

Forage Preferences by Lactating Camels in the Peri-urban Area of Marsabit Town, Kenya

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Abstract. The objective of this study was to identify the most preferred range browse species by lactating camels in the peri-urban area of Marsabit town in Kenya. Twenty Somali camels in early lactation (1-4 weeks post-partum) and parities 2 or 3 were selected for the study. The lactating camels were allowed to browse/graze for 8 hours daily and data collected continuously for 12 weeks. Local (Samburu) herders were used to identify the preferred forage species during browsing using common names and later translated to scientific names during both the short rains and dry season, respectively. Two lactating camels were observed for half an hour each in the morning between 0900 to 1000 hours weekly and recording of bite counts for each type of forage species was done. Bites made on a particular plant species by different lactating camels were summed up to get the weekly totals. The forage species were ranked according to the number of bites which reflected the browsing preference by the lactating camels. Based on the number of bites, the 20 most preferred forages were identified during both seasons. During the short rains season, camels preferred browsing on leaves and twigs of eight tree types namely; *Olea africana*, *Acacia nilotica*, *Albizia antihelminthica*, *Acacia tortilis*, *Acacia senegal*, *Acacia mellifera*, *Momordica spinosa* and *Opilia campestris* as well as two shrub types mainly; *Aspilia mossambicensis* and *Maytenus heterophylla*. During the dry season, camels mainly browsed on the first 4 tree types as for short rains season in addition to *Harrisonia abyssinica*, *Rhus natalensis*, *Ximenia americana* and *Zanthoxylum chalybeum* and two shrub types namely; *Duosperma eremophilum* and *Maytenus heterophylla*. The findings showed that there was a number of preferred browse species in the study area which varied depending on the season. Lactating camels preferred trees, especially the leguminous types, and shrubs avoiding the undergrowth comprising of grasses and forbs that were dry and scanty during these two seasons. There is need to characterize these plants and conserve the good ones for camel sustainability in the peri-urban camel production system.

Keywords: Bite counts, Browse preference, Camel, Feeding observation, Kenya.

INTRODUCTION

In northern Kenya, camels are raised under extensive production system on native rangeland forage species (Mganga *et al.*, 2015). This production system is characterized by free herd mobility in search of pasture and water for livestock (Noor, 2013). Nomadic camels

alongside other livestock species are normally moved and cover long distances searching for forage and water resources (Aujla *et al.*, 1998). Feeding behaviour of the camel is such that it does not directly compete with other livestock species while it remains productive throughout

the year (Huho *et al.*, 2011, Kuria *et al.*, 2011). Camels are also the most resilient and adaptive livestock species in the fragile and drought prone arid and semi-arid (ASAL) rangelands in the tropics (Wako *et al.*, 2017). They on average spend 60.2% of the day feeding and 2.7% ruminating (Kassilly, 2002). They tend to be selective in their feeding during the wet season when forage is abundant (Amin *et al.*, 2011), but become non-selective during the dry season due to forage deficits (Amin *et al.*, 2011). During the dry spell, they tend to consume a variety of mixed vegetation so as to compensate for declining forage availability (Elmi *et al.*, 1992). This feeding behaviour during the two seasons adopted by camels as responses of woody plants to browsing, result in changes in feeding behaviour of the browsers (Bergström, 1992). However, the dromedary camel has a remarkable ability to exploit the scanty feed resources in that they have strong prehensile mobile split upper lips that aids in selecting nutritious leaves and twigs in-between the thorns (McDowell, 1986; Rutagwenda *et al.*, 1990). They spread over a large area, thus putting less pressure on the vegetation in any one area. The camel is also tolerant to dehydration for several weeks in contrast to other animals (Nagpal *et al.*, 2011), and they can survive on a wide variety of feed resources like shrubs and trees (Kuria *et al.*, 2016).

