Milk Production Potential and Major Browse Species Consumed by Dromedary Camels in Tshabong

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Abstract

Dromedary camels are multipurpose animals and play an important role in supporting the livelihoods of millions of people in the semi-arid and arid zones of Africa and Asia. They provide milk and meat for human consumption though this is not fully realised in Botswana, mainly due to lack of awareness and knowledge about camel husbandry. This study assesses milk production potential of camels and identifies their major browse species in Tshabong Ecotourism Camel Park in Botswana. The research for this study was conducted from December 2013 to February 2014 and involved interviewing 26 informants using an open-ended semi-structured questionnaire and field observations. Camels are kept in the study area, mainly, for tourism, but also for milk and meat production. The average milk yield, produced under natural browsing conditions, was four litres per camel per day. This indicates the possibility of improving milk production through provision of appropriate supplementary feeding. The camels feed on natural browse species in the park, and *Boscia albitrunca* was reported as the most preferred browse species. The lactation period of the camels is 10 months, and the calves suckle their dams throughout the lactation period. We conclude that the camels kept in Tshabong have good potential for milk production, which can also be increased with improved management and feeding.

Introduction

There are two types of camels, namely the 'Old World' and 'New World' camels, represented by the genera *Camelus* and *Lama*, respectively. The genus *Camelus* comprises two species: *Camelus dromedarius* (one-humped or the dromedary camel) and *Camelus bactrianus* (two-humped or the Bactrian camel). The genus *Lama* comprises four species being *Lama glama* (Lama) and *Lama pacos* (Alpaca), which are domesticated while *Lama guanacoe* and *Lama vicugna* are found in the wild. The natural habitats of camels categorized in the genus *Lama* are the Andes Mountains of South America. The Bactrian camel lives in the cold deserts of Central Asia whereas the dromedary camel is mainly found in hot and drier deserts of the Middle East, North and East Africa (Wardeh and Dawa 2005). Although small in number, introduced dromedary camels are also found in southern African countries particularly Botswana, Namibia and South Africa (Wilson 2013).

The one-humped camel (*Camelus dromedarius*) plays an important role as a primary source of subsistence in the Middle East, North and East Africa. They live in arid and semi-arid areas, which are not suitable for crop production and where other livestock species hardly thrive. The primary reason for keeping camels in these areas is milk production although transportation and meat production are also important services provided by camels (Seifu 2009). In arid and hot environments, camels are the preferred dairy animals and they produce more milk for a longer period of time, even, during the dry season than local cattle (Bekele *et al*. 2002).

The number of camels in the world is reported to be 24 million, of which 89% are one-humped

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(*Camelus dromedarius*) and the remaining 11% are two-humped (*Camelus bactrianus*) camels (FAOSTAT 2010). Due to their unique physiological characteristics, the one-humped camels have become icons of adaptation to challenging ways of living in arid and semi-arid regions (Wilson 1998). Over 80% of the world's camel population is found in Africa (Faye 2015), about 63% being in North East Africa (FAO 2008). Three East African countries, namely Somalia, Sudan and Ethiopia possess the highest dromedary camel populations in the world (Faye 2015).

Dromedaries are multipurpose domestic animal species. They provide milk and meat, and are also used for riding, and as baggage and work animals (Wilson 1998). Camel milk is the main component of human diets, especially in hot regions and arid countries (Wilson 1998), but also in many parts of the world (Yagil 1982). Dromedaries can produce up to 10 litres of milk per day during a lactation period of 12 to 18 months (Farah *et al.* 2007). Annually, about 5.4 million tonnes of camel milk is produced in the world (UNDP 2012), and Somalia is the leading camel milk producer in the world followed by Ethiopia (FAOSTAT 2010). The gross composition of camel milk is similar to that of cow milk (Ramet 2001). However, camel milk has a number of unique properties as it contains high levels of iron and vitamin C (Mullaicharam 2014; Sharma and Singh 2014). The high vitamin C content of camel milk is of significant importance for human health, especially in arid and desert environments where green vegetables and fruits are not readily available.

