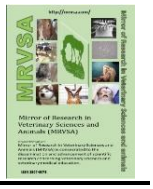
ORIGINAL ARTICLE **Mirror of Research in Veterinary Sciences and Animals MRVSA/ Open Access DOAJ**

Mirror of Research in Veterinary Sciences and Animals (MRVSA)
Journal homepage: http://mrvsa.com/
E-ISSN 2307-8073; 2520-324X (Print)



Camels and adaptation to water lack

Hussein Abdullah Al-Baka [1]*
[1] Faculty of veterinary medicine / University of Kufa

ARTICLE INFO
Received: 05.04.2016
Revised: 10. 06.2016
Accepted: 12.06.2016
Publish online: 25.06.2016

***Corresponding author:**
hussein.abdulridha@uokufa.edu.iq

Abstract
The camel is truly multi-purpose animal. For hundreds of years the camel had been exploited by man in Asia and Africa in arid and semiarid areas - often being the only supplier of food and transport for people. Camel is beast of burden and provider of milk, meat, and hides. The camel has shown to be better adapted to extreme conditions in most aspects than other domestic ruminants.The camel has an exceptional tolerance to dehydration of the body. It has a low evaporation, a low output of urine, and a low loss of water with feces, so it can go a very long time without water. In severe dehydration the plasma volume of camel is only slightly reduced. The camel is able to drink in 10 minutes about one third of its body weight water. After that the camel shows no signs of water intoxication. The camel does not drink more than necessary to obtain a normal water of the body. The camel is truly multi-purpose animal. For hundreds of years the camel had been exploited by man in Asia and Africa in arid and semiarid areas - often being the only supplier of food and transport for people. Camel is beast of burden and provider of milk, meat, and hides. The camel has shown to be better adapted to extreme conditions in most aspects than other domestic ruminants.

To cite this article: Hussein Abdullah Al-Baka. (2016). Camels and adaptation to water lack. MRVSA 5 (Special issue) 1st Iraqi colloquium on camel diseases and management. 64-69.
DOI: 10.22428/mrvsa. 2307-8073.2014. 002179.x

Keywords: adaptation, water lack, Camel, extreme conditions.

Introduction

For hundreds of years the camel had been exploited by man in Asia and Africa in arid and semiarid areas - often being the only supplier of food and transport for people. It is truly multi-purpose animal and called beast of burden. Camel provides milk, meat, and hides. Other than most domestic ruminants, camel has shown its abilities to adapt to extreme conditions. The camel has a unique tolerance to dehydration with low evaporation, a low output of urine, and a low loss of water with feces, so it can go a very long time without water. In severe dehydration the plasma volume of camel is only

slightly reduced. This review article intends to focus on camels and its adaptation to water lack.

Taxonomy

Dromedary camels (*Camelus dromedarius*) and the domestic Bactrian camel (*Camelus bactrianus*) were named in 1758 by Swedish zoologist Carl Linnaeus, who only knew of the domestic variety. Wild Bactrian camels (*Camelus ferus*) were discovered in 1878 by Nikolai Prejevalsky, Russian geographer who explored Mongolia and Tibet. For many years, the wild Bactrian was thought to be a subspecies of the domestic Bactrian. However, in recent years, DNA analysis confirmed that *C. ferus* was a separate species, the San Diego Zoo says on its website. The main difference between the two species is that the wild Bactrian has three more chromosome pairs than the domestic Bactrian.

- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Artiodactyla
- Family: Bovidae
- Genus and species: *Camelus dromedarius*, *Camelus bactrianus*.

There are two species of camels belonging to the camelidae. The two- humped or Bactrian camel (*Camelus bactrianus*) is found in Asia and thrives particularly in cold and arid regions (San Diego Zoo Global, 2009).

The one-humped or dromedary camel (*Camelus dromedarius*) also called the Arabian camel. The one–humped Dromedary occurs in India, Pakistan, the Middle East and Africa. Other forms migrated south and became the llamas, alpacas, guanacos and viçunas of South America. Fossils show that the early evolution of the Camelidae took place in North America. The earliest found ancestor (Protylopus) from the Upper Eocene period was no bigger than a hare (http://australiancamelindustry.com.au). Australia is now the only country in which there are wild camels (Yagil, 1985).

Some Prominent Physiological Features

Gestation in camel lasts some 360 – 380 days. The single young weighs about 40 kg at birth and is suckled for more than a year. Oestrus can recur as early as 1 month after parturition, but the interval between births is normally 18 – 24 months. Sexual maturity is reached in about 4 years. Camels have a life span of 20 – 25 years (http://australiancamelindustry.com.au). Camels can run at 25 mph (40 kph) for long periods. If their owner is in a hurry, they can kick their speed up to 40 mph (67 kph). (Alina Bradford, 2014). They have a third, clear eyelid that protects their eyes from blowing sand. Two rows of long lashes also protect their eyes (Wilson, 1984). Camels are known for spitting on people. In fact, the animals are throwing up the contents of their stomach along with spit. This is a defense tactic when the animals feel threatened (Alina Bradford, 2014). The hump of the camel is absent in the new–born, but can be as heavy as 200 kg in a 700 kg animal. It is made up of fat, blood vessels and fibrous tissue. During drought, the hump is a source of energy and a camel can last as long as 6 months

if water is available. Because of a slower metabolism, the camel uses fat at only half the rate of cattle (http://australiancamelindustry.com.au). The nostrils of camels have sphincter muscles which keep the nares closed except when breath is drawn (they open for about 1 second, ten times a minute) (http://australiancamelindustry.com.au).