Camels are, by preference, browsers of a variety of forage plants consisting of trees, shrubs and hard thorny, bitter and halophytic plants that are abundant in the ASALs (Dokata, 2014). They also consume herbs, forbs and grasses (Iqbal and Khan, 2001; Kuria *et al.*, 2016). Bushes, trees and dwarf shrubs make 37.9%, 29.2% and 27.6%, respectively of camel's diet and they form the bulk of feed during the short rains and dry season when grasses, forbs and sedges are insufficient to meet daily requirements (Schwartz *et al.*, 2012). Further, Schwartz *et al.* (2012) noted that trees of leguminous nature contain adequate crude protein and other nutrients that meets the camel's requirements for maintenance and production. Camels' nutrient requirements in peri-urban herds are met through tree/shrub browsing and pasture grazing (Salamula *et al.*, 2016; Kashongwe *et al.*, 2017), a feeding practice also observed in peri-urban areas of Isiolo County as reported by Noor (2013). They also prefer browsing on the canopy of taller species to intensify their forage utilization which also aid in minimizing locomotion from plant to plant (Birhane *et al.*, 2014). Camels being browsers, predominantly prefer shrubs at over 90% of the total in wet season compared to grasses as shrubs that are lower in crude fibre and ash but higher in dry matter and crude protein making shrubs more palatable (Kuria *et al.*, 2013).

Generally, there is limited documentation of the camel preferred forage species, their availability and distribution (Salamula *et al.*, 2016). Previous studies mainly concentrated in identifying feed resources for camels kept under pastoral production system (Lusigi and

Nkurunziza, 1984; Kuria *et al.*, 2004; Kuria *et al.*, 2005; Lengarite *et al.*, 2013). Such studies were undertaken in the pastoral rangelands of Korr, Kargi and Ngurunit areas of Marsabit County by Kuria *et al.* (2005), who reported that camels preferred browsing on *Indigofera spinosa* and *Duosperma eremophilum* in both the wet and dry seasons. Findings by Dereje and Uden (2005); and Chimsa *et al.* (2013) reported that *Opuntia* species, *Acacia brevispica* and *Becium* species were the most preferred forages by camels in northern Ethiopia. Further, Birhane *et al.* (2014) observed that camels in the rangelands of Ethiopia spend more time browsing on *Acacia oerfota*, *Balanites aegyptiaca* and *Acacia mellifera*. Other studies by Noor *et al.* (2012) observed that *Euphorbia tirucalli*, is a succulent plant grown as a living fence, was not a traditional camel forage but has become important alternative forage for camels in the peri-urban system particularly during droughts. Understanding the camel forage preference is vital for the peri-urban camel keepers within Marsabit town. Therefore, the aim of this research is focused on identifying camel forage species mostly preferred by camels in the study area as camel milk production and marketing in these areas is an emerging innovation with a lot of developmental potential.

MATERIALS AND METHODS

Description of study area

The study was conducted in Karare sub-location, Karare ward, Saku constituency-Marsabit County. The site was purposely selected because of an emerging peri-urban camel production system and has abundance of forage resources and large herds of camels. The area is accessible to Marsabit town where there is a niche market for camel milk provided by the highly populated sedentarized pastoral communities. Karare sub-location covers an area of approximately 233 square kilometers with a population of about 4,628 people as per the Kenyan 2019 census (KNBS, 2019). The sub-location lies between latitude 02° 19' North and 02° 11' North and longitude 37° 08' East and 37° 07' East with a mean elevation of 874m above sea level. It experiences tropical climatic conditions with temperatures ranging from a minimum of 10.1°C to a maximum of 30.2°C with an annual average of 20.1°C. Rainfall ranges between 200 mm and 1,000 mm per annum on the plains and foot slopes of the mountainous areas, respectively, and is distributed between two seasons, long rains from March to May and the short rains occurring from November to December. Soils are of low density, poor texture, shallow with low organic content. There are diverse browses ranging from trees, shrubs and forbs in the area. The primary livelihood in this area is pastoralism and abito-pastoralism.

Experimental animals

Twenty Somali camels in early stage of lactation (1-4 weeks post-partum) and parities 2 or 3 were sampled from local herds for the study. Before the commencement of the experiment, all the lactating camels were tagged, weighed and treated against ecto-parasites using Ectopor®, Triatix® and endo-parasites using Ivermectin® 1% (Coopers limited). The camels were also injected with Triquin (a prophylaxis measure against trypanosomiasis) to ensure that their health status was uniform.

