



Time-budget and Blood Parameters of the Dromedary Camels (*Camelus dromedarius*) Under Different Feeding Management Strategies

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Abstract | The current study investigated the impact of different feeding regimes on behaviours, body condition score and blood parameters of male camels in rutting season. twenty eight male dromedary camels randomly were divided into seven feeding regimes, twice daily fed on normal ration, once daily fed on normal ration but the same quantity as group 1, fed restricted diet before rutting season for 4 weeks then they fed control diet during rut season, fed restricted diet during rutting season, fed restricted diet before and during rutting season, fed same quality and quantity of control diet but offered once alternative day. Behavioural data had been collected for 66 days twice per weeks for feeding related behaviour, activity and aggression using instantaneous scan sampling. Moreover, blood samples had been collected at the end of observation period to estimate some serum blood parameters and some blood hormones. The results revealed that the standing time was significantly increased in control and daily once feeding groups when compared to other treated groups, in contrast our data did not reveal any significant difference in lying time. Moreover, feeding and rumination time was significantly affected by feeding regime where restricted and alternative feeding was significantly higher than control and daily once feeding. Regarding to behavioural patterns frequency, camel of control group are significantly exhibit more aggressive behaviour when compared to camels of other feeding systems groups. In addition, there is significant decrease in drinking behavior frequency in control group in comparison to daily once feeding or restricted (during or before + during) groups. Additionally, testosterone, urea, calcium, phosphorus, total protein levels in camels of infrequent fed restricted group had been significantly decreased when compared to control group. In summary we concluded that feeding regimes significantly can result in changes at the levels of behaviour and blood parameters of rut camels.

Keywords | Feeding, Rutting, Camel, Behavior

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INTRODUCTION

Arabian camels (*Camelus dromedarius*) have been domesticated 5,000 years ago, and throughout these years they played an important role in the camel owners'

life. Arabian camel (one humped camel) has special anatomical and physiological criteria that enable him acclimatizing to the desert ecosystem (Rabana et al., 2011). With the increase of human population and the insufficiency of food production in Africa and parts of Asia, it has be-

come necessary to develop suitable livestock production systems, and, concomitantly, to efficiently use available resources that are indigenous and non-exploited (Schwartz and Dioli, 1992). The camel could be a future hope in this regard (Faraz et al., 2019). Camels are considered one of the most important work and meat-producing animals in Egypt (Mohamed et al., 2009). Moreover, the use of camels as a source for meat, milk and work was dramatically increased in recent years (Held, 2015). The breeding season of male dromedary camels, known as rutting, in Egypt is at the coolest months of the year and lasts for 120-180 days (Padalino et al., 2015). During the breeding season, camels exhibit aggressiveness towards other males and humans (Fatnassi et al., 2014a). Due to such aggressiveness, handling of camel during breeding season can be very difficult, therefore camels are usually reared tied with ropes in pens, or, alternatively, housed singly in stalls (Abu-Zidan et al., 2012). Indeed, during such period camels show changes in temperament state reflecting changes in behaviour and productivity (Bakhat et al., 2003). Besides that, during rutting period camels show a drift from normal feeding pattern starting from partial till complete loss of appetite (off feed) (Bakhat et al., 2003; Marai et al., 2009; Al-Juboori et al., 2013) which manifested loss its condition and body weight was decreased (Skidmore, 2000). In recent times, husbandry of male camel has been altered towards using intensive and semi intensive breeding system and used for programmed mating or artificial insemination (Skidmore et al., 2013). The camel keeping regimes are currently changing due to the shortage of natural grazing land (Abbas and Omer, 2005). Enhancing nutritional conditions can therefore offer important solutions to herd health and fertility problems (Beever, 2005) in terms of implementing feeding strategies which aim to promote welfare, gastrointestinal health of animals (Berends et al., 2015; Brscic et al., 2014; Prevedello et al., 2012), blood hemoglobin concentration (Prevedello et al., 2009), and non-nutritive oral behaviours (Webb et al., 2012). Like other animal species, camel behaviour and welfare is dramatically affected by numerous factors including environmental factors and regime of nutrition (Fatnassi et al., 2014b). Therefore, the present study aims to investigate the effect different feeding strategies on behavioural and blood parameters of male camels during rutting period.