Camels are well-adapted to dry and hot environments, and are the only domestic animals that can cope with the increasing trends in climate change (Al Jassim and Sejian 2015). In Botswana, the larger part of the land area has an arid climate and is ideally suited for camel production. Camels were imported into Botswana at the beginning of the twentieth century mainly from the Cape of Good Hope (Wilson 2013). These animals were used by the police for regular patrols in the sandy Kgalagadi Desert and for postal deliveries (Molefi 2004; Moeng 2011). The police force continued to use camels on patrols up to the 1970s and retained them until 2001 (Wilson 2013). In 2001, the camels were handed over to local communities with the intention of developing a tourist industry based on camel safaris.

In Botswana, camels are kept in Tshabong, which is a semi-arid region in the Kgalagadi District. They are kept in an enclosed park known as Tshabong Ecotourism Camel Park (TECP). The camels are under the care of the local communities in Tshabong, Maubelo and Maleshe villages where Botswana Tourism Organisation (BTO) oversees the overall management of the park (Moeng 2011).

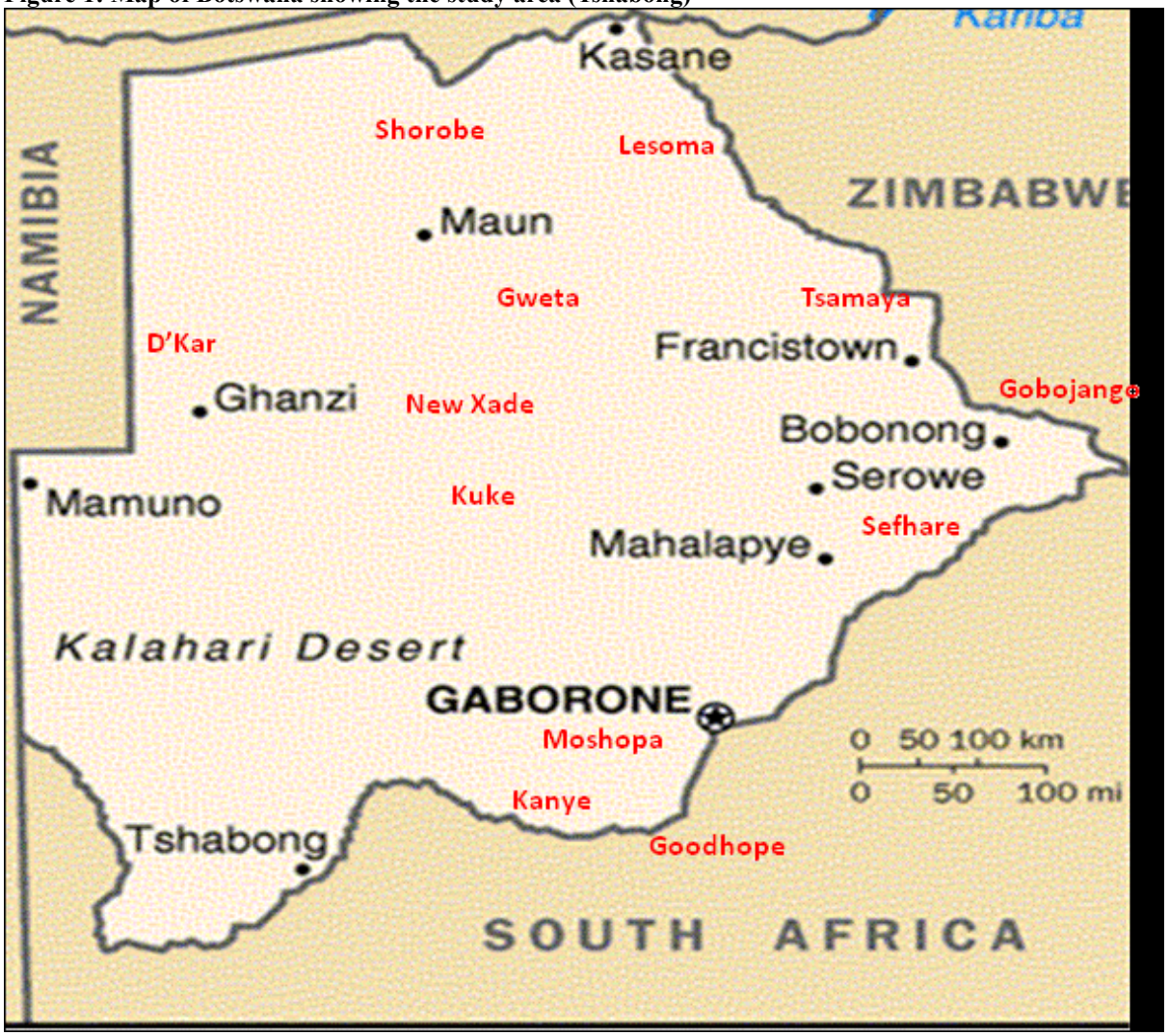
Although camels in Tshabong were used by police officers for transport to reach remote areas, the purpose of keeping them currently is not clearly defined. Despite their great potential, to date no research work has been carried out on the camels or their products. The uses of camels kept in Tshabong and their milk production potential have not been investigated. This study was, therefore, designed to assess milk production of dromedary camels in Tshabong and identify the major browse species consumed by camels in the study area.

