

**Mitigates the Negative Behavioral Effects of Rut Season in Camels: - Group Size**Ramadan D. El Shoukary ¹, Ahmed S. Osman ²¹ Department of Animal Hygiene, Faculty of Veterinary medicine, New Valley University, Egypt² Department of Biochemistry, Faculty of Veterinary Medicine, Sohag University, 82524, Egypt

The study objective was to investigate group size effect on some behavior, blood parameter, and body condition score of camels during rut. Camelus dromedarius bull camels (n = 38 ; 5 -7 years old) were assigned randomly to 4 housing group treatments of with 5, 8, 11 or 14 camels/pen with used the same supplying of a space allowance of 15 m² /camel to give the same pen density. Behaviors was recorded from video data throughout one hour per single day each week for 10 weeks using continuous focal sampling are (20- min. intervals at morning, mid-day, and afternoon) focused on posture, maintenance and aggressive behaviors. Camels housed in group (14 camels /pen) showed more maintenance behavior (feeding, drinking, and rumination), walking, and standing, and less in overall aggressive behaviors, and lying when compared to camels housed in groups (5 or 8 camels/pen). While, it had no effect on rumination, overall aggressive behaviors, and lying when compared to camels housed in groups (11 camels/pen). On the other hand, the hormonal blood parameters representing in testosterone level and T4 : T3 ratio beside to, body condition score were significantly higher with increasing the group size. While, cortisol, T3 and T4 levels were decreased linearly with group size increasing. In contrast, different groups numbering had no effect on total serum protein, albumin, globulin levels and A/G ratio. Lastly, group size as managerial practice in rutting camel's management has effects on different behavioral patterns, blood parameters and body condition score.

Key Words: camel behavior, group size, body condition score, aggressive behavior

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Introduction

Dromedary camels (*Camelus dromedarius*) are considered a high economic and agro-ecological importance due to its ability to use harsh conditions and give valuable products. Moreover, its multipurpose livestock species used for milk, meat and hide supply, as well as for other purposes such as transport, celebration, and competition as in racing and beauty show (Faye, 2014).

By attention to male breeding season; it was seasonal breeders (Deen, 2008) their season ranges from 4 to 6 months and called "rut period" (Fisher et al., 2009) in March– April or March -May or Spring (Osman and El-Azab, 1974). During the rutting period, male camel exhibits morphological; physiological; performance and behavioral peculiarities in compare with a non-breeding season (Deen, 2008). Morphological changes as an increase in testicular size; poll gland and glandular soft palate (the 'goola' pouch). While, the physiological changes include, a significant increase in testosterone and cortisol level (Bakhat et al., 2003); serum thyroxin (T4) ; tri-iodothyroxine (T3) and T4 : T3 ratio was almost double (Agarwal et al., 1986).

On the other sides, there is bad effect of rutting on camel's performance and behavior as, sexual activity of rutting males distracts it from normal feeding (Bakhat et al., 2003) as partial loss of appetite (Al-Juboori, 2013) or may tend to go off feed (Marai et al., 2009) this behavior manifested markedly tucked up abdomen; gradually decreases in hump size and loses a considerable up to 25% body weight (Bakhat et al., 2003) and rutting males loss its condition and body weight was decreased (Skidmore 2000). Moreover, The male camels rutting period is manifested by changes in his behaviors.

camel acts very aggressive either with other camels or human; it may kick (Al-Juboori 2013), increasing pacing and anxiety it becomes extremely restless; Fighting instincts are aroused and males become hostile to each other, and they cannot be easily handled besides, control is difficult or impossible (Deen, 2008 and Marai et al., 2009).

Camelide not usually aggressive except breeding males (Samimi, 2019) due to this aggressiven rut camels are traditionally reared tied with ropes in little pens and/or kept in single stalls This isolation could accompany with abnormal behaviors (Padalino et al., 2014).

Important issue of veterinary practice was first directed to aggressiveness prevention; decrease unwanted sexual behavior and soft handling of male animals (Janett et al., 2009). There are only surgical, hormonal or immunological castration methods used to control reproductive activity (Stout, 2005). So that, the aim of this works to evolution of new managerial way (group numbering) to decreasing and /or preventing aggressive and unwanted behavior or performance of reproductive activity camels.