MATERIAL AND METHODS

The current study was revised and approved by The Animal Care and Use Committee of Faculty of Veterinary Medicine, Assiut University, Egypt, according to the regulations of Egyptian laws and ethics organizing animal use. The present study was conducted at Village of Assiut, Egypt lasted for 110 days. The present work studied the impact of different feeding systems on the time budget of feeding

behaviours (feeding and rumination), and lying and standing behaviour. Blood parameters (total protein, albumin, globulin, Ca, Ph, glucose, cholesterol, Triglycerides, testosterone) of mature male camels during the rut period were also estimated.

ANIMALS

Twenty-eight clinically healthy mature male dromedary camels, ranging in age from 5 to 8 years, with a mean body weight of 450 kg and good body condition score (3.5 ± 0.35 arbitrary units; from 0 to 5) were used in the study (Faye et al., 2001).

HOUSING

Camels were housed in sandy floor yards of equal sizes (5 m Length \times 3 m Width \times 3 m Height) and restrained with head rope (3 meters away from the manager) (Fatnassi et al., 2014b).

FEEDING AND WATERING

Feeding quantity and quality remained constant throughout the duration of the experiment, and water was provided ad libitum and was changed daily. Feeding ration contained 12% crude protein, TDN 67%, Fat 2.5%, fibers 14%, and Ash 9%.

EXPERIMENTAL PROCEDURES

The experiment was divided into two periods
Pre-experimental period: Extended from the 15th to the 31st of January 2019. In this period the animal was treated with Ivomec super[®] (Merial, France) at a dose of 1 ml/50 kg body weight subcutaneously twice, with 15 days interval, in order to get rid of internal and external parasites.

Also, from the 1st to the 28th of February 2019. In day 2, 9, 16 and 23, animals were observed for 1 hour/week every Saturday 20 minutes morning, 20 minutes mid afternoon and 20 minutes afternoon in order to get the animals adapted to the presence of unfamiliar human and camera. During this period of preliminary observation, the unhealthy camels or those exhibiting any abnormal behaviour were removed and replaced other healthy individuals.
Experimental period: Extended from the 1st March till the 5th May (66 days): As the breeding season of camel in Egypt extends from March to April or from March to May (Osman and EL-Azab, 1974), the experimental subjects were observed for behavioural data, and venous blood samples were collected from jugular veins.

EXPERIMENTAL GROUPS

Animals were allocated to one of the following experimental groups

Control group (4 camels) (CG):

Camels were fed at the rate of approximately 3% of its live

Table 1: Ethogram of the recorded behaviour patterns

Behaviour	Definition
Standing	Stand inactive with no movement in upright posture on four feet.
Lying	Sit in sternal or lateral recumbency.
Feeding	Ingest food from the manger.
Rumination	Regurgitating food is returned back to mouth, re-chewed and re-swallowed in a standing or lying position.
Drinking	Drink from the water basin.
Aggression	Biting; kicking and fighting.

Table 2: Blood parameters concentrations in male dromedary camel in four managemental systems

