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Response of camels and cow calves to 100% and 50% roughage rations fed consequently

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Abstract

Background: Dromedary camels could be a successful and economic meat provider in poor greenery lands where feeds and water are scarcely available. Moreover, camels need lower amounts of protein in their rations than other ruminants, since they have an exceptional ability to recycle urea as a source of nitrogen when dietary protein is unavailable. The present preliminary study aimed to detect influence of feeding all roughage ration on growth performance of growing camels in comparison with cow calves and their response to the abrupt change into 50% roughage ration fed in the fed-lot condition.

Results: The results illustrated that with feeding 100% R ration camels could utilize available nutrients better than calves, and although the maintenance level of CP was not met for both species, camels exert higher resistance in losing weight than calves (−93.7 vs. −160.7 g/d). Shifting camels and calves on 50% R ration showed nearly similar nutritive values and comparable daily weight gain (942.75 g for camels and 968.50 g for calves). Feed conversion efficiency as Mcal ME and g DCP/kg gain was, respectively, 18.39 and 527 for camels and 18.42 and 555 for calves. Blood serum biochemical constituents were improved with 50% R than 100% R ration particularly for calves. Blood protein of camels was not influenced by changing ration. Urea concentration was higher in camel's blood than calves with either 100% or 50% R rations. Camels clearly had lower contents of cholesterol and triglycerides than calves under the two feeding regimes.

Conclusion: The results revealed that growing camels could utilize the 100% R ration of very low protein content more efficiently than cow calves and had similar growth rate as that of calves with the 50% R ration.

Keywords: *Camelus dromedarius*, Cow calves, Growth performance, Nutrients digestibility, Roughage level

Background

The problem of animal protein insufficiency of particular red meat is a growing annual problem in Egypt due to shortage of animal feeds and green fodders. Under such situation, it is a target necessary to find type of animals capable to grow under harsh environmental condition with least amount of feeds. Available literature on camels mentioned that camels possess certain unusual physiological features that enable it to thrive in extremely arid environments where normal drinking water and valuable

green forages are scarcely available. Camels have exceptional tolerance to heat and water deprivation. They can also concentrate their urine to a marked degree and can re-circulate and reutilize urinary nitrogen when they are deprived of water or stop urinating in starvation (El-Badawi et al. 2003). Under conditions of dehydration and intense heat, camels adopt certain behavioral mechanisms to conserve energy. Camels in its natural habitat can normally consume salty bushes and tolerate high saline water (Gihad 1995). In comparison with sheep as desert animals, camels maintenance requirement of energy is lower than sheep being 75 kcal ME/kgw^{0.75} (Guerouali and Filali 1992) vs. 112 kcal ME/kgw^{0.75} for Rahmany sheep (El-Badawi et al. 1999). Several studies reported that camels require less energy and protein for

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their maintenance balance than other ruminants, and in extreme cases, they are not only decrease feed intake but also reduce their metabolic rate (Guerouali and Filali 1992; Knoess 1977; Gihad and El-Bedawy 1992; Farid 1995). Some studies stated that camels are able to consume and utilize poor quality forages and salty bushes (Holler et al. 1986; Rutagwenda et al. 1990; Nagpal et al. 2003; Shawket et al. 2007).

The response of camels to economical fattening on intensive feeding system was studied by many workers, and the results were contradictory; most studied have been done under different feeding regimes, different sex and age, limited numbers, short experimental time and different types of desert range plants. The average daily weight gain was noted to be between 186 to 565 g for Tunisian male camels (Kamoun et al. 1989), and much lower values were recorded (174–227 g) for Indian camels fed rations contained 11.5% to 12.9% crude protein (Nagpal et al. 1993). On the contrary, some previous studies (El-Badawi and Yacout 1999; Yacout and El-Badawi 2001; El-Badawi and Yacout 2004) recorded average daily weight gain (ADG) between 810 to 840 g for Sudanese camel calves (2–3 years old) fed on rations contained 12 to 14% crude protein. They also noted that the ADG of camels was comparable to that of local cattle calves; however, the daily DM intake of camels was 1.44% of their body weight vs. 2.5% for cattle calves. The dressing percentage for well-fed camel calves was in average 58.6% (El-Badawi and Yacout 1999) which seems comparable to that of cattle steers. The previous background might indicate that raising camels on intensive feeding system could be an economic solution to help in providing red meat with reasonable prices for poor and developing countries.

