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EFFECTS OF FEED INTAKE OF A COMPLETE CONCENTRATE DIET ON PERFORMANCE OF OMANI CAMELS RAISED UNDER STALL-FEEDING

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ABSTRACT

The current experiment was designed to study the performance of Omani camels offered various levels of feed under stall-feeding. Twelve weaned Omani male camels (6-8 month old and 203.5± 15.5 kg average body weight, BWT) were housed in partially shaded pens and fed a concentrate and Rhodesgrass hay (RGH) diet at a 60:40 then 80:20 concentrate:hay ratio for 23 weeks. The concentrate and RGH contained 92.5 and 91.5% dry matter (DM); 14.4 and 9.4 crude protein (CP); 1.8 and 1.1 ether extract (EE); 12.1 and 9.6 ash; 19.3 and 30.6 crude fibre (CF), 24.1 and 35.8 acid detergent fibre (ADF); 51.3 and 68.3 nitrogen detergent fibre (NDF) as per cent in the DM, respectively. Camels were allocated according to BWT to 3 groups of 4 camels each. They received a feed intake equivalent to 1.5, 2.0 and 2.5% of body weight, respectively for 162 days at the end of which all camels were slaughtered. The average daily gain over the experimental period was 71, 347 and 400 g/d for the animals given 1.5, 2.0 and 2.5% BWT intake, respectively. The mean final body weight of camels was 256.6 ± 32.3 kg (range 218-322 kg). The average daily feed intake (concentrate + hay) was 2.522, 4.232 and 5.157 kg for camels fed 1.5, 2.0 and 2.5% BWT, respectively. The feed intake expressed as a per cent of BWT was 1.2, 1.8 and 2.2% for camels fed 1.5, 2.0 and 2.5% BWT, respectively. This study demonstrated that camels may be raised under stall feeding systems with no major health or management problems.

Key words: Camel, feed intake, growth, Oman, performance

Oman's climatic and topographic conditions are extremely harsh. The arid nature of the country has been aggravated by lengthy droughts resulting in progressive desertification intensified by overgrazing. Consequently, in recent years the government planned to significantly reduce camel numbers through slaughter and export of camels. The environmental conditions present a severe challenge for large-scale animal production projects. Most meat and meat products consumed in Oman are imported. Native traditional systems using small number of animals and stock movements are more suitable to the country's harsh conditions. Camel presents a more economical meat animal compared to other livestock. Their ability to thrive on low level feeds and dress well with a higher feed conversion efficiency suggest that they are more economical meat producing animals than other farm animals such as goat, sheep or cattle. However, meat produced from range camels would be of low quality and more difficult to market in supermarket systems prevailing in the country. Traditionally, camels are raised in Oman on the scarcest resources. This might be the reason that their true performance and potential for producing meat has not been exploited. Improving the environment, health, management and nutrition of the camel under intensive systems would be expected to result in marked improvement in its performance. A meat yield of camel is significant with carcasses yielding large amounts of meat and some parts such as the hump and liver are regarded as a delicacy in some parts of the world (Kadim *et al,* 2008). Camel meat has excellent quality attributes (Kadim *et al,* 2006 a,b). Camel meat is recognised as having similar flavour and texture to that of beef but a comparatively higher moisture content and less fat (Kadim *et al,* 2008).

This study was aimed to evaluate the potential of the Omani camel for meat production under feedlot system. It entails offering camels various levels of nutrition in the form of hay and concentrate feeds and monitor their performance to evaluate their potential for meat production under these systems.

