CHAPTER SIX

Feeds and feeding

Introductory anatomy

Mouth: the mouth is often open and gurgling or bellowing sounds are frequently emitted.

Dental pad: The camel has a very hard upper dental pad and a long hard palate.

Tongue: The tongue of the dromedary is a small but highly mobile or active

Lips: The lips of the camel are extremely mobile. The upper lip is thin and bifid (split in the middle); a feature thought to aid the consumption of thorny plant material. The upper lip is prehensile (able to hold on to things, especially by curling around them) for selecting and grasping feed. In other words the upper lip is sensitive enough to pick up small pieces of vegetation. The lower lip, especially in adults, tends to be pendulous.

Teeth: The adult dromedary has 34 teeth. The dental formula differs from that of true ruminants by the presence of incisor teeth in the upper jaw and canines in both upper and lower jaws. The dental formula of the dromedary is:

Milk teeth

$$\frac{1 \cdot \dot{i} \cdot 1}{3 \cdot \cdot \cdot 3}, \frac{1 \cdot \dot{c} \cdot 1}{1 \cdot \cdot \cdot 1}, \frac{3 \cdot \dot{pm} \cdot 3}{2 \cdot \cdot \cdot 2} = 22$$

Permanent teeth

$$\frac{1 \cdot \dot{i} \cdot 1}{3 \cdot \cdot \cdot 3}, \frac{1 \cdot \dot{c} \cdot 1}{1 \cdot \cdot \cdot 1}, \frac{3 \cdot \dot{pm} \cdot 3}{2 \cdot \cdot \cdot 2}, \frac{3 \cdot \dot{m} \cdot 3}{3 \cdot \cdot \cdot 3} = 34$$

Nostril: the nostrils are surrounded by sphincter muscles which keep them closed completely most of the time, thus avoiding draining of mucous

membrane, and maintain wet atmosphere, which limits the water losses in the upper respiratory tracts. Besides, nostrils prevent the entrance of sand and flies.

The nasal passage ways are cooled by the inhaled air that flows across the surfaces in the nose. When the camel is dehydrated, the nasal passages exhibit hygroscopic characteristics. A camel's hygroscopic surface will absorb water from air that passes by it. However, the difference is that water vapor is given off and then absorbed instead of heat. When dry inhaled air passes over the nasal passages, water is given off, and during exhalation, water is taken up by the then dry nasal passages.

N.B.: Under severe heat stress, the camel does not pant. The respiratory rate decreases in the dehydrated dromedary.

Oesophagus: oesophagus is a long tube of 1–2 m long. It is lined by glands which secrete mucus helping to lubricate the often rough forage consumed by the camel.

Stomach: camel is pseudo ruminant, has large fore stomachs with extensive microbial fermentation. The stomach is anatomically and physiologically different from the true ruminants. The three compartments are referred to as C1, C2, and C3.

Compartment one (C1), the first chamber, rumen, is the largest part of camel's stomach. This structure is the site of a great deal of the primary bacterial breakdown of plant cellulose into absorbable nutrients. The first compartment (rumen) often contains a mixture of food, mucus and water.