Materials and Methods

1. Experimental animals and management

This study was conducted at village in Assiut government; Egypt from 1-February to 5 May 2019 (94 days). Adults mature clinically healthy male rut dromedary camels (n = 38), 5-7 years old with a mean body weight of 400-450kg. The animals were divided randomly to 4 groups by the group size. The group contains 5, 8, 11, 14 animals respectively with the same densities with the same space allowance of 15 m² per camel in the floor area (height=3 m, length=5 m, and

width=3 m) semi covered with sand floors (Aubè et al., 2017) and 0.75 cm in feeding areas or managers. These pens were natural ventilated by windows, moreover natural sources of daylight throughout the experimental period.

Camels were fed with about 3% of its live weight (Khorachani et al., 2009) this diet consists from 40% Concentrate contains 11% protein and 60% hay which and divided in two equally weight offered twice daily in the camel manager at 8-9 am and 4-5 pm, While, green fodders as barseem was put at 11-12 pm as 1.5 kg / day /camel. Feeding quantity and quality remained constant throughout the experiment time beside that, water was available at all daytime and it changed daily.

2. Experimental procedure

28 day that starts from 1-28 February (4 week) as pre experimental period in this period, the animal was treated with ivomac super twice one each 15 day to get rid of internal and external parasite and two week (in date 16 and 23)animal was observed 1 hour per Saturday day per week (20 mint morning ,mid-afternoon and afternoon) to adapt animal for presence of un familiar human and /or camera and to be sure about camera recording , the same feeding and handling management to all groups and get out any abnormal health such as coughed or feverish or weak or abnormal behavior camel such as lammed or biting or kicking). Then, from1 march till 5 May (66 day nearly 10 week) as an experimental period because breeding season of camels in Egypt in Mar – Apr or Mar-May or Spring (Osman and El-Azab 1974) through this period behavioral data ,1 hour per Saturday days per week was collected .

3. Data recording and measurement:

3.1. Behavioral data

Behavior was recorded by using a continuous focal sampling method described by Dawkins, (2007) and didn't use instantaneous scan sampling, which is considered to be insensitive to short-lasting behaviors, such as aggression in calves. (Grasso et al., 1999). Focal sampling was conducted by the same observer using observation sheet and stopwatch during each sampling period. Behavior of each group was recorded in 1 hour per Saturday day per week, (20 mint x 3 time per day) at mornings (5-6 am), mid-afternoon (12 am-1pm) and late afternoons (3-4 pm) to calculate the mean times and frequency (total number) of each behavior: calculated as the total number of occurrences of each behavior per unit time during 10 hours / each group / throughout the experimental period according to predefine ethogram

table (1)

Table (1). Ethogram for continuous focal observation of group-housed camels

Behavior	Definition	Category
Feeding	collect food from feeders	Maintenance behavior
Drinking	Drink water from water draft.	
Rumination	A bolus of regurgitating food goes back into his mouth and the camel re-chewed and re-swallowing it again while standing or lying down.	
Standing	Standing in inactive upright posture on all four feet with no movement.	Posture
Lying	Body contact with the ground or camel sits in sternal recumbency	
Walking	Camel does more than 2 complete steps.	
Aggression	Biting; Kicking and fighting	Aggressive behavior

3.2. Blood sampling

At the end of an experiments 20 sample (5 camel x 4 group) each sample was about 10 ml of blood was collected in two evacuated with and without anti-

coagulant (EDTA) tubes. Blood was centrifuged by using automatic centrifuge at 3000 rpm for 15 min and serum or plasma was aspirated by plastic pipette and stored at -20°C until analysis as previously described by Wilson and Foster 2011.

Serum T_3 , T_4 , testosterone and cortisol hormones were estimated by stat fax-2100 (Awareness technology, INC, USA) and commercial ELISA kits. While, total serum proteins, albumin were assayed by a colorimetric method using a commercial kit manufactured by Egyptian company for biotechnology, Egypt. In addition to Serum Globulin = Total Protein of serum (g/dl) - Albumin of serum (g/dl) and Albumin/ Globulin ratio = Albumin \ Globulin.

3.3. Body condition score

Body condition score was measured at the end of the experiment according to (Faye et al. 2001) as this will provide economic important point.

4- Statistical analysis:

The obtained data in this study were statistically analyzed by SPSS (2001) Statistics for Windows, version 18 using one-way ANOVA test and differences among treatment means were compared using Duncan's multiple range tests (Duncan, 1995). Data were presented as Mean \pm SE and significance were declared at ($P < 0.05$).

