



SPATIO-TEMPORAL VARIATIONS IN CAMEL (*Camelus dromedarius*) FORAGING BEHAVIOUR ON RANGELAND ECOSYSTEM OF SEMI - ARID NORTH WESTERN NIGERIA

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ABSTRACT

A considerable number of the dromedary camels are found in the semi-arid part of Northern Nigeria. Apart from the wide use of the camel as a draught animal it now serves as a source of milk, meat and hide in this region. This paper examines the foraging behaviour of the camel on the rangeland in order to determine its major daily activities as influenced by season, sex and age to enable us improve the biodiversity of our rangelands. Four categories of animals (Adult male, Adult Female, Young Male and Young Female) were followed for three consecutive days in both dry and rainy seasons. The result indicates that the time spent by the camels in the two seasons (Wet and Dry) and between Male and Female on various activities were significant ($P < 0.05$). However, there was also a significant difference between the behaviour of the adult and younger camels. It can be concluded that camel spends most of its time grazing during the day and the grazing time is higher in the wet season which is related to the forages availability and that the behaviour is influenced by age rather than sex.

Keywords: Behaviour, Camel, Ecosystem, Foraging, Rangeland

INTRODUCTION

Animal-Season-Environment is thus: Environment offers the forage, the seasons determines their quality and quantity while the animal integrates these factors by evolving a suitable foraging behaviour pattern to meet up its nutritional requirements (Xavier and Smith, 2008). Adequate knowledge of grazing animals determines how effective they can be managed (Kassily, 2002). The camel daily intake is determined by the time the animal spent grazing and the rate of forage biting (Hodgson *et al.*, 1971; Semenye, 1988 and Alkali, 2015). Camel pastoralist plays a significant role on the grazing behaviour of the animals through herding (Zhao *et al.*, 2006). The herder decides where and when the animals go for grazing. Herders skills coupled with other environmental factors are the major determinants for a successful grazing and forage intake. Most Studies on camel behaviour conducted in different parts of the world (Wardeh, 1991; Khorchani, 1992; Igbal and Khan, 2001) did not consider variations due to location, seasons, Production cycle and other physiological condition of the animals and these necessitated more investigations in to this area. The variations might be attributed to many factors interacting at different scales over time (Dodzi and Muchenze, 2012). The time spent on different activities by different age groups and seasons will give a clear understanding on how the behaviour of such animal can be improved (Dodzi and Muchenze, 2012) and how such variations

affect foraging behaviour and forage preference of the animal. This will further enables modification of diets so as to improve targeted grazing (Ripple *et al.*, 2014) and improve the biodiversity of our rangelands, restore pasture dominated by weeds or reduce overuse of sensitive areas by the camels. However, the selectivity and wide range foraging behavior of camels is another factor that reduces serious damage to the ecosystem across the year Ghude, (2017). The main objective of this paper was, therefore aimed at evaluating the time spent on different foraging activities and how season, sex and age influence the foraging behavior of camel in the semi-arid northern Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Ilela local government area of Sokoto State, North Western Nigeria. The state covers a land area of 25,973 square kilometers with a mean population of 3,702,676 million (NPC, 2006). It lies to the North West of Nigeria on 13°04N 5°14E and shares a common boundary with Niger republic to the north, Katsina State to the east, Kwara State to the south and Benin Republic to the west. The warmest months are February to April, where daytime temperatures can exceed 45 °C (113.0 °F). The highest recorded temperature is 47.2 °C (117.0 °F). The rainy season is from June to October (Kowal and Kassam, 1975).

Management of the Animals

Twelve (12) healthy camels were randomly selected from a camel herd and were used in the study. This includes three (3) animals from each category of Adult, Young, Male and Female. The Adult animals ranged between 5-10 years while the young calves' age ranged between 7-12 months. Each of Seasons, Sex, and Age contributed 3 animals for the experiment and were considered as replicates. All animals were marked on both flanks with paint to enhance accurate identification in addition to ear tagging during recording of the grazing behaviour. This ensured that same animals were used throughout the observation period. The animals were closely monitored as they graze on the range land.