Methods

This study was carried out in the cattle farm station of the Animal Production Research Institute that belongs to Ministry of Agriculture at Nubaria province 150 km northwest Cairo city.

Animal management and feeding procedures

Eight heads of Sudanese dromedary camel calves were purchased from the camel's market, transported to the farm by a truck and kept in the quarantine area for one month. During the quarantine time camels were sprayed two times with Butox (ticks killer) and vaccinated against infectious diseases, as a medical treatment against internal and external parasites. Camels and eight heads of cow calves (Friesian x Baladi) brought from the herd of the farm were kept in two separate open shaded pens equipped with individual feeding and watering troughs

for an adaptation period of one month to keep animals accustomed with experimental rations.

The first feeding trial

The first trial was carried out to compare tolerance of the two animal species to all roughage ration (100% R) of low protein content on feed intake, weight gain, nutrients digestibility and blood biochemical constituents. At beginning of the trial, animals were weighed and the initial body weight was recorded for each animal. Camels were of one year old and weighed 284.0 ± 22.40 kg, and cow calves were of one year old and weighed 274.5 ± 24.85 kg. Animals of the two experimental groups were offered an all-roughage ration consisted of 15 kg whole plant corn silage + 2.25 kg chopped rice straw for a feeding period of 56 days (8 weeks). Feeds were offered twice daily at 8.00 am and 2.00 pm in two equal portions individually. Feed refusals were daily collected, sun dried, weekly weighed and recorded to calculate the actual daily feed intake. During the whole experimental period, animals were weighed every two weeks using a digital platform balance. Clean drinking water was available in separate buckets at day times. With this feeding regime body weight loss was expected.

The second feeding trial

The second feeding trial was consecutively carried out on the same animals for another 56 days. The aim of this experimental phase was to compare response of the two animal species to the sudden transfer from 100% R to 50:50 R:C ratio ration (50% R), since body weight loss was expected with feeding the whole roughage ration. The daily offered amounts of feeds during the second trial were based on the previous actual intake to assure that the roughage portion was consisting 50% the whole DM intake. The daily offered amounts of feeds were 4 kg of concentrate feed mixture (in mash) + 10 kg whole plant corn silage + 1.15 kg chopped rice straw per head of camels and calves. The same managerial procedures and measured parameters were followed as in the first feeding trial.

Digestibility trials and blood sampling

At end of each feeding trial, dietary nutrients digestibility was evaluated for camels and calves applying the acid insoluble ash technique based on determining silica as an internal marker in both feeds and feces according to the method outlined by Van Keulen and Young (1977). Blood samples were withdrawn individually from the jugular vein before the morning meal. Blood samples were collected in clean sterilized glass tubes, centrifuged at 3000 rpm to separate blood serum, and serum samples were kept under -20 °C until analysis.

Analytical methods

Chemical composition of feeds and feces for moisture, organic matter, crude protein, crude fiber, ether extract and ash were determined according to AOAC (2016), while nitrogen-free extract content was calculated by difference. Blood serum total protein was determined according to Gornal et al. (1949), albumin was determined according to Doumas et al. (1971), and globulin concentration was calculated as total protein–albumin. Blood urea concentration was determined according to Fawcett and Scott (1960), and creatinine was determined calorimetrically according to Husdan and Rapoport (1968). Total cholesterol was determined according to Richmond (1973). Triglycerides were determined according to Fossati and Prencipe (1982). Assay of liver function was monitored calorimetrically for aspartate aminotransferase (AST) and alanine aminotransferase (ALT) according to Reitman and Frankel (1957).

Calculations

Total digestible nutrients (TDN) was calculated as:

$$\text{Dig. OM\%} + 1.25 (\% \text{ dig. ether extract}).$$

Metabolizable energy (ME) kcal = TDN × 3.56 (McDonald et al. 2011).

