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Evaluation of Olive and Palm Byproducts in Feeding Camels

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Abstract: Metabolism trials were carried out using four mature males of Sudanese camels; *Camelius dromedaries* to evaluate the nutritive value of date stone (DS) and olive cake (OC), palm leaves (PL) and barley grains (BG) or their mixture. Results indicated that barley grains showed significantly ($p<0.05$) higher digestibility and nutritive value in all nutrients except for EE and ADF compared with either olive cake or date stone. In addition, DS showed better digestibility in all nutrients compared with OC except for EE digestibility. The ration contained BG plus DS recorded the highest digestibility for DM, OM, CP, CF and NFE. While, the ration contained BG plus OC recorded higher digestibility for NDF and ADF. No significant differences were detected in dry matter intake expressed as DMI g/$W^{0.75}$ by camels fed different either tested feeds or rations. The water intake increased with animals fed DS being 8.42 L compared with BG and OC being 7.58 and 6.92 L, respectively. Also, results showed that animals consumed the ration contained BG plus DS recorded the highest water intake being 8.33 L. Feeding on BG led up to significant ($p<0.05$) decrease in pH values compared with other feeds after 3 and 5 h. No significant differences in ammonia nitrogen concentration at 5 h post feeding with all feeds. The BG plus DS mixture gave the lowest concentration of rumen ammonia content at the three times. While, BG with PL mixture showed the highest value of rumen ammonia content at the three times. It could be concluded that date stone and olive cake used to feed camel as substitution of barley grains without any adverse effect.

Key words: Olive cake, date stone, palm leaves and camels

INTRODUCTION

Camels represent an important source of income in terms of meat and milk production in the arid and semi arid regions which include Arab world and Africa (Gaholt, 1998). The dromedary is one economic feeder, which can uniquely survive in the desert as a met producer of meat and milk (Shawket, 1999).

Ruminants feeding systems based on locally available by-product feedstuffs are often a practical alternative because the rumen microbial ecosystem can utilize by-product feedstuffs which often contain high levels of structural fiber to meet their nutrient requirements for maintenance, growth, reproduction and milk production (Bampidis and Robinson, 2006).

In Egypt, The available amount of concentrate feed for consumption about 4.1 million tons of starch equivalent and about 353.5 thousand tons of digested protein. So, we need to use agricultural and agro-industrial by-products to cover gap feeding (Hamdia *et al*., 2011). More than 21 million tons of agriculture crop residues are produced in Egypt annually (Deraz, 1996). However, only 4.0 to 4.3 million tons of these crop residues are used for feeding animals (Khorshed, 2000).

Considerable quantities of olive cake by products that are suitable for feeding to livestock are generated every year in Mediterranean countries (Sadeghi1 *et al*., 2009). Olive cake (OC) which is a by product of olive oil industry contains high concentration of crude fiber (30-40%) along with a relatively high content of residual un-extracted oil (Francisco *et al*., 1989). Annual production of date stone in Egypt about, 1.1 million tons representing 16% of total world production (FAO, 2004). The nutritive value of date pits ranged from 5.64 to 8.20% for CP, 1.60-9.35% for EE, 9.10-22.0% for CF, 58.5-75.4% for NFE, 38.5-73.1% for NDF, 17.2-35.3% for ADF (Aldhaheri *et al*., 2004)

This study aimed to determine the nutritive value of date stone and olive cake and palm leaves as camel feed and its effect on feed intake, water consumptions and rumen parameters.

MATERIALS AND METHODS

The present study was carried out at the Experimental Station of Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt.

Animals and feeds: Voluntary intake and digestibility trials were carried out using four adult male camels about 5 years old and 398 kg body weight were used and housed individually.

The experimental feeds used in this study were formulated from Barley Grains (BG), Date Stone (DS), Olive Cake (OC), Barley Straw (BS) and Palm Leaves (PL). The dietary treatments rations offered at 1% of

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live body weight for camels are summarized in Table 1. Mineral blocks were available for all animals in the different trials for free choice.

Digestion trials: All animals were dulled in individual cages during whole the study period. The preliminary period was 21 days to adapt animals for the new consumed feed and then followed by 7 days as a collection period for urine and feces. There was special preparation and procedure for a male camel to collect both feces and urine without any loses as shown in Fig. 1 and 2.