Assessment of camel foraging behavior

Feeding behaviours of the camels was determined using the scan-sampling method (Semenye, 1998; Kassily, 2002; Zhao *et al.*, 2006). The behaviors were observed and recorded at 5 minute intervals using stop watch in the morning (8:00 AM -12:00 Noon) and in the afternoon (2:00 to 6:00 Noon) daily. Four categories of animals (Adult male and female; Young male and female) were followed for three consecutive days in both dry and rainy seasons. This gave 96 observations per day per animal and 288 observations per period per animal, respectively. The records consist of the number of times the animals were engaged in specific undisturbed activities during each observation time. Behaviour was classified and recorded under five categories namely Feeding (F), Walking (W), Ruminating (R), Idling and 'others' such

as playing, grooming, agonistic behaviour, rubbing against trees and wallowing in dust (Wardeh, 1991; Khorchani, 1992; Iqbal and Khorchani, 2001).

Statistical Analysis

Data generated were analyzed using the General Linear Model procedure of GenStat 10 for the effect of age, sex and season. Individual animals were the replicates. Pearson correlation coefficients were used to determine the relationship between the feeding behavior variables.

RESULTS

Seasonal Variation on Foraging Behaviour of Camels

The time spent by the camels in the two seasons (Wet and Dry) on various activities expressed in minutes/day is presented in Table 1. Season has affected the various activities during the day. There was a significant difference ($P < 0.05$) in Feeding, Ruminating and Idling activities. Walking and other activities were not affected by the two seasons ($P > 0.05$). The camel spent much time 174.16 minutes/day feeding during wet season compared to dry season with 153.75 minutes/day. The idleness was not significant ($P > 0.05$) but higher 51.25 minutes in dry season than during the wet season (43.75 minutes/day). Other activities such as breeding, urinating, defecating, fighting were not affected by seasons but is higher during the dry season and this ranged between 27.08 minutes and 41.67 minutes respectively.

Table 1: Seasonal Variation in Camel Behavioral Time Utilization (Min/day)

Seasons	Activity				
	Feeding	Walking	Ruminating	Idling	Others
Wet	174.16	109.58	127.09	78.33	25.42
Dry	153.75	87.08	92.83	85.42	23.75
t-values	2.81	1.09	1.47	2.39	0.45

Sex Effect on Foraging Behavior of Camels

A significant difference ($P < 0.05$) was observed in the behavior of the male and female camels (Table 2). Females spent more time feeding (176.25 minutes/day) and walking (107.50 minutes/day) than the males which spent 151.67 minutes/day and 89.17 minutes/day in feeding and walking, respectively.

However, no statistical difference ($p > 0.05$) was observed in ruminating times among the two sexes. The female animals spent more time ruminating. Idleness and other activities were not affected ($P > 0.05$) by sex. Idleness is higher in males (39.58 minutes/day) than in females (29.17 minutes/day).

Table 2: Sex Effect in Camel Behavioral Time Utilization (Min/day)

Sex	Activity				
	Feeding	Walking	Ruminating	Idling	Others
Male	176.25	107.50	131.66	66.26	25.83
Female	151.67	89.17	88.74	97.49	23.33
t-values	-3.69	1.55	5.94	-3.31	-0.69

Age Effect on Foraging Behavior of Camels

Time spent in feeding between the young and adult stocks was not significant ($P > 0.05$) (Table 3). Adult camels spent more time in feeding (162.50 minutes/day) than the younger camel calves 162.50 minutes/day but walking and rumination were affected by age ($P < 0.05$). Adult animals walk more (111.67 minutes/day) while grazing than the younger calves (85.00 minutes/day). Similarly, the adult

animals spent more time 120.42 minutes/day ruminating than the young animals 101.00 minutes/day. Idleness was also not affected ($P > 0.05$) by age but calves spent more time idle than the adult animals.

The correlation between the various foraging activities is presented on Table 4. Positive correlation was observed between feeding time and walking time ($r = 0.75$).

A negative correlation exists between feeding time and ruminating time ($r = -0.46$) but no relationship exists between feeding time and other activities ($r = 0.12$). A weak negative relationship exist between walking time and ruminating time ($r = -0.15$) and no

relationship between walking time and other activities ($r = 0.31$). Ruminating time and idling time were negatively correlated ($r = -0.00$). Idling time and other activities were also negatively correlated ($r = 0.26$).

Table 3: Age Effect in Camel Behavioral Time Utilization (Min/day)

Adult	Activity				
	Feeding	Walking	Ruminating	Idling	Others
Young	111.67	85.00	101.00	87.25	26.50
Adult	162.50	111.67	120.42	76.25	22.50
t-values	0.35	-2.41	0.07	0.76	1.16

Table 4: Correlated Values of Camel daily Activities (Min/day).