Statistical analysis

Collected data of each feeding trial were subjected to T-test as two independent samples to compare means of the two animal species at α=0.05 applying the following mathematical model according to Snedecor and Cochran (1994). T_{stat} values were tested for significance on df = 14.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

Results

Chemical composition of different feedstuffs and the two experimental rations are presented in Tables 1 and 2. The first ration (100% R) was characterized by its low CP content (6.59) and high moisture and CF contents being, respectively, 62.73 and 27.70. In the comparison, the second ration (50% R) had 50.14% moisture, 10.01% CP and 17.52% CF. Soluble carbohydrates (NFE) content was nearly 20% higher and ash content 25% lower in 50% R than those of 100% R ration. The two experimental rations were manipulated to keep camels and calves under imbalanced and balanced feeding regimes.

Nutrients digestibility and dietary nutritive value

Data of nutrients digestibility and dietary nutritive values in terms of TDN% and DCP% are given in Table 3. With feeding 100% R ration, camels showed higher digestibility values than calves; however, statistical differences between the two species were only attained for CP and EE (ether extract), while OM, CF and NFE digestibility were comparable for the two species. Dietary nutritive value as TDN units was non-significantly higher for camels (55.53%) than (54.74%) for calves. Meanwhile, DCP% was significantly (P<0.05) higher for camels than calves (2.89 vs. 2.59%).

The previous results might imply that camels could utilize the all roughage ration (100% R) more efficiently

Table 1 Chemical composition of feedstuffs and the whole 100% roughage ration

Item	Moisture, %	DM composition, %					
		OM	CP	CF	EE	NFE	Ash
Corn silage	70.43	90.56	8.12	23.84	1.73	56.87	9.44
Rice straw	11.43	83.06	3.19	36.32	0.84	42.71	16.94
Whole ration	62.73	88.24	6.59	27.70	1.45	52.50	11.76

Table 2 Chemical composition of feedstuffs and the whole 50% roughage ration

Item	Moisture, %	DM composition, %					
		OM	CP	CF	EE	NFE	Ash
Corn silage	70.43	90.56	8.12	23.84	1.73	56.87	9.44
Rice straw	11.43	83.06	3.19	36.32	0.84	42.71	16.94
CFM ^a	10.56	93.67	13.51	6.94	2.17	71.05	6.33
Whole ration	50.14	91.02	10.01	17.52	1.82	61.67	8.98

^a CFM: Concentrate feed mixture consisted of 40% ground yellow corn, 35% wheat bran, 10% soya bean meal, 7% un-decoricated cotton seed meal, 4% cane molasses, 2% lime stone and 2% common salt

Table 3 Nutrients digestibility and nutritive value (%) of 100% and 50% roughage rations by camels and cow calves (means ± sd)

Item	100% Roughage ration			50% Roughage ration		
	Camels	Calves	Sign.	Camels	Calves	Sign.
<i>Nutrients digestibility, %</i>						
OM	54.68 ± 1.36	54.31 ± 1.32	NS	64.41 ± 1.43	65.74 ± 1.06	NS
CP	43.79 ± 1.10	39.34 ± 2.95	0.05	65.17 ± 2.92	70.32 ± 2.04	0.05
CF	59.04 ± 2.04	57.69 ± 2.82	NS	53.90 ± 2.44	51.76 ± 2.97	NS
EE	46.75 ± 2.37	37.93 ± 2.97	0.05	64.22 ± 3.94	63.23 ± 2.99	NS
NFE	67.55 ± 1.90	67.76 ± 1.06	NS	73.09 ± 1.84	76.41 ± 1.80	0.05
<i>Nutritive value, %</i>						
TDN	55.53 ± 1.10	54.74 ± 0.62	NS	65.87 ± 1.72	67.18 ± 2.06	NS
DCP	2.89 ± 0.18	2.59 ± 0.22	0.05	6.52 ± 0.40	7.04 ± 0.20	0.05

NS = non-significant

than calves. In the contrast, cow calves on 50% R ration showed better ($P < 0.05$) digestibility values for OM, CP and NFE than camels, while the latter showed insignificantly higher CF and EE digestibility values than calves on the supplementary ration (50% R). Dietary nutritive value as TDN or DCP units were higher by calves than camels, where TDN% was 65.87 by camels and 67.18 by calves with non-statistical difference between the two species, while the difference for dietary DCP% was significantly ($P < 0.05$) higher by calves than camels (7.04 vs. 6.52). The results pointed out to that calves were better than camels in utilizing rations contained sufficient amounts of energy and protein needed for normal growth rate. Regardless of the species differences, all digestibility values except that of CF were clearly improved by shifting animals from 100 to 50% R ration which confirmed the important role of dietary CP level on improving nutrients digestibility and feed utilization.