Results and discussion

Group size is defined as “the number of individuals that form a group” (Estevez et al., 2007). Group size is expected to act as a stress modulator that affected both physiological and behavioral responses of the animals (Michelen et al., 2012)

1- Behavioral responses

1.1- Maintenance Behavior

Results in table (2) show that, feeding, drinking and rumination frequency and duration were linear increased significantly with group size as mentioned previously by (Van et al, 2007 and Hesham and Mohamed., 2013) for feeding and drinking time and (Dias et al., 2011 and Hesham and Mohamed., 2013) in case of rumination time. While, this result in disagreement with finding of Faerevik et al., (2007) and Abdelfattah et al., (2013) who reported no effect of group size on feeding behavior frequency. Besides that, Tölu and Savas, (2007) and Jorgensen et al., (2009) who found reduced feeding behavior time in larger group size.

The feeding and rumination frequency and duration increasing may be due to a reduction in time devoted to alert behavior (Kenneth and James, 1985) because individual vigilance decreases with increasing group size. (Beauchamp, 2008); social facilitation behavior which means

another cow, whether or not hungry, is also encouraged to eat when it sees one cow eats (Curtis and Houpt, 1983); feed intake is stimulated by competition among individuals, (Van et al., 2007); the behavioural synchrony decrease linearly with group size increasing, making more time for feeding (Boissy and Dumont., 2002); high roughage feed or hay intake (Dias et al., 2011) and increased rate of foraging with group size increased (Kenneth and James, 1985). While, increase drinking frequency and duration might be due to the consumption of water is sensitive to the social behavior as competition and social facilitation (Forkman, 1996) when one animal is drinking water other animals are stimulated to drink more so increase the number per group resulted in increased drinking rate. (Barton and Broom., 1985)

moreover, water and feed intake are strongly correlated with increasing group size, increased feed intake lead to increased water intake (Hadjigeorgiou et al., 2003).

1.2- Posture

1.2.1- Standing and walking frequency and duration

There was a significant increase in frequency and duration of standing and walking with group size increasing (table 2). These data are in agreement with the previous report of Liste et al. (2015) who found that animals kept in large groups had a higher level of locomotion. Abdelfattah et al., (2013) mentioned that in veal calves standing increase with increasing the group number and increased group size was accompanied with increased locomotion; also, Hesham and Mohamed (2013) said that walking time of bucks increased with increasing of group size. Leone et al. (2010) reported that, with constant animal density, the larger groups had more movement activities. Morisse and Maurice, (1997) reported that, walking time was increased significantly under the large group and Kenneth and James, (1985) who recorded the high movement rate positively with an increase group size.

The increased locomotion in larger groups may be attributed to negative correlation between resting and walking time (Morisse and Maurice, 1997); social stimuli level increased in larger groups, and individuals are moving more to avoid others (Croney and Newberry, 2007) and higher social interaction which force calves to move away to escape competitors (Faerevik et al., 2007). On the other hand, increase frequency and duration of standing (inactive) with increasing the number of animals per group may be a result of displaced animal waiting for access to the feed (Faerevik et al., 2007) and camelide always like moving in a

single file. (Samimi, 2019) as one move the others move.

This result disagrees with Telezhenko et al. (2012) as well as Hesham and Mohamed (2013) found that, group size had no effect on movement; Michelena et al. (2012) who reported that, with increasing group size, individuals commonly spend less time standing and moving respectively.

1.2.2- Lying

Throughout the experimental period the duration and frequency of lying down was decrease as a number of camels per group increase. This finding that present in (table 2) was in agreement with previous data of Faerevik et al., (2007) ; Jorgensen et al., (2009) ; Abdelfattah et al., (2013) and Hesham and Mohamed (2013) who concluded that, time spent lying decreased with increasing group size. While, the obtained result in disagreement with Boissy and Dumont, (2002) and Childress and Lung (2003) who found that, in mammals increase the number of animals per group lead to more time of resting behavior. The obtained data may be due to a lower level of social activity in the largest group size (Andersen et al, 2011).

1.3- Aggression

Obtained data in (table 2) showed that, the frequency and duration of aggression was smaller in large group size than the small size group this result was agreed with finding in goats Kenneth and James, (1985) ; in domestic fowl (Estevez et al., 2007), turkeys (Buchwalder and Huber-Eicher, 2005) and in pigs (Andersen et al., 2004) and Andersen et al., (2011) found that agonistic interaction was negatively correlated with group size. While, disagreed with Van et al., (2007); Tölü and Savas, (2007) and Hesham and Mohamed (2013) who found that aggressive behaviour increased linearly by group size.

