	39.0	34.2	8.8
NFE	45.8	40.0	41.7	46.8	65.0
ME* (MJ/kg DM)	3.6	4.0	4.0	8.3	11.5

* ME values for both Rhodes grass hay and concentrates were calculated by determining TDN values, from an *in vivo* digestion trial using sheep, then TDN values were converted to ME (By considering one kg of TDN to be equivalent to: 3.6155 Mcal of ME and one Mcal of ME as equivalent to: 4.1855 MJ of ME). ME values for CDF (control and treated) samples were calculated by determining (IVOMD), using Tilley and Terry (1963) and the equation described by MAFF (1980).

the CDF. This is in agreement with the findings of: Badurdeen et al. (1994); Rasool and Gilani (1995); Singh et al. (1996) and Preston (1995). Treatment of CDF with urea/urea + DS also improved ME content by about 11% as compared to control CDF. The rest of the proximate components, other than the CP, were similar among treated and untreated CDF. In general treated CDF showed similar proximate composition to Rhodes grass hay. However the calculated ME content of the treated CDF samples were approximately 50% of that of Rhodes grass hay. Performance of goats and sheep on the different roughages was summarized in table 5. There was a significant difference ($p < 0.05$) between dry matter (DM) intake of the different types of roughages, with Rhodes grass hay having the lighest value, followed by untreated (control) CDF then treated CDF. Treatment of CDF with urea/urea + DS, significantly ($p < 0.05$) depressed DM intake. The depression in the DM intake between (control) unterated CDF and treated CDF was about 7% and was in contrast to the findings of Mbatya et al. (1983) ; Leng (1991) and Preston (1995). However all those researchers reported improvement in the DM intake when using cereal straws. To out knowledge, no attempt was made to treat date fronds in this country or else where, with urea. It was very clear that date fronds are chemically different from cereal straws. Date fronds are very fibrous (with CF and cell wall contents > 35 and 70 percent, respectively) and lignified (containing > 8 percent lignin), EL Hag (1995). In addition date fronds contain tannins, parti-cularly in the leaflets and frond bases, Nazem EL-Dim et al. (1983). It could be due to the different chemical nature and presence of tannins that date fronds responded differently to urea treatment than cereal straws. The depression in the DM intake of the CDF due to urea treatment was probably an appetite factor as both tannins and urea were reported to be bitter and with an unpleasant taste. It was also apparent that addition of DS to the urea treated CDF did not improve DM intake (or appetite). It seems that the amount of sugars added to the CDF, when using DS was very minimal in comparison to amounts of sugars which will be added if molasses was used. The sugar content of DS

Table 5. Effect of type of roughage on dry matter intake and performance of goats and sheep (Main effects)

Item	Type of Roughage				Species		SE	
	Rhodes grass hay	CDF untreated	CDF + urea	CDF + DS	Goats	Sheep	Species	Rough-age
Period	70	70	70	70	70	70		
Number of animals	6	6	6	6	12	12		
Initial body weight (BW), kg	22.4	22.4	22.4	22.5	19.8	25.0		
Final (BW), kg	24.2	24.0	23.2	22.9	21.2	25.9		
Average (BW), kg	23.3	23.2	22.8	22.7	20.5	25.5		
Liveweight gain (g/day)	26^{a}	23^{a}	$11^{a,b}$	6^{b}	20	13	2.9	4.1
Roughage DM-intake (g/day)	256	176	164	163	154	226		
Concentrate DM-intake (g/day)	455	455	455	455	455	455		
Total DM-intake (g/day)	711^{a}	631^{b}	619^{c}	618^{c}	609^{a}	681^{c}	3.5	5.0
Concentrate : Roughage ratio (%)	64:36	72:28	74:26	74:26	75:25	69:31		
Feed effciency (g feed/g gain)	27.4	27.4	56.3	103	30.5	52.4	6.3NS	8.8NS
DM-intake as, % (BW)	3.0	2.72	2.71	2.72	3.0	2.7		
DM-intake (g) kg $BW^{0.75}$	67	59.7	59.3	59.4	63.2	60.0		
ME (MJ/day)	7.4	6.0	6.0	6.0	6.14	6.5		
CP-intake (g/day)	81.6	69	78.5	77.5	74	79		
Nutrient composition (%/DM):								
TDN	68.4	61.4	63.3	63.0	65.3	62.7		
CP	11.5	11.0	12.7	12.5	12.2	11.7		
CF	17.9	17.8	16.9	16.7	16	18.8		
Ash	9.6	9.4	9.4	9.3	9.3	9.3		
EE	2.5	2.4	2.5	2.5	2.5	2.4		
NFE	58.5	59.4	58.5	59	60.0	58.8		