	Daily		Alternated (feeding once)		Feed restriction once daily		
	Every 12 hour	Every 24 hour	Every 48 hour	Every 72 hour	Rutting season (4 month)		
	Control (twice)	Once	At feeding day	Next day (no feeding)	Before (4 week)	During (10 weeks)	All (14 weeks)
Testosterone (ng/dl)	1.93 ± 0.04 ^a	1.88 ± 0.01 ^{a,b}	1.86 ± 0.02 ^b	1.83 ± 0.02 ^{b,c}	1.77 ± 0.01 ^{c,d}	1.74 ± 0.01 ^{d,e}	1.68 ± 0.01 ^e
Urea (mg/dl)	15.2 ± 0.17 ^a	15.03 ± 0.08 ^a	14.83 ± 0.08 ^{a,b}	14.7 ± 0.12 ^b	14.3 ± 0.36 ^c	13.67 ± 0.33 ^c	12.23 ± 0.23 ^d
Calcium (mg/dl)	2.77 ± 0.06 ^a	2.5 ± 0.06 ^a	2.57 ± 0.07 ^a	2.58 ± 0.02 ^a	2.23 ± 0.15 ^b	2.20 ± 0.1 ^b	1.9 ± 0.06 ^c
Phosphorous (mg/dl)	2.30 ± 0.06 ^a	2.37 ± 0.15 ^a	2.23 ± 0.09 ^a	2.24 ± 0.08 ^a	1.83 ± 0.09 ^b	1.67 ± 0.05 ^{b,c}	1.47 ± 0.08 ^c
Total protein (g\100 ml)	7.31 ± 0.12 ^a	7.29 ± 0.05 ^a	7.22 ± 0.14 ^{a,b}	7.11 ± 0.09 ^{a,b,c}	7.10 ± 0.12 ^{a,b,c}	6.9 ± 0.05 ^{b,c}	6.8 ± 0.11 ^c
Albumin (g\100 ml)	2.60 ± 0.12 ^a	2.53 ± 0.09 ^{a,b}	2.57 ± 0.07 ^a	2.53 ± 0.03 ^{a,b}	2.5 ± 0.15 ^{a,b}	2.4 ± 0.10 ^{a,b}	2.2 ± 0.12 ^b
Globulin (g\100 ml)	4.52 ± 0.12	4.77 ± 0.11	4.64 ± 0.17	4.58 ± 0.11	4.6 ± 0.26	4.5 ± 0.05	4.6 ± 0.12
Glucose (mmol/L)	68.3 ± 0.65	68.0 ± 0.58	68.1 ± 0.57	67.33 ± 0.88	68 ± 0.57	67.47 ± 0.52	67.33 ± 0.33
Cholesterol (mg/dl)	36.67 ± 1.2	36 ± 0.58	35.67 ± 0.88	35.53 ± 0.41	36 ± 1.7	36.17 ± 1.03	35.33 ± 0.88
Triglycerides (mg/dl)	57.03 ± 0.92	56 ± 0.9	56.37 ± 0.41	54.27 ± 0.83	56.5 ± 1.3	55.53 ± 0.44	55.57 ± 0.7

Different superscripts within the same rows depict significant differences among groups at p < 0.05.

weight (Khorachani et al., 2009). The diet consisted of 60% hay and 40% concentrate of 12% protein, and was offered to animals in two equal meals twice daily at 8-9 am and 4-5 pm, and a meal of green fodders was offered at 11am-12 pm.

Infrequent daily feeding group (4 camels) (IDFG):

Camels were fed on the same diet of the control group but once daily.

Infrequent fed restricted feeding group (12 camels) (IF-RFG):

Camels were fed on a restricted-quality diet containing 9% protein, and the same quantity of the control group but were offered once daily in three ways as follows:

Before rutting season: the restricted diet was offered for 4 weeks before the rutting season, then the control diet was offered during rutting season.

During rutting season: the restricted diet was offered during rutting season (10 weeks).

All times: the restricted diet was offered before and during rutting season (14 weeks).

Infrequent alternative daily feeding group (8 camels) (IADFG):

Camels were fed on the same diet of the control group but the diet was offered once in doubled amount every other day (on one day the animals were offered the food of two

days and the next day were offered no food).

BEHAVIOURAL PARAMETERS

The behaviours of individual animals within each group were recorded using a digital camera (OPTIKA microscopes SRL, Italy) for 90 minutes (3 sessions each for 30 minutes). The first session was carried out in the morning at 5 am, the second was in mid-afternoon at 12 am and the third was at late afternoon at 3 pm. Behavioural recordings were done for two successive days/week covering one feeding day and one non-feeding day for camels in alternative treatment group, and two feeding days for animals in the other treatments groups for 10 weeks for a total of 30 hour to each treatment group (30 hour = 100%). While Saturday was a choice per week for 10 weeks and this were at 2, 9, 16, 23, 30 March and 6, 13, 20, 27 April and 4 May).