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Materials and Methods

Animals and Feeds

Twelve 6-8 month old Omani male camels of 203.5± 15.5 kg average body weight (BWT) were used in the study. They were purchased after weaning from pastoralists in Dhofar (south Oman) and transported to Sultan Qaboos University (SQU) Agricultural Experiment Station (AES). Upon arrival, animals were quarantined for 2 months during which they were treated for internal and external parasites and some fungal skin infection. Camels were housed in partially shaded pens equipped with individual concentrate and hay troughs as well as automatic water troughs. They were fed a concentrate and Rhodesgrass hay (RGH) diet. The concentrate feed was a 14% crude protein (CP) pelleted feed manufactured by the National Livestock Development Company, Salalah, Sultanate of Oman (Table 1). The concentrate and Rhodesgrass hay (RGH) contained 92.5 and 91.5% dry matter (DM); 14.4 and 9.4 crude protein; 1.8 and 1.1 ether extract; 12.1 and 9.6 ash; 19.3 and 30.6 crude fibre, 24.1 and 35.8 ADF; 51.3 and 68.3 NDF as percent in the DM, respectively (Table 2). Camels were allocated according to BWT into 3 groups of 4 camels each. They received a feed intake equivalent to 1.5, 2.0 and 2.5% of their body weight, respectively with a 60:40 concentrate:RGH ratio for the first 10 weeks followed by an 4:1 concentrate:hay ratio for the rest of the experimental period. The feeding period continued for 162 days at the end of which that camels were slaughtered. Mineral blocks were offered *ad libitum*. Blood samples were collected monthly throughout the trial and analysed for haematological parameters.

Table 1. Composition of the concentrate feed as given by feed producing company (National Livestock Development Company; Sultanate of Oman).

Specification	Level	Unit
Moisture (maximum)	12.5	%
Crude Protein (minimum)	14	%
Crude Fat (minimum)	2	%
Crude Fibre (minimum)	12	%
Acid Insoluble Ash (maximum)	8	%
Calcium (minimum)	0.7	%
Phosphorus (minimum)	0.5	%
Vitamin A	5000	IU
Vitamin D3	500	IU
Vitamin E	20	mg
Metabolisable Energy (Minimum)	10	MJ/kg

Feed Analyses

The chemical composition of experimental feeds was determined according to standard methods of AOAC (2000). Dry matter (DM) was determined by drying in an oven for 24 hours at 80°C (method 934.01). Crude protein (CP) was determined using a Foss Tecator Kjeltec 2300 Nitrogen/Protein Analyser (method 976.05). Fat (EE) was determined by Soxhlet extraction of the dry sample, using petroleum ether (method 920.39). Ash content was determined by ashing samples in a muffle furnace at 500°C for 24 hr (method 942.05). Acid detergent fibre (ADF) was determined using cetyl trimethyl ammonium bromide (CTAB) and 1N H_2SO_4 as described by Roberston and Van Soest (1981). Neutral detergent fibre (NDF) was determined using sodium sulphite and sodium lauryl sulphate as described by Van Soest *et al* (1991). Alpha amylase was not used to determine NDF. ADF was expressed with ash whereas NDF was expressed without ash.

Experimental Measurements

Daily feed intakes were determined by weighing refusals and subtracting the weight from that of the feed offered the previous day. Concentrate feed and hay were given in separate troughs. Camels were weighed at the start of the experiment and monthly, thereafter on a weighing bridge to the nearest 2 kg. Weighing was carried out early in the morning before offering fresh feeds. Automatic watering troughs were fitted for individual pens and supplied with water measuring meters.

Statistical Analyses

Data were subjected to analysis of variance using the General Linear Models procedure of SAS (1991) for effects of level of feed intake, using the diet as a class in the GLM statement in a completely randomised experimental design. Significant treatment means were assessed using LsMEANS command on the SAS (1991). Significant differences were accepted if $P < 0.05$.

Results

The health of the camels in various experimental groups was excellent as judged by observations and haematological blood analyses. Initially some camels had a skin infection diagnosed as ring worm which is common in the region especially after the rainy season. They were successfully treated by antifungal solutions and responded very well. Experimental feeds were consumed well and there were no signs of gastro-intestinal problems such as diarrhoea or

constipation. Two camels from the group which was fed the 1.5% BWT intake died during the course of the trial because they were caught in robes and fell under the fence.

Experimental Feeds

The proximate analyses of RGH (Table 2) indicated that its CP content is low (9.4%DM) and its fibre content is high (CF, 30.6; ADF 35.8; NDF 68.3%DM). The commercial concentrate contained optimum CP content (14.4% DM) but high fibre level (19.34 crude fibre, 24.06 ADF and 51.28 NDF%/DM). it also contained a high ash level (12.1%DM). The concentrate feed was also fortified with essential minerals (Ca and P) as well necessary vitamins (Vitamin A, D3 and E) and had high metabolisable energy (Table 1).

