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Effect of different feeding system on body weight, testicular size developments, and testosterone level in pre-pubertal male camel (*Camelus dromedarius)*

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Eighteen dromedary males (*Camelus dromedarius*) were used to investigate the effect of nutrition on body weight, size of the testes, and blood testosterone concentrations in pre-pubertal male camels. Animals were divided into two groups of 9 animals each. Group A received a diet with 13% crude protein (CP) and 2.9 MCal (ME), whereas Group B received the traditional diet of the farm, and each animals' feed intake was calculated after allowing a 14 day adaptation period. Diets contain 25:75 (roughage: concentrate, respectively). Blood samples were taken from the same five animals from each group, every 15 days during the whole experimental period and plasma testosterone concentrations were measured. There was no significant difference in total body weight gain over the whole experimental period between Group A and B, although Group A showed a significant increase in body weight over the last 6 months compared with Group B. Group A consumed less feed and were more efficient at converting feed to body weight than Group (B), as shown by the (FCR) over the whole period which was 9.25 for Group A and 13.03 for Group B. There was no significant difference in testicle size between Groups A and B at the start of the experimental period, blood testosterone levels were significantly higher in Group A compared with Group B, but although there was an increase in testicle size over the experimental period, there was no significant increase in blood testosterone levels.

Key words: *Camelus dromedarius*, puberty, body weight gain, testicular size, testosterone.

INTRODUCTION

The one humped camel (*Camelus dromedarius*) has the capacity of being a better provider of food in the desertareas of the world than the cow which can be severely affected by heat and scarcity of feed and water. One of the most important factors affecting productivity, other than nutrition and disease, is the low reproductive performance of the camel, short breeding season and long gestation period of 13 months (Aboul-Ela, 1991). This low reproductive performance has remained a major obstacle to the growth of populations of dromedaries over the years (Tibary and Anouassi, 1997). High fertility levels in the camel are essential, not only for profitable production, but also to provide opportunities for selection and genetic improvements. The breeding season of camel in India extends from December to March, that is, the period of short day length (Matharu, 1966) and similar

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short day breeding seasons have been reported in Sudan (Musa and Abusineina, 1978). However, as stated by Musa et al. (1993), no organized attempts to manipulate the onset of the breeding season, or to extend it, have been reported. Thompson and Johnson (1995), Ott (1991), Osman et al. (1979), and Abdel-Raouf et al. (1975) reported that size and weight of testes are affected by the age of the camel, and the season of the year. In addition, nutrition effects the age at which male camels reach puberty as animals on a good plane of nutrition come to puberty earlier, in fact body weight has more influence on puberty than age. Nolan et al. (1991), Abdel-Rahim et al. (1994) and Abdel-Rahim (1997) however, reported that there was a highly negative correlation between testicular dimensions and the age at which spermatogenesis starts.

Testosterone is the main sex hormone controlling most of the reproductive functions including libido, later stages of spermatogenesis, and the activity of accessory sex glands in male animals (Hafez and Hafez, 2000). Azouz et al. (1992) reported a significant decrease in testosterone levels in male camels in the non-breeding season as compared with the levels during the rut. This agreed with results of El-Bahrawy and El-Hassanein (2011) who reported that basal concentrations of testosterone during the non-rutting season were 2.89±0.26 ng/ml, which significantly increased to 5.8±0.74 ng/ml during the pre-rut. This increase continued to maximum concentrations of 7.95±1.85 ng/ml during the rutting season, then finally decreased during the post rut to 3.15±0.38 ng/ml before finally reaching basal concentrations again. Also, Rateb et al. (2011) reported that the average values of blood serum testosterone were significantly lower in sub-fertile camels (1.7±0.2 ng/ml) comparing with fertile animals (3.7±0.2 ng/ml) and immature camels had overall significantly lower levels of testosterone (Al Qarawi and ElMougy, 2008).

In view of these results and considering that diet could have an effect on the age at which male camels reach puberty, the objective of this study was to evaluate the effect of diet on live body weight gain, testes size development, and blood testosterone concentrations, as reproductive parameters for pre-pubertal male camels.

MATERIALS AND METHODS

Animals and diets

This experiment was conducted in October at Camel Breeding, Range Protection and Improvement Center in Al-Jouf area, K. S. A. Eighteen dromedary males (*C. dromedarius*) were used to investigate the nutritional effect on body weight and testes size development, as well as blood testosterone level in pre-puberty camel males. Animals were divided into two equal groups according to body weight and age at the start of the trial (265 kg and 17 month, respectively). Group (A) received diet with 13% crude protein (CP) and 2.9 Mcal (ME). Group (B) received the traditional diet of the center (Table 1).

Animals' individual feed intake was calculated after allowing a 14 day period to adapt to the feed. The feed offered and orts were recorded daily for the entire experimental period of 12 months. Animals were fed with diets containing 25:75 (roughage: concentrate, respectively) and in Diet A, roughage and concentrates were in one pellet. Fresh water was available all time. Jugular vein blood samples were collected into anticoagulant, evacuated tubes from the same five animals from each group every 15 days during the whole experimental period. The plasma was then separated and frozen at -20°C until further analyses.