The recorded videos were analyzed using both focal and scan sampling technique (Altmann, 1974; Dawkins, 2007) in order to measure durations (for estimating time budget) and frequency of different behaviours. The recorded behaviour patterns are showed in Table (1).

BODY CONDITION SCORE

Body condition score of camels was estimated at the end of the experiment at 5th of May 2019 according to (Faye et al., 2001).

BLOOD COLLECTION AND ANALYSIS

Blood samples of 10 ml were collected from each animal at the end of experiment at the 5th of May 2019 at 9-11 am from the jugular vein in duplicate tubes with and without anti-coagulant. Blood samples were centrifuged using electronic centrifuge (SMIC Inc., China) for 10 min at 3000 rpm within 2 h of collection, thus serum and plasma were separated and kept at -20°C for biochemical analysis. During blood collection, animals were gently restrained with halter and rope only by a skilled handler, who stroked the neck of the animals during the procedure. All animals experienced the blood collection process with no signs of aggressiveness, distress, or pain.

Chemical parameters (Wilson and Foster, 2011):

Levels of total serum protein, albumin, inorganic phosphorus and calcium were assayed by colorimetric methods using commercial kits manufactured by Egyptian Company for Biotechnology, Egypt. While, total glucose and cholesterol were estimated by commercial test kits (Spin-react, Spain), by Digital- VIS/ultraviolet spectrophotometer (Cecil instruments, Cambridge, England, Series NO. 52.232).

Serum hormones:

Testosterone levels were estimated by stat fax-2100

(Awareness technology, INC, USA) and commercial ELISA kits.

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 16. The effects of the feeding regimes were tested by (ANOVA). Means were compared by Duncan Alpha test when a significant difference was detected. Statistical significance was declared when the coefficients were at a probability equal to or less than 0.05. Data are presented as Mean \pm SE.

RESULTS

The results of the present study showed that camels showed remarkable changes in behaviours between different experimental groups. Standing time was significantly increased in CG and IDFG when compared to other experimental groups (IFRFG and IADFG) $F_{6,21} = 20.280$, $P = 0.000047$. In contrast, data did not reveal any significant difference in lying time between different feeding regimes $F_{6,21} = 1.168$, $P = 0.335$ (Figure 1). Moreover, feeding and rumination time was significantly affected by feeding regime. IFRFG and IADFG groups showed significantly higher feeding and rumination time compared to CG and IDFG $F_{6,21} = 16.475$, $P = 0.00026$, $F_{6,21} = 5.674$, $P = 0.0092$ respectively. Regarding the frequency of behavioural patterns recorded. Camel of the CG expressed significantly more aggressive behaviours when compared to camels of other feeding groups (IDFG, IFRFG and IADFG) $F_{6,21} = 5.704$, $P = 0.00087$ (Figure 2). In addition, there was a significant decrease in frequency of drinking behaviour in CG compared to IDFG or IFRFG (during or before + during) groups $F_{6,21} = 117.203$, $P = 0.000036$. Moreover, Figure 3 showed that, there was no significant change in body condition score between the experimental groups $F_{6,21} = 1.714$, $P = 0.167$. For blood parameters, there was no significant difference between the four experimental groups for total serum levels of globulin, glucose, cholesterol and triglycerides. Whereas, total serum levels of testosterone, urea, calcium, phosphorus, total protein and albumin in camels of IFRFG were significantly lower when compared to those of the CG $F_{6,21} = 18.87$, $P = 0.00059$, $F_{6,21} = 22.101$, $P = 0.000021$, $F_{6,21} = 12.03$, $P = 0.000021$, $F_{6,21} = 3.43$, $P = 0.043$ and $F_{6,21} = 1.81$, $P = 0.170$ respectively (Table 2).