On the other hand, Jorgensen et al., (2009) and Abdelfattah et al., (2013) observed that, there were no effects of group size on aggressive interactions.

The reduction in aggressive behavior in large group size may be attributed to the development of 'futures contracts for non-aggression' hypotheses (Pagel and Dawkins, 1997), the 'tolerant system' hypotheses (Estevez et al., 1997) or the 'when the winner takes it all' hypotheses (Andersen et al., 2004).

Table (2) Frequency and time (min. /10 hour) of different behavioral patterns of rut camel under different group number.

Behavior	Rut camels numbers per group			
	5	8	11	14
Maintenance behavior				
Feeding frequency	2 ± 0.6 ^c	6 ± 0.8 ^b	8 ± 0.3 ^a	12 ± 0.9 ^a
Feeding duration	21 ± 2 ^c	29 ± 0.3 ^b	32 ± 0.7 ^b	42 ± 2 ^a
Drinking frequency	1 ± 0.09 ^c	3 ± 0.6 ^b	4 ± 0.8 ^b	7 ± 0.11 ^a
Drinking duration	8 ± 1.7 ^c	15 ± 0.05 ^b	19 ± 0.03 ^b	24 ± 4 ^a
Rumination frequency	14 ± 3 ^b	18 ± 4 ^b	24 ± 5 ^a	27 ± 3 ^a
Rumination duration	60 ± 6.5 ^b	70 ± 4 ^b	95 ± 6 ^a	100 ± 7 ^a
Posture				
Standing frequency	5 ± 3 ^c	6 ± 3 ^{bc}	7 ± 1 ^b	12 ± 3 ^a
Standing duration	50 ± 2 ^c	62 ± 5 ^b	67 ± 2 ^b	82 ± 3 ^a
Walking frequency	11 ± 2 ^b	13 ± 3 ^b	17 ± 4 ^a	19 ± 4 ^a
Walking duration	44 ± 3 ^b	41 ± 5 ^b	49 ± 2 ^b	63 ± 8 ^a
Lying frequency	9 ± 2 ^a	8 ± 3 ^a	5 ± 1 ^b	4 ± 1 ^b
Lying duration	80 ± 3.5 ^a	69 ± 5 ^a	58 ± 2 ^{bc}	50 ± 7 ^c
Aggressive behavior				
Biting	7 ± 1 ^a	6 ± 0.4 ^a	4 ± 0.9 ^b	2 ± 0.6 ^c
kicking	6 ± 0.5 ^a	3 ± 0.8 ^b	2 ± 0.6 ^b	1 ± 0.3 ^{bc}
Fighting	9 ± 1.5 ^a	7 ± 0.9 ^b	6 ± 1.5 ^b	3 ± 0.4 ^c
Overall	7.7 ± 1 ^a	5.7 ± 0.7 ^b	4 ± 1.5 ^{bc}	2 ± 0.4 ^c

The previous hypotheses explained the decline in the aggression act with increasing group size phenomenon by suggestion that, the social behavior of farm animals is show more plastic and dynamic

than originally thought. This plasticity gives the animals chance to behavioural strategy's changes and adapt more easily to varying environmental (social and physical) conditions in captivity (Estevez et al., 2007); when a group size increases the competitors number increases, more intensity fights, higher costly in terms of energy and risk of injuries to become dominant, which make more individuals will benefit from not participate in the fights and choose a less aggressive strategy (Estevez et al., 2003 and Andersen et al., 2004).

Besides that, Individuals in large groups show specific areas' movement limitations and multiple sub-groups with a local hierarchical establishing due to unable to recognize all group members would explain low aggression levels (McBride and Foenander, 1962).

2- Body condition score

Figure (1) shows liner increasing of body condition score as a group number increasing this finding was in the same line with our data of increasing feeding; rumination and less aggressive behavior between animals but this finding was greed with previous finding of Hesham and Mohamed (2013) who find the most parameters of performance representing in body wight gain (kg), average daily gain (g) and gain: feed were significantly higher under large group size.

Tapki (2007) who find an increased weight gains for group-housed calves. While, this data was disagreed with previous finding of Faerevik et al. (2007) and Sabek et al., (2017) who find not significantly effect of group size on growth parameters.