Experimental grazing site and feeding observation

The grazing/browsing site selected for the study was called Mincho Minyi and was purposely selected as the area had good terrain, was accessible from the main road and watering point. Experienced camel herders were used to identify the forages by their local names which were then matched to scientific names. The animals were followed for 30 minutes once weekly during the short rains season (December 2018 to January 2019) and the dry season (February to March 2019) recording bites for each plant species to identify the most preferred forage. Feeding observations were done through observing 2 camels in the morning hours between 0900 to 1000 hours weekly for 12 consecutive weeks by the same persons. Bites made on a particular plant species by different camels were summed up to get the weekly totals. The forages were then ranked according to the number of bites which reflected the feeding preference by the camels. Based on the number of bites, ten most preferred forages were identified for each season.

Statistical data analysis

Data on the most consumed species was first generated by tabulating the camel bite counts on different plant species. The bite counts were then subjected to descriptive statistics where percentage bite counts were generated. Ranking of the most preferred forage species was done on the basis of the percentage count variation. The species with the highest percentage bite count was denoted as the most preferred.

RESULTS AND DISCUSSION

Most preferred forage species by lactating camels in the peri-urban area of Marsabit town

The most preferred forage species by grazing/browsing lactating camels during the short rains and dry season are presented in Tables 1 and 2. During the short rains season, lactating camels preferred browsing on 8 tree

and 2 shrub types. Of the eight tree types browsed, five were from the Leguminosae family while the others were one each from Oleaceae, Cucurbitaceae and Opuliaceae families. The 2 shrub types preferred by the camels during the short rains season were *Aspilia mossambicensis* and *Maytenus heterophylla*. In the dry season, camels also preferred browsing on 8 tree and two shrub types. Of the eight tree types browsed, three were from the Leguminosae family while the rest were one each from Simaroubaceae, Anacardiaceae, Oleaceae, Olacaceae and Rutaceae families. The 2 preferred shrub types were *Duosperma eremophilum* and *Maytenus heterophylla*. Camels in the study area tends to prefer browsing on trees and shrubs during both seasons (16 trees and 4 shrubs). The bulk of camel diet (78.4%) was made up of trees during the short rains season as compared to 76.7% during the dry season. At the same time, camels consumed 21.6% of the shrubs during the short rains season and 23.3% in the dry season, respectively. During the short rains season, camels preferred browsing on trees compared to the dry season which can be attributed to the fact that during the short rains season, plants were actively growing hence abundant forage compared to the dry season when most of the trees in the range lands sheds off their leaves thus could have contributed to reduction in the biomass on the plants and a reduction in percent bite counts. The preference for trees at 78.4% during the short rains season in this study was comparable to the findings of Kuria *et al.* (2012), who recorded tree preference of 90% in Marsabit County during wet season. Corresponding dry season, camels preferred browsing on shrubs compared to the short rains season. Shrubs have characteristic features which differentiates them from trees in terms of quality in that they are lower in crude fibre and ash but higher in dry matter and crude protein making them more nutritious and palatable during periods of feed deficits and thus preferred during the dry season (Kuria *et al.*, 2013).

Shrubs are also shorter compared to trees like the *Acacia* species that can grow to a height of 20 metres reducing accessibility by most browsers (Pellew, 1980; Mabeza *et al.*, 2014). The importance of shrubs during the dry season was also observed by Abdullah *et al.* (2017) in the rangelands of Pakistan where ten forage species preferred by camels comprised of 7 shrubs and 3 tree types. Shrubs like *Duosperma eremophilum* were preferred by camels during the dry season. The high preference for *Duosperma eremophilum* by camels in Rendille area was also reported by Wangoi (1984). According to the findings of Kuria *et al.* (2004), dwarf shrubs like *Duosperma eremophilum* with a relative density of 32.8% were the most important sources of minerals for camels and were readily available in both the wet and dry season. The findings by Onjoro (2004), indicated *Duosperma eremophilum* and *Acacia* species were among the most preferred species by camels in

Table 1: Most preferred forage species by lactating camels during the short rains season.