Body weight development pattern

Body weight development of camels and calves during the two experimental periods is shown in Fig. 1. By tracing the slope lines of the biweekly body weight development for camels and calves, it illustrates that both species had lost weight with the 100% roughage ration.

However, the slope line (A) of camels weight shows that they lost weight from the first week till the fourth one, and then, their weight was gradually increased on the next four weeks, but they did not reach the initial weight up to end of the first trial (eighth week). The corresponding slope line of calves weight (B) shows that calves had lost weight along the whole first feeding period (8 weeks). It is proposed therefore that camels might have special potentiality in adjusting their metabolic homeostatic mechanism to maintain their body weight when they were exposed to inadequate nutrients. In the second trial

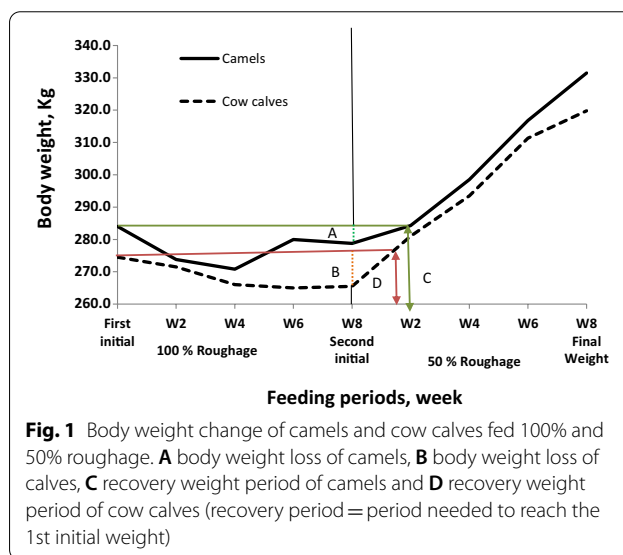


Fig. 1 Body weight change of camels and cow calves fed 100% and 50% roughage. **A** body weight loss of camels, **B** body weight loss of calves, **C** recovery weight period of camels and **D** recovery weight period of cow calves (recovery period = period needed to reach the 1st initial weight)

with 50%R ration, both species exerted similar trend in body weight development, where they had reached their first initial body weight within the first two weeks (see recovery periods expressed as C and D lines for camels and calves, respectively) and they continued gaining weight with similar rate until end of the second feeding period.

Feed intake and growth performance

Mean daily feed intake, weight gain and feed conversion of camels and calves fed 100% and 50% R rations are presented in Table 4. There were no significant differences between the two animal species for their initial and final body weight with the two experimental rations. Meanwhile, the average daily weight change indicates that both of camels and calves were lost weight with

Table 4 Feed intake and growth performance of camels and cow calves fed 100% and 50% roughage rations (means \pm sd)

