



Chewing dynamics of Bactrian camels (*Camelus bactrianus*) maintained under semi-intensive and intensive management systems in Ladakh, India

R K SAWAL^{1✉}, RAKESH RANJAN¹ and KASHI NATH¹

ICAR-National Research Centre on Camel, Jorbeer, Bikaner, Rajasthan 334 001 India

Received: 6 April 2020; Accepted: 27 December 2021

Keywords: Bactrian-camel, Chewing, Management, Nutrition, Rumination-behaviour

Bactrian or double humped camels (*Camelus bactrianus*) are strong built, climate resilient animals that can tolerate very low temperatures (often close to -20°C) in winter and moderately high temperature (up to 35°C) in summer. In ancient times, Bactrian camel was largely used for transport of goods through the silk route in Indian sub-continent. After closure of silk route in 1950, Bactrian camels belonging to local traders were left in Nubra valley of Ladakh, where its total population was limited to 56 in the year 1964. The population of Bactrian camel in Nubra valley dwindled for several decades and remained less than 100 till year 1996 (Ranjan *et al.* 2015). In an attempt to conserve this precious germplasm, Government Bactrian Camel Farm, Chusoot, Leh was established by Department of Animal Husbandry, Government of Jammu and Kashmir. It is situated at 34° 10'N, 77° 40'E, 11562 feet above the sea level.

Sea buckthorn (*Hippophae rhamnoides*) is a winter-hardy, deciduous shrub with yellow or orange berries (Bailey and Bailey 1978). It is the prominent flora growing in abundance throughout Nubra valley and is the major browse available for Bactrian camel. It provides a number of bioactive compounds and is of great importance for conservation of camel in Ladakh (Acharya *et al.* 2010). Alfalfa (*Medicago sativa*) is a major crop grown in the Nubra valley and its hay is stacked after sun-drying over the roof tops and used for feeding domestic ruminants and Bactrian camel during captivity.

Rumination behaviour in dromedary camel is an important indicator of health and welfare status and has been studied by several works in the past (Khan *et al.* 1996, Iqbal and Khan 2001). Daily rhythmicity of rumination behaviour in this species has been reported to be influenced not only by the light-dark cycle but also by scheduled feeding and fiber content of the diet (Von Engelhardt *et al.* 2006, Aube *et al.* 2017). Providing more hay or a high fiber-diet helps increase feeding and rumination time and thereby reduces feeding frustration in this species (Aube

et al. 2017). The normal rumination behaviour of Bactrian camel under farm conditions has also been studied (Cahill and McBride 1995). However, to our knowledge, effect of fiber content of diet and management system adopted on rumination behaviour has not been investigated so far in this species. The present study, therefore aimed to compare the nutritional values of feed, fodder, concentrate offered and chewing dynamics of Bactrian camel reared under semi-intensive and intensive management systems.

The present study was conducted during 17 to 20th October 2019. The detailed information regarding feeding and management of camels reared in Government Bactrian Camel Farm, Chushoot, Leh was recorded and samples of Alfalfa hay and concentrates (Wheat flour and wheat bran) were collected for nutritional analysis. Rumination behaviour and number of chews per bolus was recorded in 3 male camels during early morning hours. At one tourist spot in village Hundar, Nubra valley, providing camel riding facility, rumination behaviour and chewing dynamics were recorded in 3 male camels during morning hours for 10 rumination cycles. Information on the routine management and feeding practices were collected. Samples of wheat flour, wheat bran, concentrate, and Sea buckthorn plant were collected from owners and the nearby grazing area for nutritional analysis.

Samples of plant, feed and concentrate collected were brought to the Animal Nutrition Laboratory, ICAR-National Research Centre on Camel, Bikaner, Rajasthan; air dried in shade and ground to pass 1 mm sieve. The grinded samples were analyzed for proximate constituents and fibre fractions. Organic matter was estimated after ashing at 550°C for 4 h and nitrogen was determined by the Kjeldahl method (AOAC 1995). Neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and cellulose was determined by a procedure of VanSoest and Robertson (1988). Statistical analysis of the data obtained was performed as per the standard methods using SPSS, version 10.0 (1995) statistical software.