Growth form	Scientific name	Local name	Plant family	Bite counts	Bite (%)	Rank
Trees	<i>Olea africana</i>	Lngeriyo	Oleaceae	123	20.5	1
	<i>Acacia senegal</i>	Ildergesi	Leguminosae	109	18.1	2
	<i>Acacia nilotica</i>	Lkoriti	Leguminosae	48	7.9	3
	<i>Acacia mellifera</i>	Ilti	Leguminosae	46	7.7	4
	<i>Momordica spinosa</i>	Lbukoi	Cucurbitaceae	41	6.8	5
	<i>Opilia campestris</i>	Lbukenyi	Opuliaceae	40	6.7	6
	<i>Albizia antihelminthica</i>	Lmokotani	Leguminosae	34	5.7	7
	<i>Acacia tortilis</i>	Ltepes	Leguminosae	30	5.0	8
Shrubs	<i>Aspilia Mossambicensis</i>	Loiyapasei	Compositae	80	13.3	1
	<i>Maytenus heterophylla</i>	Sagumai	Celastraceae	50	8.3	2
Sub-total				601	100	

Table 2: Most preferred forage species by lactating camels during the dry season.

Growth form	Scientific name	Local name	Plant family	Bite counts	Bite (%)	Rank
Trees	<i>Harrisonia abyssinica</i>	Lasaramai	Simaroubaceae	216	24.9	1
	<i>Rhus natalensis</i>	Lmisigiyo	Anacardiaceae	144	16.6	2
	<i>Acacia tortilis</i>	Ltepes	Leguminosae	85	9.8	3
	<i>Olea africana</i>	Lngeriyo	Oleaceae	66	7.6	4
	<i>Albizia antihelminthica</i>	Lmokotani	Leguminosae	55	6.3	5
	<i>Acacia nilotica</i>	Lkoriti	Leguminosae	52	6.0	6
	<i>Ximenia americana</i>	Lamai	Olacaceae	26	3.0	7
	<i>Zanthoxylum chalybeum</i>	Loisugi	Rutaceae	22	2.5	8
Shrubs	<i>Duosperma eremophilum</i>	Ldurkunyanto	Acanthaceae	140	16.1	1
	<i>Maytenus heterophylla</i>	Sagumai	Celastraceae	63	7.2	2
Sub-total				869	100	

northern Kenya.

Camels widen the range of their dietary acceptance in the dry season apparently compensate for the declining forage abundance through consumption of more litter, leaves and lignified twigs (Kuria *et al.*, 2012). However, research has shown that during dry periods, camels obtain the major components of their diet from trees and shrub leaves (these are usually in green leaf while the forbs are not), whereas in the wet season they predominantly utilize ground vegetation especially forbs at 55% as they are readily available during the growing season (Lusigi and Nkurunziza, 1984; El Shaer and Gihad, 1994; Field, 1995). The authors further reported that under natural conditions, camel's diet is dominated by trees and shrubs that are more palatable during the wet season with their percentage declining during the dry season when most of the species shed off their leaves.

With the exception of *Olea africana*, *Acacia nilotica*, *Albizia antihelmintica* and *Acacia tortilis* that were preferred during both seasons, variations in forage preference was observed in both the short rains and dry season which was in line with the findings of Longo *et al.* (2007) who reported that the diet of the camel is very much affected by seasonal variations. Some of the plant species preferred by camels in the current study site were also found to be preferred by camels in Uganda as reported by Salamula *et al.* (2016), and included among others; *Acacia nilotica*, *Acacia tortilis*, *Zanthoxylum chalybeum*, *Rhus natalensis*, *Aspilia Mossambicensis*, *Acacia mellifera* and *Acacia senegal*. Similarly, some of the species that were observed as the most preferred in this study are also among those that have been reported from previous grazing observation studies by several researchers (Rutagwenda *et al.*, 1990; Elmi *et al.*, 1992 and Kuria *et al.*, 2012).

Based on the results of this study, camels appeared to prefer trees and shrubs avoiding the undergrowth comprising of grasses and forbs which were scanty during the two seasons. Shamat *et al.* (2010) made similar observation when they studied 24 and 26 forage browse plants of trees and shrubs in western and eastern Sudan, respectively. They further reported that the most preferred forage species by camels during the wet season and dry season were mainly trees and shrubs with very little gramineae forages. According to the findings of Schwartz *et al.* (1983), camels are browsers and their feed mainly consists of trees, shrubs and bushes as compared to grasses and forbs in the arid and semi-arid areas in Kenya.