	WT	RT	IT	O
FT	0.75*	-0.46*	-0.69*	0.12 ^{ns}
WT		-0.15 ^{ns}	-0.73*	0.31 ^{ns}
RT			-0.00 ^{ns}	0.20 ^{ns}
IT				-0.26 ^{ns}

WT: Walking time, RT: Ruminating, IT: idle time, O: Others, ns: not significant

DISCUSSION

According to Sanon *et al.* (2007) and Iqbal and Khan (2001) feeding behaviour refers to any action of an animal that is directed towards the procurement of nutrients. The variety of means of procuring feed is a reflection of the diversity of food used and the type of animal. Cattle, sheep, goats and camels have different feeding behaviour on pasture due to the inherent characteristics of each species. The camel is said to be an opportunist capable of utilizing low quality forage when other forages are unavailable. Calculations on the time spent by the various categories of camel in this study were based on assumption that the behaviour of the animal at the time of observation is a representative of the interval time between observations. Results obtained in this study showed that season, sex and age had varying effects on the foraging behaviour of the camels. This agrees with the reports of Wardeh (1991) Ouedraogokone *et al.* (2008) and Zhongqiu, 2013).

Results revealed that grazing time varied significantly in the two seasons (Wet and Dry) as presented in table 1. The amount of time spent grazing during the wet season is higher than that of dry season although it is within the range found for most domestic ruminants (Forbs, 1995). This variation might not be unconnected with the forage availability in the wet season. Similar result was observed by Dodzi and Muchenze (2012) in some crossbred dairy cattle. However, Semiadi *et al.* (1994) reported a contrast result in tropical deer which spent most of its time grazing during the dry season. This difference is attributed to specie variation. The decrease in feeding activities of ruminants in the dry season was also reported by Chaibou *et al.* (2013). As feed resources decreases during the dry season, all animals increased the time allocated to resting, idling and other activities. This demonstrates the variability of feed resources in the study area and its effect as a limiting factor in livestock production (Sanon *et al.*, 2005). This study also confirms the report of Diarra *et al.*

(1993) that the most critical period for ruminants is the late dry season in the Sahel zone.

This study also observed a seasonal variation in the rumination time (Table 1). This starts only after the camels had been on the range for some time (Mengli *et al.*, 2006). This is because a certain level of reticulo-rumen fill must be reached for an animal to start the process of rumination. The longer grazing time observed during dry season in this study suggests extensive selectivity which possibly resulted in a low rate of dry matter intake (Njidda and Olatunji, 2012). The little rumination time observed during the dry season is attributed to the lack of good quality fodder. During the dry season, the only available fodder in the study area consisted of shrubs, herbs and few fodder trees. This agrees with the findings of Devendra and Leng (2011) who reported that during dry season fodder trees and shrubs contribute significantly to livestock nutrition in the tropics. It further confirms the findings of Mengli *et al.* (2006 and Zhongqiu (2013) who reported that ruminations is sometimes considered a plastic behaviour because several intrinsic and extrinsic factors influence that feeding behaviour. Other activities were found to also increase with decrease in the availability of fodder in the dry season which coincide with the camel breeding season (Umaru and Bello, 2013) in which the animals increase the time for resting, idling and other activities.

The animal age was found to affects diet selection; grazing behaviour and tolerance to secondary metabolites (Forbs, 1995). The categorical differences in behavioural activities in this study seemed to be more attributed to age difference than sex. As the animals grow older, their metabolic requirements changes; thus older animals need less food and spend less time foraging (Wilson, 1984) compared with adults, young growing animals need diets higher in crude protein and energy and lower in fiber (Shawket *et al.*, 2012).

In this study, young camels were observed to be facing difficulties eating some thorny plants which might have resulted in their spending more time on careful selection of smaller but more delicate plants to meet their nutritional requirements (Gervais, 2012). Particularly in the dry season, feeding on dry twigs and thorny plants seemed to make feeding a lengthy process to this category of camels. Body size which is closely related to age is the most common important factor among all intrinsic factors (Dereje and Uden, 2005). The adult camels can feed on poor quality diets because of their low metabolic requirements to gut capacity ratio (Wilson, 1984). Metabolic requirements are allometrically related to body size, whereas gut capacity or rumen size is isometrically related to body size (Frazer, 1985), thus possibly explaining the reason why rumination was higher in the adult camels in this study. Therefore adult camels can extract more nutrients than the smaller calves because they can keep the food in the rumen longer. Moreover, in contrast with the young calves, adults have an advantage of extracting nutrients from low quality diets.