In Nubra valley, population of double-humped camel has shown an increasing trend, parallel to rise in tourist activity during the past several years. The total number of Bactrian camel in the valley at present is nearly 250. During winters

Present address: ¹ICAR-National Research Centre on Camel, Jorbeer, Bikaner, Rajasthan. ✉Corresponding author email: rksawal01@gmail.com

i.e. November to mid March, tourism activity closes and almost all bactrian camels are left in forest area of Nubra valley where they survive browsing on available bushes and shrubs. Before onset of tourist season in March, villagers capture adult camels and bring home to train for riding purposes. Pregnant she-camels are also captured and kept in open barns made from local bushy plants to minimize risk of predation of new-born by wild carnivores. During captivity, there are fed with Alfalfa hay, Sea buckthorn leaves, wheat flour and other concentrate ration. In village Hundar, Nubra valley, Bactrian camel riding activity is practiced from 9 AM to 5 PM on two tourist spots from April to October. Animals after end of riding activity in evening are offered 4 dough balls, weighing approximately 400 g each, comprising wheat bran, wheat flour and added water in ratio 3:1:1. Thus each animal consumes nearly 960 g of wheat bran and 320 g of wheat flour daily. After feeding of wheat flour-bran bolus, animals are let loose in the forest area along the bank of river Shyok. The next day, animals are again restrained early in the morning, brought to the riding activity site and allowed to graze in nearby browsing area for nearly 3 to 4 h till start of the tourist activity. The animals have free access to water throughout the day. Sea buckthorn plant is the main browse species in the Nubra valley; animals consume twigs consisting of leaves, thorny part of the stems and berries.

In Government Bactrian camel farm, Chusoot, Leh, animals are being raised under intensive management system and offered 2 kg concentrate apart from approximately 10 to 12 kg of Alfalfa (*Medicago sativa*) dry hay per animal per day and offered water twice daily.

The chewing dynamics of camel is given in Table 1, while result of nutritional analysis of feeds, fodders and concentrate is depicted in Table 2. It was found that number of chews per bolus was significantly lower ($P<0.01$) in camels of Govt. Bactrian Camel Farm, Chushoot. Chewing is an important activity that regulates the rate of passage of digesta and controls voluntary intake of

forage fed ruminants (Dulphy *et al.* 1980). Bactrian camels are reported to possess a lower maximum for time spent ruminating per day, as compared to other domestic ruminants (Cahill and McBride 1995). In a study, total time spent in rumination during 24 h by dromedary camel managed under intensive system was 31.71%, out of which 23.40% was nocturnal rumination and 8.31% was diurnal (Khan *et al.* 1996). In this species, rumination starts after midnight, reaching peak values during early morning (Iqbal and Khan 2001). Bactrian camels under wild conditions are reported predominantly diurnal with an increase in relative activity from sunrise reaching a peak towards midday and then gradually decrease in activity until sunset (Xue *et al.* 2015). In the present study, observations were recorded during the early morning to match the peak period for exhibiting rumination behaviour.

Bactrian camels consume less dry matter per kilogram body weight as compared to many domestic ruminants, perhaps due to slower fasting metabolic rates (Cahill and McBride 1995). Nevertheless, energy requirement and dry matter intake of Bactrian camels used for riding activity in village Hundar must be higher than those maintained under intensive system of management at Chushoot camel farm, Leh with minimal physical activity. In a study in Bactrian camel, Cahill and McBride (1995) observed significant ($P<0.05$) increase in chews/bolus with increasing feed intake, which further supported results of the present study. In addition, rumination time is reported to increase with increase in fiber content of the diet in dromedary camel (Von Engelhardt *et al.* 2006). It has been reported that providing more hay or a higher fiber-diet, slower to ingest and digest than concentrate, could help increase feeding and rumination times in camels and probably decrease feeding frustration (Aube *et al.* 2017). The fiber intake of animals in Nubra valley reared under semi-intensive management appeared to be higher than animals kept in Leh farm under intensive management system. Therefore, higher number of chews per bolus in camel under semi-

Table 1. Chewing dynamics of Bactrian camel under intensive and semi-intensive management system

Management system	Number of observations	Chews/ bolus				SEM
		Animal 1	Animal 2	Animal 3	Overall Mean	
Intensive	10	19.9	21	21.5	20.8a	0.0723
Semi-intensive	10	23.4	34.4	30.9	29.6b	0.190

Values bearing superscripts a, b differ significantly ($P<0.01$).

Table 2. Compositional analysis of feed, fodder and concentrate consumed by Bactrian camel

Feed/ Fodder/ Concentrate	Constituents (Per cent)										
	OM	CP	EE	CF	NFE	AIA	NDF	ADF	Hemicellulose	Lignin	Cellulose
Wheat flour	89.2	11.0	0.88	0.3	77.02	0.14	1.5	0.3	1.2	0.1	0.2
Wheat bran	88.4	13.5	6.02	1.5	67.38	0.75	6.7	4.70	2.0	0.8	3.9
Seabuck thorn	94.9	11.3	4.6	16.0	63.00	1.41	42.7	31.9	10.8	2.4	29.5
Alfalfa hay	92.2	4.9	3.40	15.0	68.90	3.35	36.1	26.0	10.1	7.8	18.2
Concentrate	89.5	18.2	4.62	6.15	60.53	2.15	24.1	12.1	12.0	4.5	7.6

OM, Organic matter; CP, Crude protein; EE, Ether extract; CF, Crude fiber; NFE, Nitrogen free extract; AIA, Acid insoluble ash; NDF, Neutral detergent fiber; ADF, Acid detergent fiber.

intensive system as recorded in the present study may be a cumulative effect of high fiber content of diet as well as high energy requirement or more dry matter intake.