Preference for leguminous plant species was indicated by the higher bite counts (8 leguminous tree species out of 16 trees total), equivalent to 50% than on dwarf shrubs. According to the findings of O'Connor (2015), camels browse on trees and shrub plants of mean heights ranging from 1.26-2.13 metres tall with majority being from the leguminaceae family. The preference of the dromedary for higher vegetation strata gives them the

advantage of easy access to high quality plant materials (Schwartz *et al.*, 1983). Such plant species remain green during the dry season or throughout the year (Le Houérou, 1980), when the herb layer is dry and highly lignified (Khan *et al.*, 2003).

Leguminous plants tends to have high protein content, have less fibre and favour higher intake than grasses, thus highly selected by camels (Celaya *et al.*, 2007). Likewise, selective grazing of camels on foliage of trees and shrubs enables them access browse that is out of reach to other livestock when pasture availability is low especially during the dry season (Bhattacharya, 1989). Leguminous tree forages that were mostly preferred during both the short rains season and dry season were *Acacia nilotica*, *Albizia antihelmintica* and *Acacia tortilis*, while the non-leguminous shrub preferred was *Maytenus heterophylla*. Yagil (1982), reported that *Acacia* species and other leguminous plants were preferred by the camel because of their salt concentration. *Olea africana* and *Harrisonia abyssinica* were highly selected by camels during the wet and dry seasons, respectively (recorded highest bite counts). These plant species were mostly preferred because of their abundance, tender and succulent leaves and twigs that were retained without being shed off during the dry spell (personal observation). In agreement with this study, Kuria *et al.* (2012) reported that camels spent more than 86% of their grazing time on an average of nine preferred plants in Marsabit County.

CONCLUSION

Camels preferred browsing on *Olea africana*, *Acacia nilotica*, *Albizia antihelmintica* and *Acacia tortilis* during both seasons. Trees and shrubs were the most preferred feed resources and formed the bulk of the grazing camel's diet in the peri-urban camel production system. Based on the findings of this study, camel keepers should be enlightened on the usage, conservation and sustainable grazing/browsing of the twenty most preferred forage species for improved camel productivity so as to enhance lives and livelihoods in this volatile peri-urban camel production system.

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REFERENCES

Abdullah M, Rafay M, Hussain T, Ahmad H, Tahir U, Rasheed F, Khalil S (2017). Nutritive potential and palatability preference of