At the end each collection period rumen liquor samples were withdrawn just before morning feeding, three and six hours post feeding. Rumen liquor samples were collected through rubber stomach tube attached to

Fig. 1: Preparation of camel to collected feces

Fig. 2: Preparation of camel to collected urine

suction pump. Samples of rumen liquor were strained through two layers of cheesecloth and the pH was recorded immediately after collection using Beckman pH meter. Strained Rumen Liquor (SRL) samples were acidified with 0.1N hydrochloric acid and concentrated orthophosphoric acid and the sample were frozen for determination of total volatile fatty acids (TVFA's).

Chemical analyses: Feeds and feces were analyzed for proximate analyses according to (A.O.A.C., 2000). Nitrogen free extract was calculated by difference. Fiber fractions were analyzed according to Van Soest *et al.* (1991). Ammonia nitrogen in rumen liquor was determined as followed by Conway (1957), while the concentration of total VFA's in rumen liquor were determined according to Warner (1964).

Statistical analyses: Data were analyzed using the general liner model procedure of SAS (1996). One way ANOVA procedure used to analyze the intake, digestibility and N-retention data following the next model:

$$y_{ij} = \mu + T_{ij} + E_{ij}$$

were, μ is the overall mean of yij; T_{ij} is the treatments effect; E_{ij} is the experimental error. The differences among means were separated according to Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition: The Chemical composition of the different tested feeds ((barley grains (BG), olive cake (OC), date stone (DS), palm leaves (PL) and barley straw (BS)) and the experimental rations is presented in Table 2 and 3. The results indicated that content of DM, OM, CP, CF, EE, NFE and ash in OC was similar to that reported by Shawket (1999). Also, result of proximate analysis for DS was similar to that recorded by EL-Shazly *et al.* (1963). Crude protein content of OC and DS (7.29% and 6.61%, respectively) was lower than BG (10.20%). Meanwhile, they were higher in EE (15.5 % and 6.7%, respectively) than BG (1.97%). Olive cake (OC) contained (22.30%) crude fiber this higher than date stone and barley grain (14.13 % and 6.51 %, respectively). Content of fiber fraction (NDF, ADF and ADL) was higher in DS and OC than BG. Tested rations barley grain+palm leaves (BG+PL), barley grain+date stone (BG+DS) and barley grain+olive cake (BG+OC) given the same content of OM and CP but (BG+BS) was lower in OM and CP content this results were confirm that determined by Gihad *et al.* (1989). Nitrogen free extract of (BG+DS) content (65.44%) was higher than other tested ration.

Digestion coefficients and nutritive values: Digestion coefficients and nutritive values of the tested feeds and rations showed in Table 4 and 5. Generally, BG showed significantly ($p<0.05$) higher digestibility and nutritive value in all nutrients compared with OC and DS except for EE and ADF. In addition, DS showed higher digestibility of all nutrients compared with OC except for EE. No significant differences were noticed between BG and DS in CF, EE, NFE, NDF and ADF digestibility, but there were significant differences ($p<0.05$) in DM, OM and CP digestibility. Also, no significant differences were observed between OC and DS in DM, OM and NDF digestibility, but there were significant differences

Table 1: Components of the experimental feeds and rations

Treatments	Components
BG	100% barley grains
OC	100% olive cake
DS	100% date stone
BG+OC	66% barley grains+34% olive cake
BG+DS	66% barley grains+34% date stone
BG+PL	66% barley grains+34% palm leaves
BG+BS	66% barley grains+34% barley straw

Table 2: Chemical composition of the tested feeds (on DM basis)

	Tested feeds			
Item	Barley grain	Olive cake	Date stone	Palms leaves
DM	90	91.44	90.48	91.4
OM	96.55	94.18	95.68	92.74
CP	10.2	7.29	6.61	5.15
EE	1.97	15.5	6.7	1.97
CF	6.51	22.3	14.13	56.1
NFE	67.87	49.09	68.24	29.52
Ash	3.45	5.82	4.32	7.26
NDF	22.74	62.67	61.17	58.61
ADF	10.53	48.09	54.03	42.28
ADL	1.53	21.85	18.95	23.4
Cellulose	9	26.24	35.08	18.88
Hemi-cellulose	12.21	14.58	7.14	16.33