Results of the present study revealed that nutritional values of sea buckthorn in terms of organic matter, crude fiber and crude protein are higher than Alfalfa hay. In corroboration to the present findings Jaroszewska and Biel (2017) also reported that Sea buckthorn leaves are rich in crude protein, crude fat, and are good source of macro-elements.

From the present study, it can be concluded that feeding and management system has a significant effect on chewing dynamics in Bactrian camel. Sea buckthorn, which is available in abundance along the River Shyok in Nubra valley, is highly nutritious and major lifeline browse species available and avidly consumed by Bactrian camel, ensuring their sustained survival, improved health and welfare in this cold desert terrain.

SUMMARY

The present study was conducted in mid October 2019 to compare the chewing dynamics and nutritional analysis of feed, fodder and concentrate fed to Bactrian camel raised under semi-intensive and intensive management systems in Leh and Nubra valley, Ladakh. Number of chews per bolus was significantly ($P < 0.01$) higher in camels reared for tourist activities under semi-intensive management system, consuming high fiber diet in comparison to animals raised under intensive management system and fed diet with lower fiber content. Sea buckthorn (*Hippophae rhamnoides*), the major browse species available for camel in Ladakh appeared to have high nutritional value in terms of organic matter, crude fiber and crude protein than Alfalfa (*Medicago sativa*) hay. From the present study, it can be concluded that management system and fiber content of the diet have significant effect on chewing dynamics in Bactrian camel.

REFERENCES

- Acharya S, Stobdan T and Singh S B. 2010. Sea buckthorn (*Hippophae sp. L.*). New crop opportunity for biodiversity conservation in the cold arid Trans Himalayas. *Journal of Soil and Water Conservation* **9**: 201–04.
- AOAC. 1995. *Official Methods of Analysis*. 16th edn. Association of Official Analytical Chemists. Arlington, VA.
- Aube L, Fatnassi M, Monaco D, Khorchani T, Lacalandra G M, Hammadi M and Padalino B. 2017. Daily rhythms of behavioural and hormonal patterns in male dromedary camels housed in boxes. *Peer Journal* **5**: e3074.
- Bailey L H and Bailey E Z. 1978. *Hortus third, A Concise Dictionary of Plants Cultivated in the United States and Canada*. McMillan Publ. Co., New York.
- Cahill L W and McBride B. 1995. Effect of level of intake on digestion, rate of passage and chewing dynamics in hay-fed Bactrian camels. *Proceedings of the Nutrition Advisory Group* **1**: 3–35.
- Dulphy J P, Remond B and Theriex M. 1980. Ingestive behaviour and related activities in ruminants *Digestive Physiology and Metabolism in Ruminants*. Ruckebusch Y and Thivend P (Eds). AVI Publishing Company, Inc. Westport, Connecticut. pp. 103–122.
- Iqbal A and Khan B B. 2001. Feeding behaviour of camel-A review. *Pakistan Journal of Agricultural Sciences* **38**: 58–63.
- Jaroszewska A and Biel W. 2017. Chemical composition and antioxidant activity of leaves of mycorrhized sea-buckthorn (*Hippophae rhamnoides* L.). *Chilean Journal of Agriculture Research* **77**: 2.
- Khan B B, Lateef M and Bilar M Q. 1996. A study of some of the activity patterns of *Camelus dromedarius* maintained in the Thal area of Punjab, Pakistan. *Pakistan Journal of Agriculture Sciences* **33**: 69–72.
- Ranjan R, Narnaware S, Kashinath Sawal R K and Patil N V. 2015. Double humped camels of Ladakh: Prospects and constraints to sustained survival. *Current Science* **109**: 857–58.
- SPSS version 10. 1997. *Statistical Packages for the Social Sciences*. SPSS Software Products, SPSS Inc, Chicago, IL.
- VanSoest P J and Robertson J B. 1988. *A Laboratory Manual of Animal Science*, 612. Cornell University, USA.
- Von Engelhardt W, Haarmeyer P, Kaske M and Lechner-Doll M. 2006. Chewing activities and oesophageal motility during feed intake, rumination and eructation in camels. *Journal of Comparative Physiology B* **176**: 117–24.
- Xue Y, Li D, Xio W, Liu F, Xhang Y, Wang X and Jia H. 2015. Activity patterns of wild Bactrian camels (*Camelus bactrianus*) in the northern piedmont of the Altun Mountains, China. *Animal Biology* **65**: 209–7.