Item	100% Roughage ration			50% Roughage ration		
	Camels	Calves	Sign.	Camels	Calves	Sign.
Initial weight, kg	284.0 \pm 22.40	274.5 \pm 24.85	NS	278.7 \pm 15.56	265.5 \pm 13.67	NS
Final weight, kg	278.7 \pm 15.56	265.5 \pm 13.67	NS	331.5 \pm 30.25	319.7 \pm 19.82	NS
Average weight, kg	281.4 \pm 16.1	270.0 \pm 16.5	NS	305.1 \pm 17.4	292.6 \pm 14.5	NS
Body weight change, g/d	-94.6 \pm 60.1	-160.7 \pm 94.3	0.05	942.8 \pm 27.10	967.9 \pm 12.00	NS
<i>Average actual daily feed intake</i>						
DM, kg/h/day	5.84 \pm 0.08	6.22 \pm 0.26	NS	7.23 \pm 0.09	7.54 \pm 0.04	NS
TDN, kg/h/day	3.24 \pm 0.08	3.40 \pm 0.09	NS	4.76 \pm 0.14	5.07 \pm 0.05	0.05
ME, Mcal/h/day	11.53 \pm 0.16	12.11 \pm 0.16	NS	16.63 \pm 0.19	18.05 \pm 0.11	0.05
DCP, g/h/day	169 \pm 7.46	161 \pm 2.10	0.05	471 \pm 5.68	531 \pm 2.85	0.05
DM intake of body wt%	2.08 \pm 0.12	2.30 \pm 0.17	0.05	2.37 \pm 0.16	2.58 \pm 0.10	NS
Roughage % of actual DM intake	100	100	-	50.5 \pm 0.58	52.7 \pm 0.50	NS
ME Mcal/kg ration	1.974 \pm 0.00	1.949 \pm 0.00	NS	2.300 \pm 0.00	2.394 \pm 0.00	NS
<i>Average actual feed intake</i>						
DM, g/kg ^{0.75}	85 \pm 4.04	93.4 \pm 5.38	0.05	99.04 \pm 5.16	106.6 \pm 4.28	0.05
TDN, g/kg ^{0.75}	47.15 \pm 2.28	51.22 \pm 4.13	0.05	65.20 \pm 3.26	71.66 \pm 2.81	0.05
ME Kcal/kg ^{0.75}	167.80 \pm 8.22	181.8 \pm 10.47	0.05	227.8 \pm 11.60	255.1 \pm 9.81	0.05
DCP, g/kg ^{0.75}	2.46 \pm 0.12	2.41 \pm 0.14	NS	6.45 \pm 0.34	7.51 \pm 0.30	0.05
<i>Feed conversion efficiency</i>						
TDN, kg/kg gain	-	-	-	5.05 \pm 1.34	5.19 \pm 0.62	NS
ME, Mcal/kg gain	-	-	-	17.64 \pm 4.68	18.65 \pm 2.19	NS
DCP, g/kg gain	-	-	-	499.6 \pm 74.75	548.6 \pm 65.75	NS

NS = non-significant

100% R ration but in two different rates, where camels lost ($P < 0.05$) lower daily weight than calves (-94.6 vs. -160.7 g/d). On the other hand, with feeding the 50%R ration camels and calves were recorded very close values of average daily gain (ADG) being 942.8 g for camels and 967.9 g for calves. Average daily feed intake as kg DM or TDN or Mcal ME was non-significantly lower for camels than calves on feeding the 100% R ration, while camels showed higher significant ($P < 0.05$) digestible crude protein (DCP) intake than calves with the low protein ration (100% R) being 169 g for camels and 161 g for calves.

This result might reveal that camels could utilize the very low level of dietary protein more efficiently than calves. In the contrast, daily intake of the 50% R ration in terms of TDN, DCP and Mcal ME was significantly ($P < 0.05$) higher for calves than camels; however, the daily DM intake was not statistically different between species. It seems that calves could utilize the 50%R ration which had sufficient protein more efficiently than camels. The metabolizable energy content (Mcal ME/kg DM) of 100% and 50%R rations by the two species was of comparable values being, respectively, 1.974 and 2.300 by camels and 1.949 and 2.394 by calves. Such result implies that camels and calves could utilize available dietary energy in nearly similar efficiency. Feed intake calculated as g DM,

TDN DCP or Kcal ME/kg $w^{0.75}$ was significantly ($P < 0.05$) higher for calves than camels on the two feeding regimes; however, DCP (g/kg $w^{0.75}$) was non-significantly varied between them. Feed conversion efficiency of camels and calves with the 50%R ration was very nearly typical, where camels recorded 5.05 g TDN equivalent to 17.64 Mcal ME and 499.6 g DCP/kg gain; the corresponding values were nearly identical for calves being, respectively, 5.19, 18.65 and 548.6/kg gain.

Blood biochemical parameters

Blood serum biochemical constituents for camels and calves fed the two experimental rations are given in Table 5.