Materials and Methods

Study area

The study was conducted from December 2013 to February 2014 in Tshabong Ecotourism Camel Park, in the Kgalagadi District in south-western Botswana. The site is located at a distance of 520 km from the country's capital Gaborone, and 10 km north of Tshabong town (Figure 1), and comprises a fenced area of 4 x 4 km. The area has sparsely distributed vegetation dominated by *Grewia*, *Senegalia* and *Vachellia* species and some species of grasses (Kgaudi 2014).

Figure 1: Map of Botswana showing the study area (Tshabong)



Source: Mpotokwane (2011).

Tshabong is the capital of Kgalagadi South District. The highest proportion (31.6%) of the human population of Kgalagadi South District is found in Tshabong village. It had a total human population of 9,471 (Statistics Botswana 2015). The region or district has a hot and dry climate with summer temperatures ranging from 28.5 to 35 °C while winter temperatures range from 1 to 12 °C. Rainfall occurs in summer (November to March) and averages 26 mm per annum, ranging from 0.6 to 61 mm monthly (Zweistra 2012). The area is an inland plateau of relatively flat savannah woodland and grassland with an average altitude of 1,000 m above sea level. Agriculture, in the form of cattle and game (wildlife) farming and hunting, has historically been the main economic activities of the area (Zweistra 2012). The Kgalagadi Desert that covers nearly 70% of the country's land area encompasses this region. The area's soil is generally sandy and infertile (Batisani 2010) and, hence, arable agriculture is limited in the area.

Key informant interviews

A survey was conducted by purposively choosing and interviewing a total of 26 key informants who are knowledgeable about the camels since they are working and/or had worked in TECP. A semi-structured questionnaire was developed, field tested, revised based on the feedback from the field test, and used for the interview.

The questionnaire was designed to generate data on herd size, herd composition, milking procedure, milking frequency, milk yield, utilization of milk, reasons for keeping camels, feed of camels, climatic condition of the study area, vegetation found in the area, history of introduction of camels to the area, and the major feeds of camels in the area.

Moreover, secondary data about camels in Tshabong area were referred to supplement the primary data generated through the survey.

Plant sample collection

Before plant sample collection, the major browse species consumed frequently by the camels were identified with the assistance of camel herders in the premises of TECP. Accordingly, complete (with vegetative and reproductive parts) herbarium specimens of nine such species were collected, pressed and dried following international standard procedures (Bridson and Forman 1992; Victor *et al*. 2004). The specimens were, then, brought to Botswana University of Agriculture and Natural Resources Herbarium (BACH) and identified by staff members of the herbarium.

The species were identified using herbarium specimens identified and deposited in BACH and published references (Ellery and Ellery 1997; Setshogo 2002 and 2005; Setshogo and Venter 2003). The forage values of the nine browse species were obtained from the study reported by Hendzel (1981).

Data analysis

Data generated through the key informant interviews were sorted and analysed using descriptive statistics, such as means and percentages. The parameters analysed included herd structure and composition, daily milk yield, weaning period, lactation length, purpose of keeping camels, constraints to camel production as well as identity and forage values of browse species identified.