Body Weight Growth

The camel's initial weight averaged 203.5 kg whereas their mean slaughter body weight was 256.6 ± 32.3 kg (range 218-322 kg). The camels on the 2.5% BWT intake gained more weight (64.5 kg) over the study period followed by those on the medium intake (56.3 kg). The camels on the low feed intake (1.5% BWT) grew at the slowest rate but did not lose weight gaining 11.5 kg over the experimental period (Table 3). The average daily gain was 71, 347 and 400 g/d for the animals given low, medium and high intake (Table 3).

Fig 1 describes the growth curves of the camels in various treatment groups. Camels on the 2.5%BWT intake grew at a much higher linear pattern indicating a greater growth potential and they were closely followed by those on the medium intake allowance (2.0%BWT). Animals on the lowest feed intake grew at a much slower rate with a trend of increasing growth rate after the 3rd month. This was coinciding with the increase of the concentrate:hay ratio form 3:2 to 4:1.

Feed Intake and conversion

The camels on the high feed intake obviously consumed more concentrate feeds than the other 2 groups. The 2.5%BWT intake group feed intake was more than double that consumed by camels on the low intake (Table 3). Both animals on the medium and high intake consumed more hay than those on low intake but there was no difference between the 2.0 and 2.5%BWT groups in hay intake (Table 3). This indicates that high concentrate intake will be accompanied by low hay intake at this level. This most probably was because of the high fibre content in the concentrate diet (Table 2). The average daily feed intake (concentrate+hay) was 2.522, 4.232 and 5.157 kg, for the low, medium and high feed intake (Table 3).

The feed intake in experimental camels expressed as a per cent of BWT was 1.2, 1.8 and 2.2%

Table 2. Chemical composition of the concentrate feed and Rhodesgrass hay used for feeding camels.

Feed	DM%	CP	EE	Ash	CF	ADF	NDF
Concentrate	92.46	14.35	1.8	12.12	19.34	24.06	51.28
Rhodesgrass hay	91.52	9.43	1.08	9.59	30.62	35.82	68.32

Table 3. Body weight growth parameters, feed intake and feed conversion in Omani camels maintained on 3 levels of feed intake.

Parameter	Experimental Group						Treatment effect
	Low		Medium		High		
	Mean	SE	Mean	SE	Mean	SE	
Average daily concentrate intake (kg)	1.451	0.228	2.520	0.198	3.487	0.198	***
Average daily hay intake (kg)	1.071	0.077	1.712	0.066	1.670	0.066	***
Average daily total intake (kg)	2.522	0.263	4.232	0.227	5.157	0.227	***
Total feed Intake (kg)	408.5	42.53	685.6	36.83	835.46	36.83	**
Intake/BW (%)	1.20	0.004	1.84	0.003	2.19	0.003	***
Initial BW (kg)	204.0	17.021	202.8	14.74	203.75	14.74	NS
Final BW (kg)	228.0	22.600	259.0	15.98	268.50	15.98	NS
Total BW gain (kg)	11.50	6.000	56.25	4.243	64.50	4.243	**
Average daily gain (g/d)	71	37.0	347	26.2	400.0	26.2	**
Feed conversion ratio	35.48	0.590	12.21	0.590	12.96	0.590	*