NDF: Neutral detergent fiber
ADF: Acid detergent fiber
ADL: Acid detergent lignin
Cellulose: NDF-ADL
Hemi-cellulose: NDF-ADF

Table 3: Chemical composition of the tested rations (on DM basis)

	Tested rations			
Item	Barely+ Palm leaves	Barely+ Date stone	Barely+ Olive cake	Barely+ Barely straw
DM	90.46	90.15	90.48	90.73
OM	85.94	87.76	86.24	84.58
CP	8.36	9.00	9.22	7.51
EE	1.58	3.53	7.40	1.54
CF	21.58	8.38	11.77	16.95
NFE	54.42	66.85	57.85	58.58
Ash	14.06	12.24	13.76	15.42
NDF	71.22	35.53	36.05	39.05
ADF	55.04	25.03	23.05	22.4
ADL	4.92	6.82	8.30	4.44
Cellulose	16.18	10.5	13.00	16.65
Hemi-cellulose	50.12	18.21	14.75	17.96

(p<0.05) in CP, EE, CF, NFE and ADF digestibility. Similar digestion coefficients were obtained by Bhattacharya *et al*. (1988) and Gihad *et al*. (1989). The DS showed higher digestibility of all nutrients compared with OC except in EE digestibility which was better in OC compared to DS (92.13 vs. 72.63%, respectively).

No significant differences were found among the tested feeds in TDN, but BG significantly recorded (p<0.05) higher DCP being 6.71% compared with OC and DS being 3.6 and 3.16%, respectively, while there were insignificant differences in DCP between OC and DS.On the other hand, the results indicated that the ration contained BG+DS was the highest digestibility in DM, OM, CP, CF and NFE. However, the ration contained BG+OC recorded the highest NDF and ADF digestibility. Also, the ration contained BG+PL recorded the highest digestibility of EE. No significant differences were detected in OM or NFE digestibility among all the experimental rations. The digestibility of ADF and NDF BG+OC mixture was significantly (p<0.05) higher (72.29 and 68.22%) compared with other rations. The ration contained BG+DL significantly recorded (p<0.05) the lowest value of DM, CP and CF digestibility (55.4, 48.33 and 29.0%, respectively) compared with other rations. In the same time, the ration containing BG+BS significantly recorded (p<0.05) the lowest EE digestibility being 51.56% compared with other rations. Camel calves gave the same results (Yacout and El-Badawi, 2001).

Nitrogen balance with feeds and ration have a positive values, it means that protein level in camels feeds was enough to cover their requirements. The SV value with olive cake was significantly (p<0.05) lower 44.32% than date stone 55.41 and barley grains 60.19%, this results may be due to the increasing in CF % in olive cake 22.13% and the decreasing of fiber digestibility 29.13% than other feeds.

Results related rations evaluation in Table 5 showed that barley plus palm leaves ration have a lower value of SV (36.90) than other rations. These results attributed to an increase of fiber content in this ration by 50% than barley plus date stone or live cake. No significant differences among all rations in TDN values except the ration contained BG+OC that recorded significantly (p<0.05) the lowest value of TDN while, the highest value recorded for the ration containing BG+PL mixture. There were no significant differences among all rations except with the ration contained BG+DS which recorded significantly (p<0.05) the highest value of DCP being 5.77% compared with other rations.

Rumen parameters: Rumen liquor parameters of the experimental feeds are summarized in Table 6 and 7. Most of ruminal parameter measured was affected by different types were acceptable with the normal range of rumen parameter. Ruminal pH recorded the highest values with animals fed OC at zero time compared with other feeds. The gradual decrease in pH value over time

Table 4: Nutrients digestibility, nitrogen balance and nutritive values of tested feeds