Lab analysis and measurements

The following parameters were measured or calculated: (i) body weight every 15 days in kg, the animals were weighed after 10 h of fasting; (ii) body weight gain in kg, (iii) daily weight gain in Kg/day.

Jugular vein blood samples were collected in ethylenediaminetetraacetic acid (EDTA) vials twice a month always at 8.00 Am, samples centrifuged at 5000 rpm for 20 min, plasma were separated and stored at -20°C until used to measure plasma testosterone concentrations using commercial Elisa kits (Diagnostic Automation inc. CA. USA).

The axes of the testicles were measured using calipers and the size calculated by using the equation for ellipsoid volume: '4/3 π a*b*c' a.b.c. = axes of ellipsoid (http://en.wikipedia.org/wiki/volume).

Statistical analysis

Data had been subjected to statistical analysis using the SAS program (SAS, 2000). Data for changes in body weight were analyzed according to the following model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where Y_{ij} is the observation of the dependent variable obtained from J^{th} animal of I^{th} treatment, μ is the overall mean; T_i is the effect of i^{th} treatment (i = A or B); and e_{ij} is the residual term. For the testicular size and testosterone concentrations the model was:

$$Y_{ijk} = \mu + T_i + P_j + e_{ijk}$$

Where Y_{ijk} is the observation of the dependent variable obtained from K^{th} animal of I^{th} treatment, of J^{th} period, μ is the overall mean; T_i is the effect of i^{th} treatment (i = A or B); P_j is effect of j^{th} period (j = 1 to 4); and e_{ijk} is the residual term. The interaction between groups and months failed to be significant for that deleted from the model. The general linear model (GLM), least squares means (LSMEANS) procedures were used.

RESULTS AND DISCUSSION

Changes in live body weight

The total body weight gain over the whole period was not significantly higher in-Group (A) compared with Group (B), 146.6±6.9 *vs* 138.3±6.8, respectively, however Group (A) showed significantly ($P<0.05$) higher body weight gain over the last 6 months compared with group (B) 79.01±4.5 *vs* 62.3±4.5 kg, respectively (Tables 2 and 3). The difference between Group A and B in feed intake was significant ($P<0.05$) and interestingly Group A consumed less feed but showed higher body weight gain,

Table 1. Diet composition and chemical constituents (dry matter bases).

Item	Diets	
Raw materials (%)	**A**	**B**
Barley	60.22	62.23
Wheat bran	9.63	12.08
Soya meal 48%	4.25	-
Salt	0.47	-
Limestone	2.10	-
Acid buf	1.00	-
Molasses	3.00	-
Premix	0.30	-
Alfalfa	19.03	15.23
Wheat straw	-	10.46
Nutrient (%)		
Dry matter (DM)	90.20	92.52
Crude protein (CP)	13.08	12.43
ADF	16.00	18.5
NDF	33.8	37.7
Calcium	1.67	0.35
Phos.	0.42	0.27
Salt	0.78	1.38
ME Mcal/kg	2.9	2.7

ME = Metabolisable energy.

Table 2. Treatment effect on live body weight and body weight gain.

Treatment	LBW 6 m (kg)	LBW 12 m (kg)	BWG 6 (kg)	BWG 12 (kg)	Total BWG (kg)
A	349.6±12.2	398.6±15.4	67.6±3.6	79.0±4.5^{a}	146.6±6.9
B	355.7±11.9	419.6±15.2	75.4±3.5	62.3±4.5^{b}	138.3±6.8

Values with different superscripts within the same column are significantly different (P≤0.05). LBW6 = Live body weight at 6 months. LBW12 = Live Body Weight at 12 months. BWG6 = Body weight gain over first 6 months. BWG12 = Body weight gain over last 6 months.

Table 3. Treatment effect on feed conversion ratio over first, last 6 months and whole period.

Item	Groups	
First 6 months	**A**	**B**
FI (Kg)	4.36±0.08^{b}	5.76±0.06^{a}
DWG (Kg)	0.400±0.05	0.400±0.04
FCR	10.90	14.40
Last 6 months		
FI (Kg)	4.63±0.07^{b}	5.68±0.07^{a}
DWG (Kg)	0.560±0.09^{a}	0.431±0.08^{b}
FCR	8.26	13.17
Whole period		
FI (Kg)	4.35+0.03^{b}	5.50±0.03^{a}
DWG (Kg)	0.470±0.06	0.420±0.06
FCR	9.25	13.03

Values with different superscripts within the same row are significantly different (P≤0.05).
FI = Feed Intake. DWG = Daily body weight Gain. FCR = Feed conversion ratio.

Table 4. Treatment effect on testes size and blood testosterone level.

Treatment	R. Testicular /cm^3	L. Testicular /cm^3	Testosterone ng/ml
A	120.61±9.41	108.55±10.39	3.88±0.08^a
B	114.44±13.95	90.39±13.83	3.65±0.08^b
Month			
3	86.67±15.24^b	67.17±16.20^b	3.84±0.11
6	140.85±27.33^a	102.86±29.49^a	3.80±0.11
9	91.73±12.34^b	99.55±15.57^b	3.89±0.12
12	150.85±9096^a	128.30±8.70^a	3.54±0.12

Values with different superscripts within the same column are significantly different (P≤0.05). R = right L = left.