DISCUSSION

Behaviour and welfare of camel have been shown to be affected by environmental conditions and nutrition strategies (Fatnassi et al., 2014a). The present study compared the impact of four feeding regimes on camel behaviours and blood parameters during rutting season. As revealed by the data, camels of infrequent restricted and infrequent alternative feeding regimes spent longer time in feeding and rumination behaviours when compared to control

group, and this result agrees with those of (Phillips and Rind, 2001; Danilo et al., 2012; Sayed, 2009) who postu

(control) regimes, we found that rumination time were 20% and 23% respectively. This result may due to the increase of feeding frequency that results in a quadratic response in ruminating activity (Robles et al., 2007), and the increase of feeding frequency may increase surface area and height of rumen tissue papillae (Tassia et al., 2014). Besides that, the presence of fresh feed may have a stimulatory effect on eating activity (DeVries et al., 2005) which might have increased feeding time and the rumen capacity for rumination. Also, data revealed no significant differences in feeding frequency between experimental groups. This result agrees with those of (Phillips and Rind, 2001; Hart et al., 2014) who found no difference in daily feeding time in cows fed frequently compared to cows fed once daily.

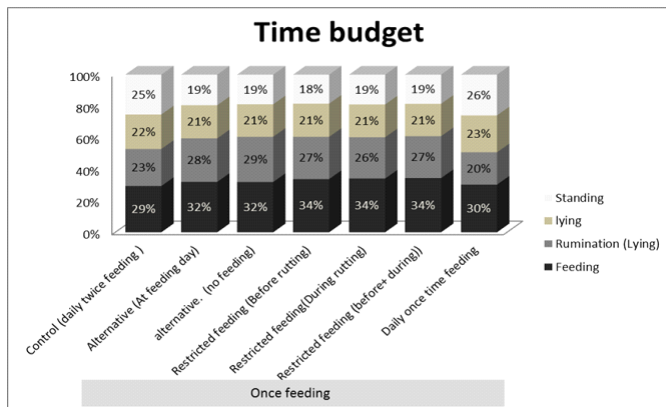


Figure 1: Time budget of different behaviours recorded in male dromedary camel in four managemental systems: Control group, infrequent daily feeding group, infrequent fed restricted feeding group, infrequent alternative daily feeding group.

The rise in the drinking behaviour in control group (daily twice feeding) compared to infrequent daily feeding group may be due to the increase in feeding frequency. Robles et al. (2007) reported increasing feeding frequency produced a quadratic response in water consumption. Moreover, restricted group (during and before rutting) showed more drinking frequency than control group, but this finding disagrees with the that of (Amit et al., 2020) who reported that reduction in energy level increased water intake.

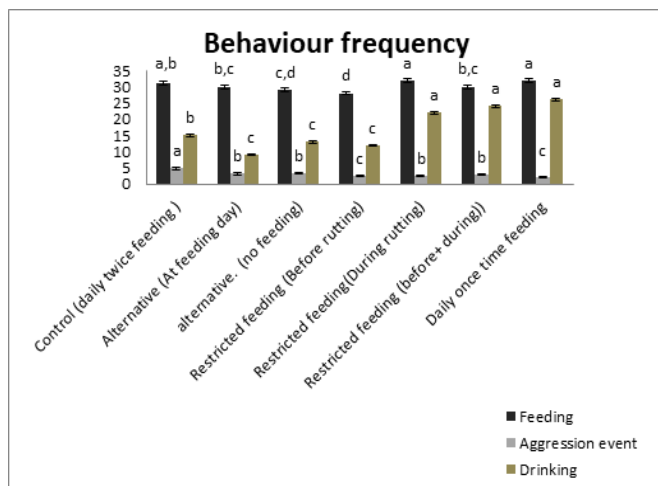


Figure 2: Frequency of different behaviours recorded during observation period in male dromedary camel in four managemental systems: Control group, infrequent daily feeding group, infrequent fed restricted feeding group, infrequent alternative daily feeding group.

lated that decreasing the dietary concentrate and energy levels resulted in an increase of feeding and rumination time. Moreover, feeding of low level of concentrates stimulated cellulolytic fermentation in the rumen and by its role stimulates rumination process (Jakhmola and Roy, 1992). The increased rumination in restricted and alternative feeding regimes may be related to frequency of offering food for these animals, that feeding ruminants more than once daily reduced diurnal variation in rumen pH and stimulated rumination process (French and Kennelly, 1990; Shabi et al., 1999).