- browse foliage by livestock in arid rangelands of Cholistan desert (Pakistan). *J. Anim. Plant Sci.*, 27(5):1656-64.
- Amin AS, Abdoun KA, Abdelatif AM (2011)**. Observations on the seasonal browsing and grazing behaviour of camels (*Camelus dromedarius*) in southern Darfur-Sudan. *Res. Opin. Anim. Vet. Sci.* 1(4):213-216.
- Aujla KM, Jasra AW, Munir M (1998)**. Socioeconomic profile of camel herders in South-western mountainous areas of Pakistan. In Proceedings of the third annual meeting for animal production under arid conditions, Al-Ain, United Arab Emirates, (2):154-174.
- Bergström R (1992)**. Browse characteristics and impact of browsing on trees and shrubs in African savannas. *J. Veget. Sci.* 3(3):315-324.
- Bhattacharya AN (1989)**. Nutrient utilization of *Acacia*, *Haloxylon*, and *Atriplex* species by Najdi sheep. *J. Range Manag.* 28-31.
- Birhane E, Balehegn M, Kiros D, Tsegaye D (2014)**. Distribution, animal preference and nutritive value of browse species in the rangelands of Afar, northern Ethiopia. *Ethiop. J. Biol. Sci.* 13(2):135-148.
- Celaya R, Oliván M, Ferreira LMM, Martínez A, García U, Osoro K, (2007)**. Comparison of grazing behaviour, dietary overlap and performance in non-lactating domestic ruminants grazing in marginal heathland. *Livest. Sci.* 106:271-281.
- Chimsa MB, Mummed YY, Kurtu MY, Leta MU, Hassen A, Gemedo BS (2013)**. Forage preference of camel calves (*Camelus dromedarius*) in eastern Ethiopia. *J. Anim. Plant sciences*, 23(5):1237-1240.
- Dereje M, Udén P (2005)**. The browsing dromedary camel: II. Effect of protein and energy supplementation on milk yield. *Anim. Feed Sci. Technol.* 121(3-4):309-317.
- Dokata MD (2014)**. Factors influencing camel milk production in central division of Isiolo District: A case of three camel milk women self-help groups in Isiolo County, Kenya, Doctoral dissertation, University of Nairobi, Kenya.
- EI Shaer HM, Gihad EA (1994)**. Halophytes as animal feeds in Egyptian deserts. In *Halophytes as a resource for livestock and for rehabilitation of degraded lands* (pp. 281-284). Springer, Dordrecht.
- Elmi AA, Thurrow TL, Box TW (1992)**. Composition of camel diets in central Somalia. *Nomadic Peoples*, 51-63.
- Field CR (1995)**. Range management handbook of Kenya, Volume 111, 8 (Evans J.O, Simpkin S.P, Atkins D.J). Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.
- Huhu JM, Ngaira JK, Ogindo HO (2011)**. Living with drought: the case of the Maasai pastoralists of northern Kenya. *Educ. Res.* 2(1): 779-789.
- Iqbal A, Khan BB (2001)**. Feeding behaviour of camel review. *Pak. J. Agric. Sci.*, 38:58-63.
- Kashongwe OB, Bebe BO, Matofari JW, Huelsebusch CG (2017)**. Effects of feeding practices on milk yield and composition in peri-urban and rural smallholder dairy cow and pastoral camel herds in Kenya. *Tropical animal health and production*, 49(5):909-914.
- Kassilly FN (2002)**. Forage quality and camel feeding patterns in Central Baringo, Kenya. *Livest. Prod. Sci.*, 78(2):175-182.
- Kenya National Bureau of Statistics, KNBS (2019)**. Kenya population and housing census: Distribution of population by administrative units. Volume 11, page 52.
- Khan BB, Arshad I, Riaz, M (2003)**. Production and management of camels. PhD Thesis, University of Agriculture, Faisalabad, Pakistan.
- Kuria SG, Adongo AO, Muriithi S, Koech OK, Njoka JT, Kamande P (2016)**. Acquisition and management of Somali camel breed for pastoral resilience within peri-urban Isiolo and Marsabit counties of Northern Kenya. *Livest. Res. Rural Dev.* 28(9): 1-10.
- Kuria SG, Tura IA, Amboga S, Walaga HK (2012)**. Forage species preferred by camels (*Camelus dromedarius*) and their nutritional composition in North Eastern Kenya. *Livest. Res. Rural Dev.*, 24(8).
- Kuria SG, Tura IA, Amboga S, Walaga, HK (2013)**. Status of minerals in camels (*Camelus dromedarius*) in north eastern Kenya as evaluated from the blood plasma. *Livest. Res. Rural Dev.* 25(8):1-5.
- Kuria SG, Tura I, Amboga S, Walaga HK, Lesuper J (2011)**. The current status of camel (*Camelus dromedarius*) Calf management among pastoral communities of northern Kenya. *Livest. Res. Rural Dev.* 23(7):1-5.
- Kuria SG, Wahome RG, Gachui CK, Wanyoike MM (2004)**. Evaluation of forages as mineral sources for camels in western Marsabit, Kenya. *South Afr. J. Anim. Sci.* 34(3):181-186.
- Kuria SG, Wanyoike MM, Gachui CK, Wahome RG (2005)**. Nutritive value of important range forage species for camels in Marsabit district, Kenya. *Trop. Subtrop. Agroecosyst.* 5(1):15-24.