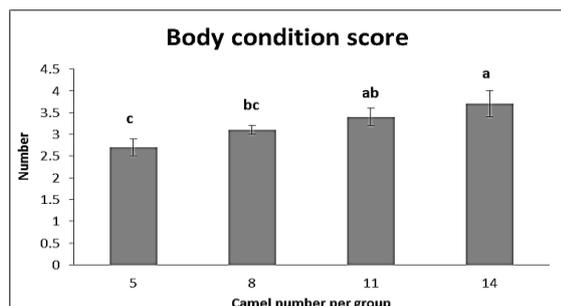


Figure (1) shows body condition score of camels reared in different group numbers

3- physiological responses

Table (3) showed that, there are a significant decrease in cortisol level with the group size increasing this data was in agreement with previous work of Michelena et al. (2012) who reported that, cortisol concentration in sheep decreased as a group size increased. While, it disagreed with finding of Veissier et al. (1998); Abdelfattah et al., (2013); Ahmed et al., (2017) and Sabek et al. (2017) who reported that, group size did not alter circulating cortisol.

This data might be due to group size is expected to act as a stress modulator (Michelen et al., 2012) so that, small group had higher cortisol level and lower testosterone level due to cortisol was negatively correlated with testosterone (Aubè et al., 2017) and stress response negatively affected sexual behavior (Kirby et al. 2009) ; vigilance behaviour is thought to be largely controlled by the threat of predation and decreases with increasing group size Mendl and Held, (2001); vigilance behaviour is in line with the 'many-eyes hypothesis' (Masucci et al., 2016); The presence of conspecifics or social cues reduced stress responses in several species (Kikusui et al., 2006);

As a consequence, less fear accompanied with less stress and less cortisol secretion and more time can be

devoted to other activities (Penning et al., 1993).

On the other side, there is significant increase in testosterone level with the increasing group size which is in agreement with previous work of Aubè et al. (2017) who reported that cortisol was negatively correlated with testosterone.

Increase in Testosterone level and $T_4 : T_3$ was a good indicator for good libido ; fertility and productivity due to $T_4 : T_3$ ratio was positively correlated with the number of spermatozoa (Gauly et al. 1997). This finding is in line with the literature that suggests that poor welfare may lead to poor reproductive performance, namely lack of libido and hypo-fertility (Padalino et al., 2015).

There are non-significant differences in total protein; albumin and globulin level between different groups that may be due to the same feeding and management point between groups. Moreover, A/G ratio as an indicator of immunity had non-significant difference between different group size which is in agreement with Masucci et al., (2016) in buffalo and Turner et al., (2000) in pigs.

Table (3) Blood parameter of rut camel reared under different group number.

	Rut camels numbers per group			
	5	8	11	14
Blood parameters				
1- Chemical parameters				
Total serum protein g/100 ml	6.30 ± 0.15	6.32 ± 0.05	6.29 ± 0.14	6.35 ± 0.14
Albumin g/100 ml	4.11 ± 0.09	4.10 ± 0.11	4.09 ± 0.18	4.12 ± 0.24
Globulin g/100 ml	2.19 ± 0.11	2.22 ± 0.08	2.20 ± 0.04	2.23 ± 0.10
A/G ratio	1.88 ± 0.07	1.87 ± 0.11	1.86 ± 0.14	1.85 ± 0.24
2- Hormonal parameters				
Cortisol n. mol/L	76.9 ± 6.8 ^a	52.4 ± 3.3 ^b	55.8 ± 5.5 ^b	47.7 ± 3.2 ^c
Testosterone (pg mL-1)	1.58 ± 0.9 ^b	2.05 ± 0.14 ^b	2.29 ± 0.29 ^b	3.61 ± 0.4 ^a
T_3 n. mol/L	4.13 ± 0.8 ^a	3.93 ± 0.8 ^a	2.36 ± 0.24 ^b	2.65 ± 0.03 ^b
T_4 n. mol/L	255 ± 6.42 ^a	240 ± 2.42 ^{ab}	190 ± 6.3 ^c	217 ± 5.52 ^b
$T_4 : T_3$ ratio	39.71 ± 3.42	61 ± 1.3 ^b	80 ± 3.4 ^a	81 ± 2.5 ^a

Conclusion

Group size as managerial practice in rut camels management has good effects on different behavior patterns and body condition score, where group size increases some of maintenance behavior and body condition score (as performance parameters) increases and aggressive behaviors beside cortisol level were decreased so that, for practical implications keeping camels in groups of 11 or 14 Individuals per pen was better than 5 or 8 camels per group.

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Conflict of interest statement

The authors declare that they have no conflict of interest.

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