With feeding 100% roughage ration, camels had higher ($P < 0.05$) total protein, albumin and globulin concentrations than calves, while corresponding concentrations were of comparable values in both species with feeding 50%R ration. Blood urea (ml/dl) was ($P < 0.05$) higher for camels than calves under the two feeding regimes. Creatinine concentration was almost similar in camels and calves fed either 100% or 50%R ration; however, it was decreased with feeding the high protein ration (50% R) in both species. It is interesting to note that blood cholesterol and triglycerides were obviously lower ($P < 0.05$)

Table 5 Blood serum biochemical constituents of camels and cow calves fed 100% and 50% roughage rations (means \pm sd)

Item	100% Roughage ration			50% Roughage ration		
	Camels	Calves	Sign.	Camels	Calves	Sign.
Total protein, g/dl	6.30 \pm 0.12	6.08 \pm 0.20	0.05	6.35 \pm 0.14	6.37 \pm 0.16	NS
Albumin, g/dl	3.41 \pm 0.10	3.31 \pm 0.10	0.05	3.44 \pm 0.12	3.45 \pm 0.10	NS
Globulin, g/dl	2.89 \pm 0.18	2.77 \pm 0.26	0.05	2.91 \pm 0.22	2.92 \pm 0.24	NS
Urea, mg/dl	30.03 \pm 1.86	18.33 \pm 1.48	0.05	34.44 \pm 1.99	28.06 \pm 1.42	0.05
Creatinine, mg/dl	1.22 \pm 0.06	1.15 \pm 0.04	NS	0.85 \pm 0.06	0.87 \pm 0.10	NS
Cholesterol, mg/dl	45.67 \pm 1.68	98.16 \pm 2.06	0.05	46.32 \pm 2.88	109.17 \pm 3.25	0.05
Triglycerides, mg/dl	23.31 \pm 0.80	52.29 \pm 1.78	0.05	25.36 \pm 1.56	58.82 \pm 1.12	0.05
ALT, U/L	18.70 \pm 1.12	25.42 \pm 0.70	0.05	21.03 \pm 1.29	28.58 \pm 1.64	0.05
AST, U/L	34.02 \pm 1.62	38.09 \pm 1.38	0.05	43.19 \pm 1.78	47.87 \pm 2.56	0.05

NS = non-significant

in camels than calves with the two experimental rations. Cholesterol (mg/dl) in camels was 45.67 vs. 98.16 in calves with feeding 100%R ration and 46.32 vs. 109.17 with 50%R ration. Triglycerides had similar trend, where camels recorded much lower values (23.31 and 25.36 in camels and 52.29 and 58.82 in calves) with 100%R and 50%R rations, respectively. Liver transaminases (ALT and AST) were generally within the normal range of both animal species, but camels had significantly lower values than calves under the two feeding regimes.

Discussion

Regarding results of the present study, it was clear that the most limiting nutrient of the 100% R ration was the CP content, which made up 6.59% of the whole ration. The all-roughage ration fed ad libitum provided 2.46 and 2.41 g/kg $w^{0.75}$ for camels and calves, respectively. Both of the two DCP intake (g/kg $w^{0.75}$) levels were below the maintenance requirements for camels and calves. The maintenance DCP was recommended to be 2.70 for camels and 2.82 g/kg $w^{0.75}$ for calves according to the nutrients requirements of camels and cow calves (Wardeh 1997; ARC 1980). Meanwhile, the daily feed intake of the two animal species was sufficient to provide the energy needed (ME kcal/kg $w^{0.75}$) for maintenance plus at least 500 g weight gain (Wardeh 1997) for growing camels and calves (ARC 1980). However, both species did not achieve any weight gain, but they lost weight with feeding the 100%R ration for 56 days (-5.3 and -9.0 kg for camels and calves, respectively). It is interesting to note that camels exhibited more resistance in losing weight than calves particularly, after the first 4 weeks of the feeding period, where they could restore their body weight until end of the feeding period (Fig. 1). In this concern, several studies concluded that camels could regulate their metabolic rate to bring their weight into a constant level when they