[a,b] Row values, within each main effect, with different superscripts differ significantly ($p < 0.05$).

was about 14% where as the sugar contents of molasses are usually over 50%, Preston (1995). One kg of CDF treated with DS in this study (one kg treated with 500 ml DS) will contain 70 mg sugars (500 ml × 14%) where as if one kg of CDF was treated with 4% molasses (w/w), it will contain 20 g of sugars (1,000 × 4 % = 40 g molasses, containing 50% sugars will yield: 40 × 50% = 20 g sugras). It is very obvious that very little or trace amounts of sugars (about 70 mg) were added to the CDF when it was treated with DS. This may explain lack of response due to addition of DS to the urea treated CDF and similarity of the results obtained with both CDF treated with urea/urea + DS.

Results of liveweight gain obtained by feeding CDF to goats and sheep were parallel and matching to the results obtained for DM intake. However, liveweight gain for untreated CDF was similar to that obtained for Rhodes grass hay and so was feed conversion efficiency. It is very interesting to note that, although DM intake of animals fed on untreated CDF was lower than that of Rhodes grass hay, yet the animals fed on untreated CDF performed similarly to animals fed on Rhodes grass hay, which reflects efficient utilization of the digestible nutrients from untreated CDF, compared to Rhodes grass hay. In general animal performance was depressed by feeding treated CDF. Comparing performance of goats and sheep on those high fiber diets, it was clear that goats performed better than sheep with relatively better liveweight gain and feed conversion efficiency (table 5.) and with lower cost of feeding and cost/kg gain (table 6.). This is in agreement to the findings of EL Hag (1976) and Leng (1991), who both reported better efficiency for goats when utilizing fibrous feeds in comparison to sheep. Feeding untreated CDF decreased daily feeding costs by 29% and cost/kg gain by 23% (table 6.). Although urea treatment was effective in increasing and rectifying the CP deficiency of the CDF, however animal performance was depressed mainly due to the depression of the DM intake. It was apparent that the amounts of sugars added due to the addition of DS to the urea treated CDF was very low and insignificant to enhance the inherently low palatability of the CDF which was further aggravated by urea treatment. Further research is planned to study the effects (effects on feeding value to ruminants) of treating CDF with urea and 4-5% molasses.

Table 6. Cost of feeding as affected by type of roughage and animal species

Item	Type of roughage				Species	
	Rhodes grass hay	Untreated CDF	CDF + urea	CDF + urea + DS	Goats	Sheep
Average amount of consumed feed (kg/day)	0.781	0.696	0.684	0.685	0.678	0.761
* Cost of consumed feed/day (Baisa)	69	49	49	49	52	54
Average daily gain (kg)	0.026	0.023	0.011	0.006	0.02	0.013
Cost/kg gain (Baisa)	2,760	2,130	4,455	8,166	2,600	4,154

* Cost of consumed feeds/day were calculated by considering cost of one kg concentrate to be = 96.5 Baisa, cost of one kg Rhodes grass to be = 75 Baisa, cost of one kg CDF to be = 3 Baisa, cost of one kg CDF + urea to be = 3.5 and cost of one kg CDF + urea + DS to be = 4 Baisa.

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