Animals might find it difficult searching for food in bad weather especially when the temperature is high or too low. Younger camels were observed to be idle especially when the temperature is high. This explains the discrepancy in the Idling time between the adults and the younger calves. Iqbal and Khan (2001) reported that bad weather conditions change

rumination and grazing behaviour of animals, hence the finding of this study corroborates their findings.

The pattern of the correlation observed in this study on the camels behaviour (Table 4) was similar to that previously reported by Shirman *et al* (2012) for Holstein dairy cows. Feeding and rumination are the most important components of the behavioural study and are a function of seasonal availability and quality of the forages which are known to change the animal's response to increased feeding time. Rumination was observed to start when the animal have ingested some feed indicating that it is a function of dry matter intake (Khorchani, 1992). No correlation was observed between rumination and idling times.

Conclusion and Recommendations

It can be concluded that camel spend most of its time feeding during the day and the feeding time is higher in the wet season which is related to the forages availability. Camels also behave differently during both wet and dry season and that adults and young calves behave differently. It was therefore deduced that foraging behaviour of the camel is attributed to age rather than the sex. Understanding the effect of season, sex and age of camel foraging behaviour is a powerful tool that can help the herders modify diet selection to increase the effectiveness of animals used to manage vegetation. It is therefore recommended that further studies on the effect of herding systems and plants condition on the grazing behaviour of camels be investigated.

REFERENCES

- Alkali, H.A. (2015). Forage diversity, feed preferences and behavior of camels (*Camelus dromedarius*) on rangeland ecosystem of semi-arid North Western Nigeria. PhD Dissertation, Department of Animal Science, Bayero University, Kano – Nigeria.
- Chaibou, B., Faye B. and Lapeyronie P. (2013). Biomass Production Of Natural Courses In zArid Lands And Their Valorisation By The Camels. Proceedings of the 3rd International Society of Camelid Research and Development Conference, Oman.
- Dereje, M. and Uden, P. (2005). The Browsing Dromedary Camel I. Behaviour, Plant Preference and Quality of Forage Selected. *Animal Feed Science and Technology*. 121: 297–308.
- Devendra, C. and Leng R.A. (2011). Feed Resources for Animals: Issues, Strategies for Use, Intensification and Integration for increased Productivity. *Asian Australian Journal of Animal Science*, 24(3):115-119.
- Diarra, L., Leeuw P.N. and Hiernaux, P. (1993). An Analysis of Feed Demand And Supply for Pastoral Livestock: The Gourma Region, Mali. Overseas Development Institute.
- Dodzi M.S., Muchenje, V. (2012). Seasonal variation in time budgets and milk yield for Jersey, Friesland and crossbred cows raised in a pasture-based system. *Trop Anim Health Prod* 44:1395–1401.
- Forbs, J.M. (1995). Voluntary Feed Intake and Diet Selection in Farm Animals. Wallingford: CAB International.
- Frazer, A.F. (1985). Ethology of Farm Animals. A comprehensive study of the behavioural features of the common farm animals. World Animal Science A5, Amsterdam: Elsevier
- Gervais T. (2012). Grazing Behavior Affects Forage Management. Minnesota Beef Cow/Calf Days Publication BP-1204.
- Ghude, M.I. (2017). Dromedary camel milk yield, composition and diet selectivity in selected locations in North–Western Nigeria. PhD Dissertation, Department of Animal Science, Bayero University, Kano – Nigeria. Pp 207.
- Greter A.M. (2012). Towards Understanding Feeding Motivation and Management Factors Affecting Feeding Behavior in Limit–Fed Dairy Heifers. M.Sc. Thesis, The University of Guelph.
- Hodgson, J., Tayler J. C. and Lonsdale, C. R. (1971). The relationship between intensity of grazing and herbage consumption and growth of calves, *J. Br. Grassld. Soc.*, 26: 231–237.
- Iqbal, A. and Khan, B. (2001). Feeding Behaviour of Camel - Review *Pakistan Journal of Agricultural Science*, 38: 58–63.
- Kassily, F.N. (2002). Forage Quality and Camel Feeding Patterns in Central Baringo, Kenya. *Livestock Production Science*, 78:175-182.