- Kuria SG, Wanyoike MM, Gachui CK, Wahome RG (2004)**. Indigenous camel mineral supplementation knowledge and practices on Manyatta based camel herds by the Rendille pastoralists of Marsabit district, Kenya. *Livest. Res. Rural Dev.* 16(7):2004.
- Le Houérou HN (1980)**. Chemical composition and nutritive value of browse in tropical West Africa. Browse in Africa, the current state of knowledge. Le Houérou, HN (ed.), ILCA, Addis Ababa, 261-289.
- Lengarite MI, Mbugua PN, Gachui CK, Kabuaga LW (2013)**. Mineral intake of sheep and goats grazing in the arid rangelands of northern Kenya. *Livest. Res. Rural Dev.* 25, 182.
- Longo-Hammouda FH, Siboukheur OE, Chehma A (2007)**. Aspects nutritionnels des pâturages les plus appréciés par *Camelus dromedarius* en Algérie. *Cah. Agric.* 16(6):477-483.
- Lusigi WJ, Nkurunziza S (1984)**. Forage preferences of livestock in the arid lands of northern Kenya. *J. Range Manag.* 37(6):542-548.
- Mabeza G, Mpofo ID, Masama E (2014)**. Potential of *Acacia tortilis* as Protein Concentrate for Goats. *J. Renew. Agric.* 49, 52.
- McDowell RE (1986)**. Feed source: Animal interactions as production determinants. *Farm Animals*, 1:1-8.
- Mganga KZ, Musimba NKR, Nyariki DM, Nyangito MM, Mwang'ombe AW (2015)**. The choice of grass species to combat desertification in semi-arid Kenyan rangelands is greatly influenced by their forage value for livestock. *Grass Forage Sci.* 70(1):161-167.
- Nagpal AK, Roy AK, Chirania BL, Patil NV (2011)**. Growth, nutrient utilization and serum profile in camel calves as affected by dietary protein levels. *Indian J. Anim. Nutr.* 28(2): 166-171.
- Noor IM (2013)**. Characteristics, feeding and marketing practices of the emerging peri-urban camel production system in Isiolo County, Kenya, Doctoral dissertation, Egerton University, Kenya.
- Noor IM, Bebe BO, Guliye AY (2012)**. Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *J. Camelid Sci.* 5(1): 41-61.
- O'Connor DA, Butt B, Fofopoulos JB (2015)**. Foraging ecologies of giraffe (*Giraffa Camelopardalis reticulata*) and camels (*Camelus dromedarius*) in northern Kenya: Effects of habitat structure and possibilities for competition. *Afr. J. Ecol.* 53(2): 183-193.
- Onjoro PA (2004)**. Effects of mineral status on milk production of free ranging Somali camels (*Camelus dromedarius*) in Northern Kenya. PhD Dissertation, Humboldt University of Berlin, Germany.
- Pellew RA (1980)**. The production and consumption of *Acacia* browse and its potential for animal protein production. Browse in Africa: the current state of knowledge. International livestock centre for Africa, Addis Ababa, Ethiopia, 223-231.
- Rutagwenda T, Lechner-Doll M, Schwartz HJ, Schultka W, Von Engelhardt W (1990)**. Dietary preference and degradability of forage on a semi-arid thorn bush savannah by indigenous ruminants, camels and donkeys. *Anim. Feed Sci. Technol.* 31(3-4):179-192.
- Salamula JB, Aleper D, Egeru A, Namaalwa J, Tenagashaw MW, Kenji GM, Kinyuru JN (2016)**. Camel forage range in Uganda's dryland. In Fifth African Higher Education Week and RUFORUM Biennial Conference 2016, Cape Town", South Africa, 17-21 October 2016, 1039-1046.
- Schwartz H, Wilson JAJ, Folan RBD (1983)**. Camel production in Kenya and its constraints. Productivity. *Trop. Anim. Health Prod.* 15:169-178.
- Schwartz HJ, Wolfgang S, Isaac L (2012)**. Feeding preferences of one-humped camels (*Camelus dromedarius*) on a semi-arid thorn bush savannah in East Africa-adaptive advantages in view of increasing aridity of the environment. In Third International Conference of the Society of Camelid Research (ISOCARD), Muscat, Oman.
- Shamat AM, Babiker IA, Mukhtar MS, Ahmed FA (2010)**. A study of the seasonal and regional variations in nutritive value of some important plant species selected by camels in Arid and Semi-Arid Lands (ASAL) of Sudan. *J. Appl. Sci. Res.* 6(8): 1265-1272.
- Wako G, Tadesse M, Angassa A (2017)**. Camel management as an adaptive strategy to climate change by pastoralists in southern

Ethiopia. Ecol. Process. 6(1):1-12.

Wangoi E (1984). The trophic relations and habitat adaptability of livestock in the Central part of Rendille land in Kenya .PhD Thesis, Colorado State University, Fort Collins, Colorado, USA.

Yagil R (1982). Camels and camel milk. FAO animal production and health paper. Rome: Food and Agriculture Organization of the United Nations (FAO).

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