Thermoregulation

Temperature and heat are not the same thing. Heat is form of energy, so it is measured in units of joules (or calories). If a given amount of heat is added (removed) to an object, its temperature goes up (down) by an amount that depends on its specific heat capacity. High heat capacity: absorbs heat with little change in temperature. While the Low heat capacity: absorbs heat with greater change in temperature. Moreover, the body heat = heat produced + heat gained - heat lost. The heat produced by metabolic reactions. Examples - 58% of energy released by electron transport chain is trapped in ATP, so 42% released as heat. 75% of energy released from ATP in muscle goes to mechanical work of contraction, so 25% is released as heat (Thermoregulation: Dealing with Heat and Cold). The dromedary camels have very special anatomical and physiological characteristics, which enable the animals to live, and to work under extreme conditions of heat and aridness - even during periods of drought when cattle, sheep and goats barely survive (Dorman, 1984). Camels, like most other animals, need to maintain a constant brain temperature. However, this is very difficult considering they live in an extreme hot environment. To assist this, camels have a "rete mirabile", it is a complex of arteries and veins lying very close to each other which utilizes countercurrent blood flow to cool the blood flowing to the brain. Doing so helps camels maintain a stable brain temperature, essential for survival (Ana Maria, 2011). A special feature of the Camelidae is the oval shape of their red blood-cells -unique among mammals that help continue blood flow during times when water is scarce. (Wilson, 1984). Camels usually maintain a body temperature of 41 Celsius during the day, and almost 34 Celsius over the night (Yagil, 1985).

In the aftermath of the devastating droughts, which hit Africa during the 1970s and 1980s an interest has awakened in this beast of burden and provider of milk, meat, and hides. They have shown to be better adapted to extreme conditions in most aspects than other domestic ruminants husbanded in the harsh environments of arid and semiarid Africa and Asia (Bornstein and Younan, 2013). Camels have learned to face the sun when lying down, causing less of the body to be exposed. In this way, the body catches less sun and doesn't heat up as fast (Schmidt-Nielsen, 1956). The Arabian camel stands over 2 meters at the shoulders and an adult camel weighs about 400-700 kg (Wilson, 1984). The long legs and the large humps, containing adipose tissue, gives to the camel a large skin surface in relation to the body mass, which is another advantageous feature in regards to heat regulation (Kataria *et al.*, 2001 A). The height above the ground (long legged) it is used to hold their body far from the hot sand and allows the desert winds free access to the body thus in some circumstances cooling it effectively (Kataria *et al.*, 2001 A).

Water conservation

Camels are the only mammals that can withstand a loss of 25% of body weight due to sweating, while others do not survive after 3-4% (Yagil, 1985). During the winter and cool season (6-7 months) in the Sahara the camels can go without water. They do not even drink when offered water.

In winter they need not drink at all (Kataria *et al.,* 2001 B). During the dry season when pastures have dried up. Camels are taken to water every 6-10 days. In extreme situation they can go without water for over a month (Evans and Powys, 1984). When the mean temperature reach 30-35°C in the Sahara and in the Sahel, camels can go 10-15 days without water but when the temperature exceeds 40°C, shorter periods between watering is necessary(Kataria *et al.,* 2001 B). Mechanisms of temperature regulation are closely related to osmoregulation and water balance, respiration, pH balance, body size, and ecology (habitat use) (Kataria *et al.,* 2001 A). Instead of dissipating most of its heat through loss of water during the hot part of the day by sweating, the camel, when dehydrated can store some of the heat allowing its body temperature to rise as high as 40.7°C. During the evening and cooler part of the night the temperature of the body can fall to a little above 34C° (Wilson, 1984). This difference in temperature (34.5-40.7°C) of 6.2° of a camel weighing 500 kg is equivalent to approximately 2 500 kcal, which by dissipation via evaporation would require nearly five litres of water (sweat), which is thus saved (Evans and Powys, 1984). At high ambient temperatures the respiratory rate increases slightly in the camel from 6-11 to 8-18 breaths per minute. This raise in respiration rate does not significantly increase evaporation or loss of water (compare the panting in the dog) (Yagil, 1985).