When comparing between daily once feeding and twice

Body condition score

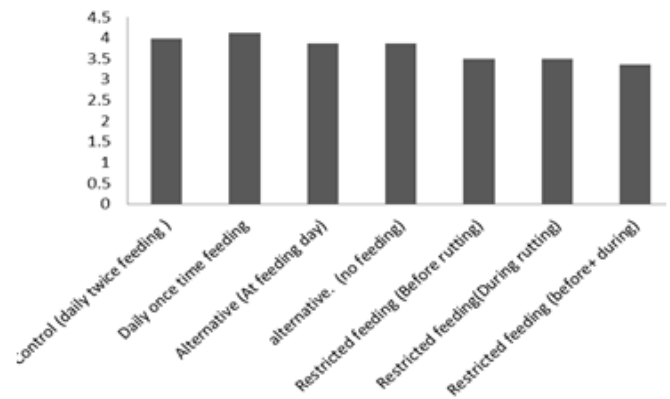


Figure 3: Body condition score in male dromedary camel in four managemental systems: Control group, infrequent daily feeding group, infrequent fed restricted feeding group, infrequent alternative daily feeding group.

The significant decrease in aggression frequency between daily feeding groups and alternative fed group in comparison to control (daily twice feeding) agrees with the finding of (Phillips and Rind, 2001) who concluded that regular offering of food is a destabilizing factor. Moreover, (Mistleberger, 1994; Jensen, 1995; Rind and Phillips, 1999) suggested that extra feeding increased aggression between animals. Additionally, it has been reported that alternate-day fed cows were more relaxed as they groomed

themselves longer than daily fed cows (Phillips and Rind, 2001). Besides that, a liner increase in aggression frequency was noticed with increasing feeding frequency (Jeziarski and Podluzny, 1984). On the other side, the significant decrease in aggressive behaviour in restricted feeding groups compared to the control group could have been due to that the control group had more protein or energy level than the restricted group which is in line of results of (Rasa and Van den Hoovel, 1984) who reported that the increase in social activity, particularly aggression could derive from increased protein intake, because increased nitrogen status is correlated with aggressive behavior in field voles, and that of (Wise et al., 1973) who found that high-protein diets increased dominant-aggressive interactions in monkeys.

Lying behaviour is a vital indicator to assess animal comfort, and to provide significant data about animal-environment interaction such as total time of lying (Haley et al., 2000; Fregonesi and Leaver, 2001) and lying bouts number and duration (Haley et al., 2000). Such measures have been identified as significant measures used to assess stall comfort and welfare status. According to the data of the current experiment, there was no significant difference in lying time between infrequent (one) and frequent (twice) feeding regimes. This finding agrees with those of (DeVries et al., 2005; Hart et al., 2014) who concluded that the increase of feed frequency had no impact on total daily lying time. In contrast, our data disagrees with the findings of (Mäntysaari et al., 2006; Mattachini et al., 2020) who found that feeding cows five times per day resulted in an increase of restlessness and a decrease lying time compared to cows fed once a day, and that high feeding frequency (9 time) can disturb lying bouts duration and can alter lying behavior patterns throughout the day.