- Kowal, J.M. and Kassam, A. H. (1975). Rainfall In The Sudan Savanna Region of Nigeria. *Weather* 30: 24–28.
- Khorchoni, T., Neffati, M., Hammadi, M., Abdouli, H. and Nefzaoui, A. (1992). Nutrition of the One Humped Camel II. Intake and Feeding Behaviour on Arid Ranges in Southern Tunisia. *Livestock Production Science*, 39: 303–322.
- Mengli, Z., Walters D.W. and Jin, Y. (2006). Bactrian Camel Foraging Behaviour in Haloxylon ammeodendron Desert of inner Mongolia. *Applied Animal Behaviour*, 99:330-343.
- Mohammed I., Hoffmann, I. (2006). Management of Drought Camels (*Camelus dromedarius*) in Crop-livestock Production System in North West – Nigeria. *Livestock Research for Rural Development*.
- Njidda, A.A., and E.A. Olatunji (2012). In Situ Degradability of Dry matter of Browse Forages Consumed by Ruminants in the Semi Arid Region of Northern Nigeria. *Journal of Biology, Agriculture and Healthcare*, 2(9):39-43.
- NPC (2006). National Population Commission Census figures. Retrieved from <http://www.population.gov.ng/index.php/state-population> on May, 13th 2015.
- Ouedraogo-Kone, S., Kabore-Zoungrana, C.Y. and Ledin, I. (2008). Important Characteristics of Some Browse Species in an Agrosilvopastoral System in West Africa. *Agroforestry Systems*, 74:213-221.
- Ripple J., Smith, P., Helmut, H., Montzka, S.A, McAlpine, C. and Boucher, D.H. (2014). Ruminants, climate change and climate policy. *Nature Climate Change*, 4: 2-4.
- Sanon, H.O., Kabore C.Z. and Ledin, I. (2007). Behaviour of Goats, Sheep and Cattle and their Selection of Browse Species on Natural Pasture in a Sahelian Area. *Small Ruminants Research*, 67:64-74.
- Sanon, H.O., Nianogo, J.N., Nanglem, N.S. and Sanou, S. (2005). Amount of Fallen Fodder Components from *Acacia raddiana*, *Balanite aegyptiaca* and *Ziziphus mauritania* Available to Ruminants in Sahelian Pastures. *Livestock Res.For Rural Development*. article 147. Retrieved May, 29, 2015 from <http://www.lrrd.org/lrrd17/12/sano17147.htm>
- Semenye, P.P. (1988). Grazing behaviour of Maasai cattle. In: Dzowela B H (ed), *African forage plant genetic resources, evaluation of forage germplasm and extensive livestock production systems*. Proceedings of the third workshop held at the International Conference Centre, Arusha, Tanzania, 27-30 April 1987. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 325-330.
- Semiadi, G., Muir, P.D. and Barry, T.N. (1994). Voluntary feed intake, growth and efficiency of feed conversion in growing sambar (Cervus unicolor) and red deer (Cervus elaphus). Proceedings of the New Zealand Society of Animal Production 54:63-65.
- Shawket, S.M., Mohsen, M.K., Abdel-Raouf, E., and Rabee, A.M. (2012). Nutrient Utilization and Performance of Pregnant Camels Kept on Different Energy Levels. Proceedings of the 3rd Conference of the International Society of Camelid Research and Development. Pp. 253–254. Oman.
- Schirmann, K, Chapinal, N., Weary, D.M., Heuwieser, W. and von Keyserlingk, M.A. (2012). Rumination and its relationship to feeding and lying behavior in Holstein dairy cows. *J Dairy Sci*, (6):3212-7. doi: 10.3168/jds.2011-4741.
- Umaru, M.A. and Bello, A. (2013). Reproduction in the One Humped Camel (*Camelus dromedarius*) in Semi Arid Nigeria. *S. Journal*, 2(1): 1–7.
- Wardeh, M. (1991). Camel Nutrition and Grazing Behavior. Proceedings of the International Conference on Camel Production and Improvement Pp. 99–107. Arab Center for Studies of Arid Zones and Dry Lands.
- Wilson, T. R. (1984). The Camel. Essex, United Kingdom: The Longman Group Ltd.
- Xavier, M.V. and Smith, A.J. (2008). The Tropical Agroecologist: Livestock Behaviour, management and Welfare. Macmillan Publishers Limited. Pp 57.
- Zhao, M., Walter, W.D., Guodong, H. and Jin, Y. (2006). Bactrian Camel Foraging Behaviour in Haloxy Ammodendron Desert of Inner Mongolia. *Applied Animal Behaviour Science*, 99: 330–343.
- Zhongqiu L. (2013). Sex-Age Related Rumination Behavior of Père David's Deer under Constraints of Feeding Habitat and Rainfall. PLoS ONE 8(6): e66261. doi:10.1371/journal.pone.0066261