	Tested feeds			
Item	Barley grain	Olive cake	Date stone	± SE
Digestibility (%)				
DM	71.97^{a}	48.13^{c}	60.03^{b}	2.78
OM	70.60^{a}	49.97^{c}	60.96^{b}	1.78
CP	65.77^{a}	46.80^{b}	47.90^{b}	2.06
EE	67.73^{b}	82.13^{a}	72.36^{b}	5.86
CF	60.16^{a}	29.13^{c}	46.43^{a}	1.82
NFE	72.40^{a}	47.37^{c}	65.60^{a}	1.23
NDF	56.32^{a}	58.59^{a}	70.27^{a}	3.04
ADF	55.67^{b}	54.80^{b}	72.10^{a}	2.98
Nitrogen balance				
g/h/d	0.68	0.47	0.59	0.02
Feeding values (%)				
SV	60.19^{a}	44.32^{c}	55.41^{b}	5.05
TDN	62.22^{a}	61.79^{a}	60.4^{a}	1.52
DCP	6.71^{a}	3.41^{b}	3.16^{b}	0.17

$^{a,b,c...}$Means in the same row with different superscripts are significantly different (p<0.05)

Table 5: Nutrients digestibility, nitrogen balance and nutritive values of tested rations

	Tested rations				
Item	Barely+ Olive cake	Barely+ Date stone	Barely+ Palm leaves	Barely+ Barely straw	± SE
Digestibility (%)					
DM	55.40^{bc}	70.50^{a}	57.73^{a}	53.93^{a}	2.25
OM	64.33^{a}	64.62^{a}	59.03^{a}	58.80^{a}	3.12
CP	48.33^{c}	68.10^{a}	52.06^{b}	52.63^{b}	3.23
EE	87.06^{a}	76.33^{b}	59.26^{c}	51.56^{d}	0.80
CF	29.00^{c}	61.96^{a}	51.73^{b}	57.80^{a}	2.95
NFE	72.00^{ab}	74.43^{a}	59.53^{ab}	67.30^{ab}	2.40
NDF	51.02^{b}	57.77^{b}	68.22^{a}	51.61^{b}	1.39
DF	51.11^{b}	57.90^{b}	72.29^{a}	51.84^{b}	1.32
Nitrogen balance					
g/h/d	0.38	0.21	0.36	0.53	0.18
Feeding values (%)					
SV	59.31^{a}	63.43^{a}	36.90^{c}	41.79^{b}	7.00
TDN	77.00^{a}	65.94^{a}	46.33^{b}	63.20^{a}	1.43
DCP	4.43^{bc}	5.77^{a}	4.81^{b}	3.95^{c}	0.15

$^{a,b,c...}$ Means in the same row with different superscripts are significantly different (p<0.05)

Table 6: Rumen parameters of tested feeds

	Tested feeds			
Item	Barley grain	Olive cake	Date stone	±SE
Rumen pH:				
0 time	5.72^{c}	6.61^{a}	6.24^{b}	0.11
3 h	4.83^{b}	5.81^{a}	5.16^{a}	0.15
5 h	5.15^{b}	7.07^{a}	6.93^{a}	0.13
Rumen ammonia (mg):				
0 time	5.83^{ab}	6.16^{a}	5.59^{b}	0.14
3 h	10.12^{b}	12.01^{a}	9.92^{b}	0.31
5 h	8.32^{a}	8.26^{a}	7.48^{a}	0.28
Total volatile fatty acids (mEq):				
0 time	8.05^{a}	8.29^{a}	7.23^{b}	0.17
3 h	15.71^{a}	14.01^{b}	11.22^{c}	0.51
5 h	12.76^{a}	9.36^{b}	8.53^{b}	0.41

$^{a,b,c...}$Means in the same row with different superscripts are significantly different (p<0.05)

after feeding was synchronized with gradual increase in ruminal total volatile fatty acids concentration at the same times. Feeding on BG resulted in significant ($p<0.05$) decrease in pH values compared with other feeds after 3 and 5 h. In this respect Abdel-Rahman *et al*. (2003), found that the ruminal pH values of four animal species (camels, bulls, sheep and goats) before feeding were 7.5, 6.8, 6.95 and 6.95, respectively and all pH values after feeding were lower than those before feeding, being 6.78, 6.45, 6.77 and 6.64, respectively.