were exposed to inadequate feeding. It was stated that camels require less energy and protein for maintenance than other ruminants and they are not only decrease feed intake but also reduce their metabolic rate under feed scarcity. It was also noted that camels could tolerate dietary protein shortage by conserving N loss in feces and urine besides promoting urea recycling capability to provide ruminal microbes with their N demands (Gihad and El-Bedawy 1992). It was also noted that when protein was decreased from 13.6 to 6.1% in dromedary rations, the fraction of urea entry rate that was degraded rather than excreted in urine increased from 47 to 86% (Emmanuel et al. 1976). Under the administration of feeding the 100% R ration total DM intake was significantly lower for camels than calves as per 100 kg body weight (2.08 vs. 2.30 kg) or as g DM/kg $w^{0.75}$ (85 vs. 93.4). Even though, camels could utilize available dietary energy and protein more efficiently than calves as TDN (55.53 vs. 54.74%) and DCP units (2.89 vs. 2.59%) of the all roughage ration. The nutritive value of a given ration is the direct impact of nutrients digestion coefficient (%) which were higher by camels than calves in particular CP and fat digestibility. On this context, Hashi et al. (1995) mentioned that the metabolizable energy requirement for maintenance (ME_m) of the dromedary camel had been assumed to be lower and its efficiency of utilization for body weight gain is higher than other ruminants. Many workers had suggested that the ME value of feeds measured on camels was higher than corresponding feeds measured on sheep, which means that camels could extract more energy from feeds they consumed than other ruminants (Degan et al. 1987). The high tolerance of camels for inadequate good quality feeds was also noted in many studies, where they concluded that camels have exceptional ability to maintain their body weight under feed shortage or inadequate dietary protein. They attributed tolerance of inadequate

feeds to that camels are capable to get their energy and protein requirements through activating the gluconeogenesis and urea recycling processes to their life (Hashi et al. 1995; Wardeh 1997; Shawket et al. 2007). The previous studies might support our results that camels fed the 100% R ration were better than calves in utilizing available dietary energy and protein to maintain their body weight in a steady state level.

On the other hand, with feeding the supplementary ration of 50:50 C:R ratio both of camels and calves could score similar ADG being, respectively, 942.8 and 967.9 g/d. The daily DM intake of 50%R ration had provided 227.8 and 255.1 kcal ME/kgw^{0.75} and 6.45 and 7.51 g DCP/kgw^{0.75} for camels and calves, respectively, which were sufficient to provide energy and protein requirements for maintenance and daily gain of 1.0 kg for both camels and calves (ARC 1980; Wardeh 1997). Although calves performed slightly better than camels in utilizing dietary DM in terms of TDN and DCP%, the feed conversion efficiency was nearly identical by both species, where camels recorded 5.05 kg TDN, 17.64Mcal ME and 499.6 g DCP/kg gain and calves 5.19 kg TDN, 18.65 Mcal and 548.6 g DCP/kg gain.

Several studies mentioned that feeding camels on supplementary rations improved their daily weight gain. Daily weight gain between 326 to 565 g was recorded on Tunisian camel calves fed wheat bran and olive pulp at 1.6% of body weight (Kamoun et al. 1989). Growing camels had achieved ADG of 285 g with roughage-based ration supplemented with daily 2 kg barley (Kamoun et al. 1995). In a comparative study on 10 heads of each of Sudanese camel calves and Baladi cow steers where all animals were fed on concentrate mixture (14% CP) at 2% of body weight with ad libitum amounts of rice straw, camels consumed less daily DM intake than steers (1.75 vs. 2.50 kg/100 kg body weight), while ADG was 810 g for camels and 770 g for steers. And feed conversion efficiency of camels was slightly better than steers.