Table 5. Treatment effect on mean blood concentrations of 'total protein, albumin, globulin, glucose, and cholesterol'.

Items	Treatments	
	A	B
Total protein (TP) g/l	67.66±1.17	64.98±1.20
Albumin (Alb) g/l	44.28±0.66^a	41.65±0.68^b
Globulin (Glo) g/l	23.28±1.04	23.33±1.06
Alb/Glo	2.01±0.08	1.95±0.08
Glucose (Glu) mg/dl	140.29±4.73^b	162.26±4.83^a
Cholesterol (Chol) mg/dl	29.50±1.40	32.52±1.43

Different letters within row indicates significant difference (P<0.05).

thus indicating a better food conversion rate than Group B. This was shown in the results by the feed conversion ratio (FCR) which was 10.9 (Group A) *vs* 14.4 (Group B) over the first 6 months (Table 3); 8.26 in Group A *vs* 13.17 in Group B over the last 6 months (Table 3) and 9.25 (Group A) *vs* 13.03 (Group B) over the whole period (Table 3). These results agreed with those of Mohamed, (2007) who observed a clear variation in camel FCR when they were fed different types of rations. The daily body weight gain (DWG) in this study was higher than that obtained by Sahani et al. (1998) and Faye et al. (2001) who reported that the daily gain for male camels between 18 to 24 months of age ranged from 0.111±0.015 to 0.219±0.24 kg/day. This result could be due to the difference in the management system, the nutritive value of the diet distributed to the animals and the breed characteristics. Indeed, the conformation of adult camel breeds in Saudi Arabia (Waddah and Majaheem) which are used in the present trial) and consequently their adult weight was on average much higher than the Indian and Ethiopian breeds which were used by these authors, respectively. In Kenya, on Somali breed with similar conformation than Saudi breed, the DWG (387 g/day) was similar to our observations (Kaufmann, 1998). In very intensive systems for fattening young camels, it has been reported exceptional post-weaning DWG superior to 500 g (Faye, 1997).

Changes in testes size

The size of the testicles was not significantly different between Groups A and B and although the right testicle tended to be larger, it was not significantly bigger than the left testicle (Table 4). This difference between right and left testicle was already reported in adult camel by several authors, whatever the season or the age groups, but generally, it observed a higher size of the left one (Singh and Bharadwaj, 1980). Over the whole experimental period, there was a significant increase in size of both the right and left testicles which agrees with the results of Al-Asaad et al. (2007) and El-Harairy and Attia (2010) who reported that there was a considerable development in testicular dimensions with increasing age. Group A had significantly higher blood testosterone concentrations (P<0.05) compared with group B but although there was an increase in testicle size over the experimental period, there was no significant increase in blood testosterone levels (Table 5). This result indicates that the testes did not secrete testosterone yet. Testosterone levels in this study match those during the non-rutting season (2.89±0.26 ng/ml) reported by El-Bahrawy and El-Hassanein (2011), and Yagil and Etzion (1980). However, in prepubertal camel, El-Harairy and Attia (2010) reported lower values (0.31±0.05 ng/ml) than in our study. Reported testicular dimensions in the

dromedary camel vary from one author to another. This variation is attributed to the age, to the sexual activity in the adultand probably to the breed (Tibary and Anouassi, 1997). These factors did not interfere in our case as breed composition was similar in the two groups, the mean ages were comparable and the animals were not yet adult. However, in spite of the juvenile status of the camel, a seasonal effect was observed, the testicle size being higher during the months 6 and 12 corresponding to the rutting time (Table 4). This seasonal variation is well known in adult camel (Tingari et al., 1984).

Physiological status

Regarding blood parameters as an indicator of the physiological status of the animals, only 2 parameters, albumin and glucose, showed significant differences due to treatment (Table 5). In Group A, the albumin level was significantly higher compared with Group B. Albumin provides the body with the protein needed to both maintain growth and repair tissues, which reflected in a higher body weight gain in Group A compared with Group B. The glucose level in Group A was lower than in Group B due to using more glucose as an energy source, to increase body weight. The values for albumin are in the normal range for camel in good conditions (Amin et al., 2007). For glucose, the values are higher than the normal range for adult (50 to 120 mg/100 ml) according to Faye and Mulato (1991). Indeed, it has been reported that the young camel has usually a higher glycemia than adult linked (Souilem et al., 1999).

Conclusion

In spite of only a slight difference in the protein contents of the two diets compared in this study, it appears that the nutrition had a slight effect on live body weight gain, and would thus affect the age at which they reach puberty. Pre-pubertal camels receiving a balanced diet with 13% crude protein, 2.9 Mcal ME and the required vitamins and minerals, improved body weight gain, testes size, and testosterone concentrations in the blood. Thus it would be expected that these animals would come into puberty earlier than those which received an unbalanced diet. However, more research is needed on the effect of nutrition on decreasing the age at which male camels reach puberty, especially by taking into account probable other limiting factors such as vitamins or minerals.

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