The sweat evaporates directly from the skin surface in the dromedary camel rather than from the tip of the hairs as it does on heavily furred animals. Latent heat of vaporization is therefore drawn directly from the skin. Evaporation that takes place directly on the skin saves more energy and cools the skin more effectively than if the evaporations took place at the tip of the hairs (Kataria *et al.,* 2001 A). That the daily urine volume excreted by dehydrated camels was one thousandth of the animal's body weight. Dehydrated sheep living in the same environment excreted one two-hundredth of its body weight. If an adult man (80 kg) would excrete urine as the dehydrated camel does, it would mean a daily volume of 0.08 liters (Yagil, 1985). A wide variation of data on the volume of urine excreted by camels are found. In Kenyan camels urine volumes declined from 0.8 litres a day when water was given ad libitum to 0.2 litres per day when the camels where dehydrated (Yagil, 1985). As camels become dehydrated when deprived of water, protein is secreted into the plasma. Blood volume is maintained while water is drawn from the gut and cells. This process allows them to continue in circumstances where men, horses, cattle and sheep would suffer circulatory failure and die (Siebert & Macfarlane, 1975).

Salt (NaCl) is a very important part of the camel’s diet. Traditional grazing management by most camel breeders involve regular supplementation of salt, usually by taking the camels to saline pastures, saline wells or salty earth, at least twice a year. It is believed that they will lose condition, abort, give less milk and will be prone to diseases like skin necrosis and arthritis if not given enough salt (Kataria *et al.,* 2007). The animal can also produce urine with extremely low concentration of urea, when fed a diet low in proteins.

Thus the camel can conserve urea for protein synthesis when food is low in protein or when growing or pregnant (Kataria *et al.*, 2001 A).

Another adaptive mechanism of this extraordinary animal includes its metabolic activity, which is sensitive to temperature fluctuation. Like all other mammals, exposed to high ambient temperatures, the metabolic rate increases with increasing body temperature. However, in camels dehydration leads to a reduction in the metabolic rate. There is inhibition of thyroxin production during periods of dehydration which decreases pulmonary water loss and reduced metabolism (Nielsen, 1979; Yagil, 1985). None of the adaptive mechanisms to cope with the environmental stresses are unique to the Arabian camel, but the efficiency of its adaptation is superior (Nielsen, 1979). At high ambient temperatures the camels adapt to the scarcity of water by reducing their fecal, urinary and evaporative water losses (Kataria *et al.*, 2001 A).

During dehydration, the kidneys reduce water losses both by decreasing the glomerular filtration rate and by increasing the tubular reabsorption of water. Also their ability of regulating their body temperature from 34.5-40.7°C conserves a lot of water, when most needed (Kataria *et al.*, 2001 A).

References

Ana Maria V. (2011). Transcript of Homeostasis on Camels and Plumeria Homeostasis on Camels and Soaptree Yuccas**.**

Alina Bradford (2014). Camels: Facts, Types & Pictures.

Bornstein Set and Mario Younan. (2013). Significant veterinary research on the dromedary camels of Kenya: Past and Present / Journal of Camelid Science 2013, 6:1-48. http://www.isocard.org Invited Review.

Dorman AE. (1984). Aspects of the husbandry and management of the genus camelus. In: The camel in Health and Disease .Edited by Higgins, A.J. 1st edition. Bailliere Tindall, london.

Evans JO and **Powys JG (1984).** Camel husbandry in Kenya: Increasing the productivity of Ranch lands. - In: The Camelid - an all- purpose ani-ma/, Vol. l. Proceedings of the Khartoum Workshop on Camels, 1979. Scandinavian Institute of African Studies, Uppsala.

Kataria N, Kataria A K, Agarwal VK, Garg SL, Sahani MS. (2001 A**)**. Changes in glomerular filtration rate and effective renal plasma flow during seasonal water restriction in Indian camel (*Camelus dromedarius*). J. Camel Pract. Res. 8:215-220.

Kataria N, Kataria A K, Agarwal VK, Garg SL, Sahani MS. (2001 B). Filtered and excreted loads of urea in different climatic conditions and hydration states in dromedary camel. J. Camel Pract. Res. 8, 203-207.

Nalini Kataria, Anil Kumar Kataria, Virendra Kumar Agarwal, Sohan Lal Garg, and Mohan Singh Sahni. (2007) Solute loads and transfer function of kidney in dromedary camel during dehydration and rehydration in winter and summer. Veterinarski Arhiv.77 (3), 237-246.

Nielsen KS (1979). Desert Animals. Physiological problems of heat and water. 2nd Edition Dover publications, Inc, Newyork, USA

San Diego Zoo Global. (2009). Taxonomy & nomenclature

Schmidt-Nielsen K. (1956). Animals and arid conditions: Physiological aspects of productivity and management. - In: The future of arid lands, pp. 368-82. Washington, D.C.: American Association for the Advancement of Science.

Siebert BD. & Macfarlane WV. (1975). Dehydration in desert cattle and camels. Physiological Zoology 48: 36-48.

The feral camel (*Camelus dromedaries)*
http://australiancamelindustry.com.au/cjamel/images/pdfs/feralcamels/The.Feral.Camel.pdf.

Thermoregulation: Dealing with Heat and Cold. Biol 411. Animal Physiology **Lecture 22 & 23.**

Yagil R. (1985). Comparative physiological adaptation. 1st Edition, Karger, Basel, Munchen, London, Tokyo and sydney.

Wilson R T (1984). The camel. 1st Edition, longman group limited. Burnt Mill, Harlow Essex, UK.