Results and Discussion

Herd structure and composition of camels

The park had a total of 287 dromedaries, of which 130 and 110 were female and male camels, respectively (Table 1). The ratio of male to female camels in the herd was almost 1:1. However, the common ratio of male to female animals in a camel herd is 1:30-50 (Mukasa-Mugerwa 1981; Elmi 1989). This shows that there are excess male camels in the herd than required, which should be culled. The higher number of male camels in the study herd may be attributed to the lack of clear management and breeding objectives and emphasis of the park on tourism rather than milk production. Future interventions aimed at improving the productivity of camels in the park should consider setting clear management and breeding goals as well as maintaining the recommended ratio of male to female animals in the herd. Because of lack of controlled breeding, there is high rate of inbreeding in the herd, which can be witnessed from the frequent encounter of calves born with deformities and low productivity of the herd as reported by the respondents.

Table 1: Camel herd structure and composition in Tshabong Ecotourism Camel Park in 2014

Camel Herd Structure	Number
Male camels	110
Non-lactating female camels	109
Calves	52
Lactating camels	16
Total	287

Current study

Except the introduction of camel bull from Libya in 2008, no attempt has been made to introduce new camel breeds into the herd since the initial importation of these animals into the country. Thus, there is a dire need to solve the problem of inbreeding by introducing new bloods into the herd.

Milking procedure and frequencies

All the lactating camels are kept in the same kraal and branded with numbers for easy identification. During milking, the dam is tied with a rope around its head and taken into the kraal where calves are kept. The calf is allowed to suckle its dam to stimulate milk let-down. One person holds the rope and two individuals (males) start to milk the camel while standing from both sides. Since they milk the camel standing on both sides (right and left), the calf has no access to suckle its dam and waits until they finish milking. This is in line with Seifu (2009) who reported that the calf is allowed to suckle its dam for a few minutes to stimulate milk ejection, and then, suckle again at the end of milking.

The milking of camels is done in the kraals, which are not regularly cleaned, and this affects the quality of the milk. Respondents reported some incidents of mastitis in the camel herd and this might be partly attributed to the unsanitary milking environment and the poor hygienic condition practiced during milking. Thus, milkers and those who take care of the camels should be given training on sanitary milking and milk handling practices.

According to the respondents, the presence of the calf is crucial to initiate milk ejection by camels. The camels do not let down milk in the absence of their calves. Hence, there is a need for careful and proper management of camel calves so as to reduce their mortality. It was also observed that the camel handlers do not wash the udder and teats before milking. This potentially leads to contamination of the milk by microorganisms, indicating the need for providing a clean milking environment and follow hygienic milking procedures in order to maintain the quality of the milk. Therefore, the workers need to be taught the importance of hygienic milking procedures.

The majority (88%) of the respondents reported that camels in the study area are milked once a day although some reported that they milk camels twice a day at 8 am in the morning and at 4 pm in the afternoon (personal communication with Fredrick Cooper, camel park supervisor, 15 December 2013). The reason for milking once a day is mainly due to low milk production, especially in the dry season. According to Seifu (2009), the majority of the households in eastern Ethiopia milk their camels twice a day, in the morning at 7 am and in the afternoon at 4 pm.

Milk yield

The respondents reported that camels produce on the average four litres of milk per day (Table 2) depending on the availability of feed, compared with local cows, which produce seven litres of milk per day in the area.

Table 2: Daily milk yield, weaning period and lactation length of camels kept at Tshabong Ecotourism Camel Park in 2014

Variables	Average Values (n = 23)
Milk yield (litres/day/head)*	4 (3-5)
Lactation length (months)	10
Weaning period (months)	10

*Values in bracket indicate the range for milk production.