Furthermore, the findings of the current experiment revealed a significant decrease in body condition score in restricted groups (all) when compared to the control group. This finding agrees with that of (Farid et al., 2010) who stated that restricting concentrates levels significantly reduced the average daily gain (ADG) (691, 305 and 189 g/d in camels fed 100, 75 and 50 % of ad lib concentrate intake respectively). These results could conclude that growing camels having the preference to select from concentrates and roughages diets were able to regulate their voluntary food intake mainly through physiological mechanisms to get sufficient requirements of energy. While the finding of significant increase in control group than the restricted group agrees with that of (Khan et al., 2002) who concluded that cows fed ad libitum gained more weight than those of restricted feeding. Indeed, the lack of no significant differences between restricted groups agree with those of (Brito et al., 2007, Dexter et al., 2019) who concluded that restricted feed during calf hood had no impact on growth hormone. Generally, feed efficiency and average daily gain

had an irreversible relation to protein and energy levels in the diet (Ebrahimi, 2007). The level of energy is significantly related to the average daily feed intake. Lambs fed on low energy ration consumed more ration compared to other treatment groups (Hossain et al., 2003; Yagoub and Babiker, 2008). Increasing the energy level may allow the production of more fermentable metabolized energy (ME) for rumen microorganisms resulting in a rise in the synthesis of microbial protein and in the amount of protein available to the animal.

Results of the current experiment also revealed that total levels of blood glucose, protein, albumin, triglycerides, cholesterol and creatinine between groups showed no significant difference. While, serum concentrations of urea, calcium and phosphorus were higher in control group when compared to restricted groups. These results agree with those of (Nagpal et al., 2011; Nagpal, 2013; Nagpal and Singh, 2015) who reported that levels of serum urea, calcium and phosphorus had a liner increase with protein levels. Moreover, (Swelum et al., 2017) concluded that plasma concentrations of urea, and calcium were significantly lower in restricted feeding group than ad libitum fed group. Serum urea concentration is a marker of protein intake and digestion, degradation of protein sources, and energy availability in the rumen (Roseler et al., 1993). The greater protein intake in high restricted feed intake (RFI) animals the greater the rate of body protein degradation, or deviations in the supply of amino acids, due in part to variations in the efficiency of microbial protein production in the rumen (Kahn et al., 2000). Moreover, data of the current work did not reveal changes in the level of serum globulin, which agrees with those of (Caldeira et al., 2007) who stated that the higher stability of serum globulin in varying nutritional regimes reflected the important role of globulin in controlling body osmoregulation and the immunological defense in the animals. In addition, (Amit et al., 2020) also mentioned that no significant difference was found for plasma concentrations of glucose in varying nutritional regimes.

Noticeably, there was a significant decrease in testosterone level in restricted fed groups compared to control group. This finding agrees with that of (Brito et al., 2007) who illustrated that feeding on restricted ration during calf hood inhibited the hypothalamic gonadotropin releasing hormone, impaired steroidogenesis in testicles, reduced both physiological and GnRH-stimulated testosterone secretion which adversely affected the level of the hypothalamus-pituitary-gonad axis. Also, (VanDemark and Manger, 1964) reported that extremely low energy intake beginning in early life can delay puberty. Moreover, (Melo et al., 2014; Guan and Martin, 2017) found that nutrients and protein restriction decreased the Sertoli cell efficiency leading to a decrease in testosterone level. Moreover,

nutrition directly affects Leydig cell number and function (Brito et al., 2007). Such effects are known to be mediated by IGF-I, since receptors have been identified in Leydig cells in several species and IGF-I increased proliferation and differentiation of Leydig cells (Lin, 1995). On the other side, the finding of the significant increase in testosterone level in control group compared to the restricted fed groups agrees with that of (Santaella et al., 2019) who stated that in the male, feeding on high-energy diets can enhance the reproductive function, showed a significant increase in the Sertoli cell function and a tendency for higher blood testosterone levels. An increase in the testosterone levels due to a modified diet in rams (Hotzel et al., 1998) and bulls (Dance et al., 2015).

CONCLUSION

Feeding regimes of male rutting camels can result in an increase in feeding-related behaviors and a decrease in aggressive behaviour that is considered the main bad rutting-related behavioural changes. These behavioural alterations could be reflected in good health status and ease in handling of camels during the period of rut.

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AUTHORS CONTRIBUTION

All authors conducted the study equally, analyzed and discussed the results, wrote and approved the final manuscript.

CONFLICT OF INTERESTS

There is no conflicting interest with regards to the publication of this research work.

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