Ruminal ammonia concentration at zero time was different significantly ($p<0.05$) with camels fed on OC (6.16), followed those fed on BG then DS (5.83 and 5.59, respectively). At three hours post feeding, NH_3-N was significantly higher with animals fed on BG (12.01) compared with other feeds. No significant differences in ammonia concentration at 5 h post-feeding with camels fed all feeds. Abdel-Rahman *et al*. (2003) found that ammonia concentration in camels were lower than those reported in bulls, sheep and goats, either before feeding (13.3, 16.10, 16.30 and 15.80 mg/dL, respectively) or at 5 h after feeding (10.0, 19.3, 20.2 and 18.0) in the same order. The beneficial effect of high level of ammonia might be in part due to increasing amount of substrate available for microbial protein synthesis in the rumen (Church 1988).

Total volatile fatty acids concentration showed significant decrease ($p<0.05$) in values at zero time with camel fed on DS (7.23) compared with other feeds. The production of TVFA's at three hours postfeeding was significantly different among feeds where, animals fed on BG recorded the highest value of TVFA's followed by OC then DS (15.71, 14.01 and 11.22, respectively). Also, significant differences ($p<0.05$) among feeds at six hours post feeding in production of TVFA's where BG recorded the highest value being 12.76 compared with other feeds.

On the other side, ration containing BG+BS recorded the lowest rumen pH value at zero time, after 3 and after 5 h post-feeding. The BG+DS mixture ration gave the highest value of rumen pH value at the three times.

Table 7: Rumen parameters of tested rations

Item	Tested rations: Barely+ Olive cake	Barely+ Date stone	Barely+ Palm leaves	Barely+ Barely straw	±SE
Rumen pH:					
0 time	6.19^{a}	6.22^{a}	5.90^{a}	5.34^{b}	0.12
3 h	6.05^{b}	6.72^{a}	6.09^{ab}	5.21^{c}	0.22
5 h	7.21^{b}	9.84^{a}	7.20^{b}	7.01^{b}	0.19
Rumen ammonia (mg %):					
0 time	5.74^{a}	4.53^{b}	5.80^{a}	4.60^{b}	0.1
3 h	12.03^{ab}	8.19^{c}	13.06^{a}	10.86^{b}	0.49
5 h	7.71^{a}	5.77^{b}	7.98^{a}	6.32^{b}	0.24
Total volatile fatty acids (mEq):					
0 time	7.33^{b}	7.16^{b}	8.20^{a}	5.90^{c}	0.15
3 h	12.32^{a}	10.22^{b}	13.63^{a}	10.53^{b}	0.48
5 h	8.28^{a}	8.65^{a}	8.73^{a}	8.96^{a}	0.43

$^{a,b,c,...}$Means in the same row with different superscripts are significantly different ($p<0.05$)

Significant differences ($p<0.05$) were observed among the rations where the ration contained BG+DS mixture recorded the highest value of rumen pH content after hours post-feeding compared with other rations. While, The BG+PL mixture ration gave the highest value of NH_3-N at the three times. Total volatile fatty acids concentration showed significant decrease ($p<0.05$) values at zero time with camel fed on BG+BS (5.9 meq/dL) compared with other rations. The production of TVFA's at three hours post feeding was significantly different among feeds where, animals fed on BG+PL recorded the highest value of TVFA's (13.63 meq/dL) and the lowest value recorded with BG+DS mixture (10.22 meq/dL). No significant differences among the rations at six hours post feeding in the production of TVFA's. Such results were obtained by Maloiy (1972).

Feed intake: The results of feed and water intake are summarized in Table 8 and 9. No significant differences

Table 8: Feed consumption (Dry matter, TDN and DCP) and water intake with tested feeds