Current study

The respondents stressed that camels can produce this amount of milk per day throughout the year

whether dry or wet season while cows only produce the amount stated during summer times when there is ample pasture. During winter, cows are not usually milked in the study area because of shortage of feed. Knoess (1977) reported that daily milk yield of dromedary camels in Ethiopia was 6.6 litres. Similarly, Jemmali *et al.* (2016) reported that Maghrebi camels in Tunisia produce 6.72 litres of milk per day. Raziq *et al*. (2011) also reported that Raigi camels (one-humped) reared by Pashtoon pastoral people in Pakistan and Afghanistan produce 6-10 litres of milk per day per camel with an average value of 7 litres per head per day. A report from Ethiopia indicates that dromedary camels managed under traditional pastoral system in Jigjiga District in the eastern part of the country produce a daily milk yield ranging from 1-6 litres with an average value of 3 litres per day per camel (Mahamed *et al*. 2015).

On the other hand, Onjoro *et al*. (2006) carried out a study on effects of mineral supplementation on milk yield of free-ranging camels (*Camelus dromedarius*) in northern Kenya and found that mean daily milk yield of camels increased from 3.4 to 4.3 litres per day and 5.2 litres per day in the dry and wet seasons, respectively. Similarly, Khan and Igbal (2001) reported that well-fed and managed dromedaries produce 9 to 14 litres of milk daily. This amount is higher than the milk production by camels in the present study area. The high milk yield reported by Khan and Igbal (2001) could be attributed to provision of supplementary feed to the camels and/or the breed of camels used. The camels raised in the present study area have neither been selected for milk production nor given supplementary feed. Although the milk yield of camels kept in the study area is low, there is a good potential to increase milk yield through provision of supplementary feed, selective breeding for milk production and proper health care of the camels in the future. Hence, concerted efforts are required by all concerned to improve the feeding system of the camels and select camels for milk production.

The average lactation length of camels and weaning age of calves in the study area was 10 months. This is in line with reports of other studies. Raziq *et al*. (2011) reported a lactation length of 10 to 12 months and a weaning age of 9 months for Raigi camels in Pakistan and Afghanistan. By the same token, Kayastha and Dutta (2012) reported a lactation length of 9 to 18 months and a weaning age of 12 months for dromedary camels in India. On the other hand, Mahamed *et al*. (2015) reported a weaning age of camels in Jigjiga District of eastern Ethiopia to be 6-18 months, and this depends on the availability of feed, milk production of the dam and growth of the calf.

Purpose of keeping camels in the study area

As indicated earlier, the camels in the study area are used for riding, milk and meat production (Table 3). However, it should be noted that the main reason for keeping camels in the study area is for tourism (riding) purpose. Although the camels are milked and occasionally slaughtered for meat, these camel products are mainly consumed by the park workers.

Table 3: Purpose of keeping camels in Tshabong Ecotourism Camel Park

Contribution	Proportion (%) of Respondents (n = 26)
Camel safaris (riding)	100
Milk production	100
Meat production	100
Transportation	11.5

Current study

However, according to Fredrick Cooper, park supervisor, the people in Tshabong area have great interest and positive attitude towards camels and camel products in the form of milk and meat. He said they appreciate these products to the extent that when camels are slaughtered occasionally, some of the

people request and collect the meat for domestic consumption (personal communication with Cooper 15 December 2013). He also reported that the local people frequently come to the park and collect milk free of charge. The fact that local communities have interest in camel milk and meat is a good indicator and opportunity to promote the camel sector and justifies the need for increasing camel milk and meat production in the country. Some (11.5%) of the respondents indicated that camels are used for transport by police officers. Although camels have other uses, the respondents in the study area only reported the above benefits.

Constraints of camel production

The major constraint that hinders camel production in the study area is feed shortage (Table 4). The study area experiences low rainfall. This results in the area having poor pasture, which makes it difficult to meet nutrient requirements for camels to survive or remain in good conditions for most of the year. The area is characterized by high ambient temperature and the vegetation is dominated by sparsely distributed perennial shrubs and trees.

Table 4: Constraints of camel production in Tshabong Ecotourism Camel Park

Major Constraint	Proportion (%) of Respondents (n = 26)
Feed shortage	88.4
Lack of knowledge of camel husbandry	76.9
Lack of awareness	57.6
Labour shortage	46.2
Disease prevalence	11.5
Water shortage	7.7

Current study

It may be helpful to introduce improved feeding systems, such as provision of quality supplementary feeds, and introduction of drought resistant, palatable and nutritious shrub/tree species as alternative sources of feed for camels to solve the problem of feed shortage in the area.