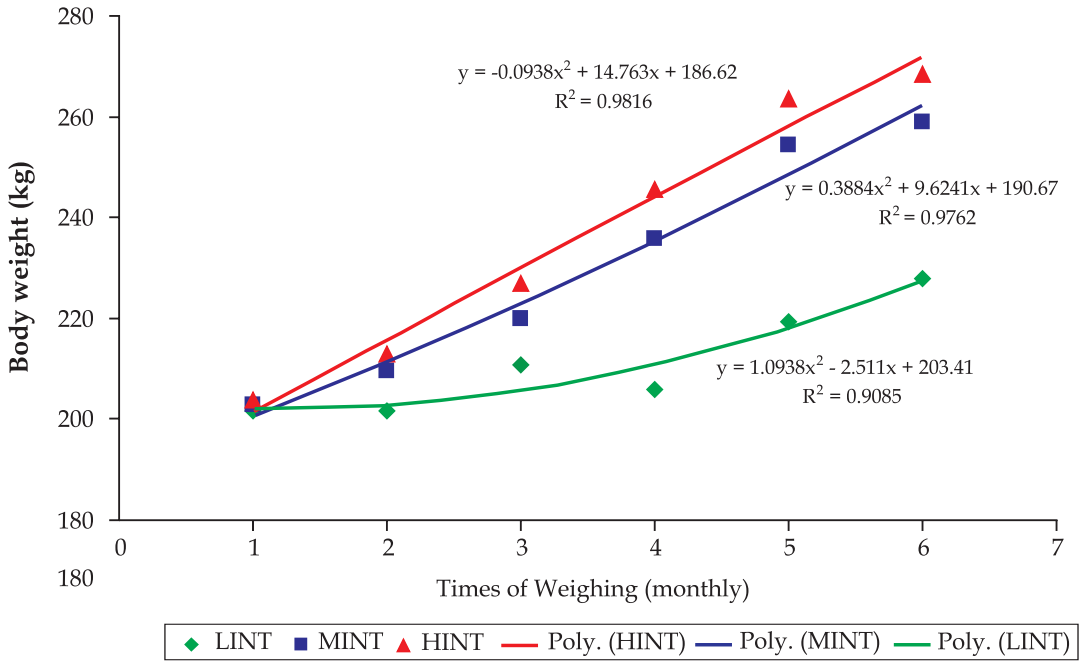

Fig 1. Growth curves and equations of 3 camel groups fed low, medium and high level of concentrate and Rhodesgrass hay.

which was equivalent to 1.11, 1.69 and 2.01 on DM basis, for the low, medium and high feed intake, respectively (Table 3).

Feed conversation ratio (kg feed/ kg weight gain) was 35.5, 12.21 and 12.96. The better feed conversion in the 2.0 and 2.5%BWT diets was because of the higher concentrate intake in the diets of the medium and high intake groups.

Discussion

Experimental Feeds

Chemical analyses indicated that RGH, the most commonly-used roughage for livestock production in Oman, including camels, is of low nutritive value and is unlikely to support a good level of growth in camels without supplementation. The commercial concentrate was destined to be marketed by the manufacturing company (The National Livestock Development Company, Salalah, Oman) as a complete diet to be fed with no extra roughage. This is obvious because of its high fibre level which would provide good rumen digestible material. Its CP content is adequate for finishing camels of this weight (>200 kg). The concentrate appears to contain optimum levels of essential minerals (Ca and P) as well as necessary vitamins (Vitamin A, D3 and E) and had high metabolisable energy. Therefore, it would be suitable for feeding camels either in stall or as a supplement feed for free ranged camels especially, during drought times. Mineral containing blocks provided for individually penned camels *ad libitum* would assure that camels received enough minerals supply and are not in a risk of suffering from deficiencies. Camels are sensitive for mineral deficiencies especially, salt and trace elements. Therefore, supplementation would be needed if camels are to be finished under zero grazing conditions.

Body Weight Growth

There was a clear effect of feed intake on body growth with body weight gain decreasing with the decreasing feed intake. However, it is important to note that the camels on the 1.5% BWT did not lose weight throughout the trial. This indicates that this level of intake from this diet combination is above their maintenance requirements.

Body growth rates reported for the camel in general vary greatly according to geographical region, nutrition, sex, age and breed and also within the same breed (Kadim *et al,* 2008). Post-weaning growth rate depends mainly on husbandry practices and conditions of the vegetation (Babiker and Tibin, 1989). Growth rates differ between pre-weaning and post-weaning periods. For instance, Hammadi *et al* (2001) reported a daily growth rate of 580 g/d between birth and 90 days of age. Bissa (1996) reported a growth rate of 733 g/d between birth and 180 days of age. These figures are higher than the 400 g/d recorded for Omani camels on the highest intake between 1

and 2 years of age in the current study. Differences may be due to breed, age or feeding regime. Kadim *et al* (2008) analysing the data of Tandon *et al* (1988) on Bikaneri Indian camels, concluded that the average daily growth rate increased from 400 g/d in the 0-1 year group to a maximum of 720 g/d in the 7-8 year group then declined to 300 g/d by 10-11 years of age. However, these figures should be considered as maximum rate, as a daily growth rate of 300 g would result in an annual increase of 100 kg which does not match with the range of camel live weights reported in the literature (Kadim *et al,* 2008).