Item	Tested feeds: Barley grain	Olive cake	Date stone	±SE
Live BW	402	402	400	
$W^{0.75}$	89.77	89.77	89.44	
Water intake, L	7.58	6.92	8.42	0.69
Dry matter Intake (DMI):				
kg/h/d	4	4	4	NS
g/kg$w^{0.75}$	44	44	44	NS
kg/100kgBW	0.01	0.01	0.01	NS
Total Digestible Nutrients intake(TDN):				
kg/h/d	2.26^{a}	2.41^{a}	2.38^{a}	0.42
g/kg $w^{0.75}$	25.19^{a}	26.77^{a}	26.51^{a}	2.5
kg/100Kg BW	0.56^{a}	0.50^{a}	0.59^{a}	0.01
Digestible Crude Protein intake(DCP):				
g/h/d	241.5^{a}	132.04^{a}	114.58^{b}	6.13
g/kg$w^{0.75}$	2.70^{a}	1.47^{b}	1.28^{b}	0.07
g/100KgBW	60^{a}	33^{b}	29^{b}	10

$^{a,b,c,...}$Means in the same row with different superscripts are significantly different ($p<0.05$)

Table 9: Feed consumption (DM, TDN and DCP) and water intake with tested rations

Item	Tested rations: Barely+ olive cake	Barely+ Date stone	Barely+ Palm leaves	Barely+ Barely straw	±SE
Live BW(kg)	399	399	398	398	-
$W^{0.75}$	89.38	89.38	89.21	89.15	-
Water intake, L.	7.25	8.33	8.16	7.50	0.6
Dry matter Intake (DMI)					
kg/h/d	4.5	4.5	4.5	4.5	NS
g/kg$w^{0.75}$	50	50	50	50	NS
kg/100kgBW	0.011	0.011	0.011	0.011	NS
Total Digestible Nutrients intake (TDN)					
kg/h/d	3.13^{a}	2.67^{ab}	2.07^{a}	2.58^{ab}	0.33
g/kg $w^{0.75}$	35.34^{a}	30.02^{a}	21.27^{b}	29.07^{a}	3.22
kg/100Kg BW	0.79^{a}	0.67^{ab}	0.52^{c}	0.65^{ab}	0.13
Digestible crude Protein intake (DCP)					
g/h/d	180.19^{bc}	234.05^{a}	195.85^{b}	161.59^{c}	6.19
g/kg$w^{0.75}$	2.03^{bc}	2.63^{a}	2.20^{b}	1.82^{c}	0.08
g/100KgBW	45b^{c}	59^{a}	49b	40^{c}	4

$^{a,b,c,...}$Means in the same row with different superscripts are significantly different ($p<0.05$)

were detected in dry matter intake expressed as DMI g/W$^{0.75}$ by camels fed on the experimental tested feeds. Also, there were insignificant differences among the tested feeds in TDN consumed by animals. While, animals consumed DS significantly recorded ($p<0.05$) the lowest value of DCP intake being 114.58 g/h/d or 1.28 g/kgw$^{0.75}$ or 29.0 g/100Kg BW compared with BG and OC that recorded 241.5, 2.7 and 60.0 and 132.04, 1.47 and 33.0, respectively. The water intake increased with animals fed DS being 8.42 L compared with BG and OC that recorded 7.58 and 6.92 L, respectively. Such results were obtained by Gihad *et al*. (1989), Kandil *et al*. (1991) and El-Banna (1993).

While results indicated that animals consumed the ration contained BG+DS recorded the highest water intake being 8.33 L compared with each of animals consumed the rations contained BG+PL, BG+OC or BG+BS which recorded 8.16, 7.25 and 7.50 L, respectively. No significant differences were observed among the tested rations in DMI by animals. Significant differences ($p<0.05$) in TDN consumed by animals where the ration contained BG+PL recorded the lowest value of TDN intake being 21.27 g/kgw$^{0.75}$ or 0.52 g/100KgBW compared with other rations. A similar result was obtained by Shawket (1999). Significant differences ($p<0.05$) were detected among the rations experimental where the ration contained BG+DS mixture recorded the highest value of DCP intake compared with other rations. Also, the ration contained BG+BS recorded the lowest value of DCP intake compared with other rations. While, no significant differences were noticed between the rations containing BG+PL and BG+OC or BG+OC and BG+BS. The same results were obtained by El-Shazly *et al*. (1963) and Rashed and Alwash (1976).

Conclusion: It could be concluded that date stone and olive cake may be used to feed camel as substitution of barley grains without any adverse effect. Date stone showed better nutritive value than olive cake. Also, the mixture of barley grains plus olive cake or date stone gave the best results than other mixtures.

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