The second problem reported by the respondents was lack of knowledge on camel husbandry. Knowledge and skills on camel husbandry by locals in Botswana is non-existent and, as such, productivity and interest in camels as sources of food are limited. Most of the local people who are taking care of camels have never been trained on camel husbandry. The people managing camels are mostly relying on limited personal experiences. Moreover, camel husbandry is not included in the agricultural curricula of schools and tertiary level education in Botswana. Given the vast desert conditions in the south-western part of the country, the potential of a 'camel industry' should have been given appropriate attention by the relevant authorities.

Therefore, it is very important to create awareness about the importance of camels and train camel herders and development agents on camel husbandry, disease control and hygiene, processing of camel milk and meat, feed management and production of feed from alternative shrub/tree species. This could help them to raise camels properly and help in the development of a camel sector in Botswana – thus diversifying the country's agricultural portfolio.

Lack of awareness was also identified as another problem. Most people are not aware of the benefits of camels and, thus, are reluctant to raise camels or get involved in camel development activities. They are not aware of food and non-food products that can be obtained from camels due to inadequate knowledge. Most of the people in the area are cattle farmers, and cattle farming is very important in their lives. Hence, they are reluctant towards embarking on camel production. All responsible authorities should make sure

that education on camels reach the people and create awareness about the importance of camels.

Labour shortage was also identified as the constraint that hinders camel production. Camels are owned by the Tshabong, Maubelo and Maleshe communities and managed by Tsamama Community Trust that represents the three communities (Moeng 2011). The Trust has to raise money in order to employ people who look after the camels. In most instances, the committee does not have enough money to pay its employees and, as a result, the camels do not get proper care and management, leading to their poor performance. However, in 2005, the BTO, a state-owned organization, has intervened and forged partnership with the Trust by also covering payment of the employees and expenses related to the general management of the camels.

According to the respondents, water shortage is one of the constraints. However, it is occasional since, currently, the park owns a borehole, which supplies camels with water although not potable. Prevalence of diseases, such as mastitis, ticks, internal parasites (worms in the faecal matters) is a common problem in the area and the veterinary support obtained to treat the sick animals is not adequate.

Plant Species Browsed by Camels

Species composition

Nine species of plants were reported by respondents as being the major sources of feed in TECP (Table 5). The nine species belonged to seven families and seven genera of flowering plants. Fabaceae and *Vachellia* exhibited the highest proportion (33.3 and 22.2%, respectively) of the nine browse species.

Table 5: Plant species browsed by camels in Tshabong Ecotourism Camel Park and their forage values

Species*	Family	Common Name		Botanical Description	Forage Value**	Other Uses***
		English	Setswana*			
Boscia albitrunca (Burch.) Gilg & Benedict	Capparaceae	Sheperd's tree	Makgolela	Evergreen, ≥ 11 m high tree	Good	CS, BE, EF, HU, ME-H and PO
Grewia flava DC.	Tiliaceae	Velvet raisin	Maphokwe	Deciduous shrub/ small tree	Good	AD, BAS, EF, FE, PO,
Rhigozum trichotomum Burch.	Bignoniaceae	Three – Thorn	Lekhubare	Perennial deciduous, 1-2 m high woody shrub	Intermediate	FE, RFB, SP and SS
Rhus tenuinervis Engl.	Anacardiaceae	Kalahari currant	Modupaphiri	Deciduous, up to 8 m high shrub/ small tree	Good	EF, FE and TA
Schmidtia kalahariensis Stent	Poaceae	Kalahari sour grass	Tshube	Annual tufted grass forming dense stands	Intermediate	FE and SP
Senegalia mellifera (M. Vahl) Seigler & Ebinger	Fabaceae	Sweet thorn	Gaba/Mokha	Semi-deciduous, 3-5 m high shrub/ small tree	Good	EG, FE, FEN, FU, FW, ME-A, ME-H and RO
Tribulus terrestris L.	Zygophyllaceae	Devil's thorn	Mosetlho	Creeping annual herb	Poor	FO and ME-H
Vachellia erioloba (E. Mey.) Seigler & Ebinger	Fabaceae	Camel thorn	Mogotlho	Semi-deciduous, up to 16 m high shrub/small tree	Good	BF, CS, CO, EG, FE, FEN, FW and ME-H