Supplementation of camels with a concentrate diet improved their body weight growth. Kamoun (1995) reported that camels fed a high protein and energy diet gained more (550 g/d) than those non-supplemented ones (260 g/d). Therefore, stall feeding would be recommended for finishing camels to improve their growth and carcass composition for better meat quality.

Final body weights of camels are affected by pre and post-weaning growth rates which are affected by nutrition and system of management (Kadim *et al,* 2008) as well as age, sex and health (El-Amin, 1979). The final body weights of camels in the current study ranged between 228-268.5 kg for animals on 1.5 and 2.5%BWT, respectively. These figures are within the range reported for Bikaneri camels (Kadim *et al,* 2008; Tandon *et al,* 1988). It had been demonstrated in the current study that it is possible to raise camels under stall feeding. This would help reducing pressure on the deteriorating rangeland affected by overgrazing in Oman especially during the dry season.

Feed Intake and conversion

The feed intake data matched the feed allowance as percentage of body weight. Both animals on the medium and high intake consumed more hay than those on low concentrate intake. This indicates that higher levels of concentrate in the diet would enhance roughage (hay) intake. On the other hand, the animals with the lowest concentrate intake consumed less hay. Dromedaries are reported to digest cell wall carbohydrates better than small ruminants (Gihad *et al,* 1989). This was attributed most probably to their special digestion physiology characteristics such as long retention time of feed and higher efficiency of nitrogen utilisation (Wilson, 1998). Non the less, higher levels of fibre such as those used in the current study might reduce feed intake in camels.

In grazing camels, daily feed intake was estimated at 1.2-12 kg/d which is equivalent to 2.45%BWT of a 500 kg camel or 104 g DM/kg0.75 (Wardeh, 2004). The maintenance DM requirements for the 200-300 kg dromedary were 2.5-3.39 kg/d (Wardeh, 2004) which indicates that even the camels on the lowest intake (1.5%BWT) group had a minimum maintenance level feed. Camels on the 2.5%BWT had an intake within the recommended DM intake to support a daily growth rate of 500 g (Wardeh, 2004).

The feed intake in experimental camels expressed as a per cent of BWT matched the amount offered to the animals throughout the trial. It was within the range reported for camels elsewhere. For instance, Gihad *et al* (1989) reported that 594 kg heavy Egyptian camels consumed less feed (1.27 kg/100 kg weight) followed by sheep (2.03 kg/100 kg weight) whereas goats had the highest intake 2.68 kg/100 kg weight. There were reports of higher feed intakes per kg BWT in camels. For instance, Khorachani *et al* (2009) reported an intake of approximately 3% of camel live weight. However, it should be noted that the latter figures were obtained from heavy Tunisian Maghrebi milking camels.

Feed conversation ratio (kg feed/ kg weight gain) matched the data of feed intake and bodyweight gain. The better feed conversion in the 2.0 and 2.5%BWT diets was because of the higher concentrate intake in the diets. This is of important practical implication indicating that increasing concentrate feed in camel diets, especially, those destined for meat production would improve their body weight growth, feed intake and feed conversion efficiency. This is in contrast of feeding regimes of camels raised for dairy production. Khorachani *et al* (2009) stated that dry matter intake in dairy camels could be improved by offering good quality fodder like alfalfa than by increasing the amount of concentrate in the diet.

The current study demonstrated that camels may be successfully raised under stall feeding with no apparent health or management problems with higher feed allowances improving performance. This system would also contribute for reducing pressure on natural rangeland be removing significant numbers of camels to relief pasture.

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