Camels consumed less daily DM intake than steers (1.75 vs. 2.50 kg/100 kg body weight), while ADG was 810 g for camels and 770 g for steers. And feed conversion efficiency of camels was slightly better than steers (El-Badawi and Yacout 1999). The effect of dietary protein level on growth performance of camel calves revealed that feeding growing camels on concentrates mixture contained 10% CP was sufficient to achieve 829 g ADG with only 1.44% DM intake under stall-fed conditions (Yacout and El-Badawi 2001). In Israel, young camels recorded 840 g ADG with rations provided daily 19.45 MJ metabolizable energy (Degan et al. 1987). The same trend was also noted that the DM intake of dromedary camels fed coarse roughages was improved by 16% and 60% with a high protein supplement for, respectively, oat hay and

wheat straw based-rations (Hashi et al. 1995). They stated that in any case, the DM intake was voluntarily limited at 1.6–1.7 kg/100 kg body weight even with a ration containing 50% concentrates of the total ration. In a study on Arabic camel calves, ADG of 642 and 542 g was recorded with, respectively, daily 2 kg/head watermelon seeds or ground nut cake plus grazing for one hour in a natural pasture, while the only grazing camels recorded 214 g/day (Bakheit et al. 2019). The previous studies confirmed the importance of concentrate feeds in feeding growing camels or cow calves to achieve their nutrients requirements as in the present study.

The relatively higher DM intake of camels in this study (2.1% of 100% R and 2.4% of 50% R of body wt.) than other studies might be regarded to that corn silage which is a high moistened feed could increase the passage rate and decrease retention time in the gastro-intestinal tract particularly, with feeding the all roughage ration (100% R). Such assumption might hold true, since most nutrients digestibility values were obviously decreased by both animal species in comparison with those of 50% R ration. We suggested that camels were more sensitive than cow calves in eating and utilizing high moistened roughage feeds because they are traditionally fed on dry feeds in their natural habitat.

Concentrations of blood serum biochemical constituents illustrate that total protein, albumin and globulin of camels were not changed with feeding low (6.6%CP) or high (10% CP) protein ration. However, blood protein concentration of calves was significantly influenced by the dietary protein level. Blood urea concentration was higher in camels than calves under the two feeding regime; however, blood urea of camels was increased as the level of dietary protein increased. Similar approaches were previously achieved with camels fed 9.50, 12.00 and 14.50% dietary protein levels (Nagpal et al. 2011). This particular phenomenon could be regarded to the active urea recycling mechanism promoted in camels when they were exposed to dietary protein shortage (Emmanuel et al. 1976). Blood cholesterol and triglycerides were remarkably lower in camels than calves. This trend was also noticed on Indian dromedary calves fed rations of different CP levels (Nagpal et al. 2011). Liver transaminases (ALT and AST) were generally within the normal range of both species; however, camels recorded lower values than calves. Liver enzymes in this study were increased as the level of dietary protein increased, which were not compatible with Nagpal et al. (2011) who found no effect of dietary protein level on enzymatic liver. Such difference between the two studies could be fairly regarded to the high dietary protein level (9.5 to 14.5%) used in their study which was almost over the maintenance requirements of protein for camels. It is logic to

state that the blood biochemical constituents of camels were more stable than calves when fed low or high protein rations.

Conclusion

The results of this preliminary study revealed that growing camels could utilize the poor protein roughage ration more efficiently than cow calves and they could achieve similar growth rate and feed conversion efficiency as those of calves when fed supplementary at 50% concentrates. Future studies are needed on adequate number of camels to explore their potentiality as animal meat providers in developing countries and poor greenery lands.

Abbreviations

R: Roughage; C: Concentrate; CFM: Concentrate feed mixture; g: Gram; d: Day; Mcal: Mega calorie; ME: Metabolizable energy; DCP: Digestible crude protein; wt: Weight; kcal: Kilocalorie; DM: Dry 376 matter; OM: Organic matter; CP: Crude protein; CF: Crude fiber; EE: Ether extract; NFE: Nitrogen-free extract; TDN: Total digestible nutrients; df: Degree of freedom; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; ADG: Average daily gain.

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Authors' contributions

AYE, MY and GA contributed to conceptualization; AYE, AH and SE helped in data curation; AYE, FH and SE contributed to investigation; AYE AA, AH, MY, MK and SE contributed to methodology; AYE and AA helped in supervision; AA, AH Mk and GA helped in validation; AYE and SE contributed to visualization; AYE AA and SE contributed to writing—original draft; AYE and SE contributed to writing—review and editing. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate

The experimental design and all the research protocols were approved by the Medical Research Ethics Committee (MREC) of the National Research Center with ethical approval code 1471022021.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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