Vachellia karoo (Hayne) Banfi. & Galasso	Fabaceae	Black thorn	Mongana	Deciduous, up to 9 m high shrub/ small tree	Poor	BA/WE, CO, FE, FW, ME-H and WW/ CA

***** Plant nomenclature follows Setshogo (2002, 2005) and Setshogo and Venter (2003); ****** Source: Hendzel (1981); ******* Uses; AD = alcoholic drink (fruits), BA/WI = bag making/weaving (stem and root bark), BAS = basket making (bark), BE = beer making (roots), BF = bee forage, CS = coffee substitute (seed), CO = construction; EF = edible fruits, EG = edible gum; FE = feed; FEN = fencing; FO = food (leaves), FU = furniture making; FW = fire wood; HU = household utensils, ME-A = medicine-animals; ME-H = medicine-human; PO = porridge (roots), RFB = reserve fodder bank (during drought periods), RO = rope making (bark); SP = soil protection; SS = shelter sites (for seedling development), TA = tanning (bark), and WW – Wickerwork/Cane (source: Ellery & Ellery, 1997; Roodt, 1998a and b, Van Oudtshoorn 2012).

Camels can survive drought periods for long times with little food and can feed on the available pasture whether shrub, trees, grass or other edible plant species. They mostly browse on pasture within the park though sometimes they can be trekked outside to browse and taken back to the park. Out of the nine browse species identified in the park, five namely*, Boscia albitrunca, Grewia flava, Rhus tenuinervis, Vachellia erioloba* and *Vachellia karoo* have good forage values (Table 5) and grow abundantly during the rainy season. Ninety six percent (96%) of the respondents reported that camels prefer to browse *B. albitrunca* more than other species because it is evergreen and seems to be more palatable to the camels.

Forage value of the browse species

The forage values of the nine plant species were categorized as poor (22%), intermediate (22%), and good (56%) (Table 5 and Hendzel 1981). As just indicated above, the camels prefer *B. albitrunca* tree whose foliage is evergreen, although some leaves are shed around flowering time (Stapelberg *et al*. 2008). The roots provide a valuable food source for both animals and humans (Palgrave 2000) although the leaves and twigs are the preferred source of forage for livestock Alias and Milton 2003).

The mature leaves and twigs of B. albitrunca have a crude protein content of 9.04% (Aganga and Adolga-Bessa 1999; Alias and Milton 2003) and are rich in vitamin A (Palgrave 2000). The leaves also contain high quantities of calcium, phosphorus, potassium and sodium, similar to other browse species, such as *G. flava* and *Senegalia mellifera* (Alias and Milton 2003).

Conclusion

The camels kept in Tshabong Ecotourism Camel Park are mainly used for riding as was the case when they were first introduced to Botswana at the beginning of the nineteenth century. The main reason for keeping camels in other countries is for their role in food production, in particular milk production. This aspect of the camels has not yet been exploited in Botswana, and the camels kept in the park are underutilized despite their potential for food production and their adaptation to the harsh climatic condition of the country. Camels can significantly contribute to food security and economic diversification in Botswana. A potential exists to develop the camel sector and commercialize camel milk and meat production in the country. Thus, this calls for due attention and concerted efforts by all concerned bodies in order to develop this important, but neglected sector.

The Tshabong camels have neither been selected for milk production nor given supplementary feed. Although milk yield of these camels is low, there is a good potential to increase milk production through improved husbandry practices, provision of supplementary feed, selective breeding and proper health care. Nine browse species consumed by camels were identified in the park of which *Boscia albitrunca* is the browse species most preferred by the camels. However, the nutritive value of the major browse species consumed by the camels should be analysed and documented. Moreover, the

local people in Botswana lack knowledge and management skills about camels. Thus, there is a need to create awareness and educate the people about camels.

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