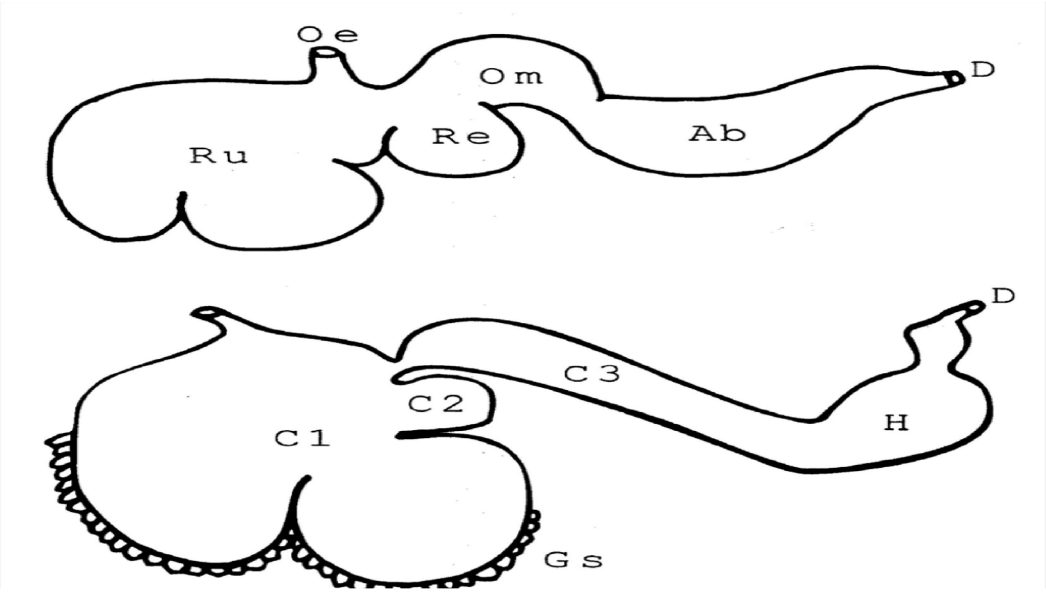
Compartment one (rumen) is partially divided into a cranial (forward) and caudal (rearward) portions. In the ventral portion there are areas containing series of glandular sacs that secrete mucous and buffers which are rich in carbonates. The capacity of these sacs is estimated to be 5-7 litres while that of the total capacity of compartment is between 30 to 50 litres.

The first chamber may contain ingesta that are relatively homogenous throughout and amounting to approximately 11–15% of the animal's body weight. These contents are rich in the water necessary for digestion in ruminants. In this regard C1 holds approximately 83% of the total gastric volume. The cud as well as the green, stinking ingesta of a full-fledged spit is regurgitated from C1. The salt content of C1 is like that of blood. **Compartment two (C2), reticulum**, is relatively small and has a small capacity. C2 holds around 6 % of the total gastric volume and contains liquid ingesta that enter from C1. Reticulum can be divided into dorsal lesser and ventral greater curvatures and itself

Reticulum empties into C3 via a short, thick walled, muscular tube that can constrict to control the rate at which material moves into the third compartment. Its contents are more fluid than those of the rumen.

Stomach system of ruminants (above) and camels (below)

Oe=oesophagus, **Ru**=rumen, **Re**=reticulum, **Om**=omasum, **Ab**=abomasum, **D**=duodenum, **C1**= Compaetment1, **C2**= compartement2, **C3**=compartement3, **Gs**= glandular sacs, **H**= hindstomach



Compartment three (C3), omasum, is elongated structure, continuation of C2 and intestine like organ. The omasum lies below C2 and comprises approximately 11% of the gastric volume. The third compartment contains the gastric glandular mucosa that characterizes the true stomach; but this is only within the distal 1/5th of the compartment. On its distal end, the third compartment empties into a dilated ampulla that delineates the beginning of the small intestine.

Within the small intestine water, vitamins, minerals, and more volatile fatty acids are absorbed from passing ingesta. Bile flows in continuously from the liver as camelids lack the gall-bladder necessary for storage.

N.B.: Camels are more efficient at feed conversion than are ruminants in extracting protein and energy from poor quality forages.

Intestines: the intestines are similar to those of ruminants. The colon is large in diameter and is a major site of water absorption, where the fluid luminal contents suddenly change into hard, very light in weight, shiny and almost black fecal pellets of dung. They are so dry that in treeless areas they can rapidly be used for fuel. They burn readily, owing to their abundant cellulose content.

Gallbladder: camel has no gallbladder and does not produce bile to help indigestion.

Kidney: the camel's kidney plays a major role in the process of conserving water through increasing the osmolarity of urine. The kidney has a strong capacity of water reabsorption and a faculty to eliminate very concentrated urine, which helps to explain the great tolerance of the dromedary to salt.

The kidney is characterized by a long loop of Henle, and a well developed medulla. Due to the higher proportion of long loop of Henle, there is a higher water reabsorption potential and ability to concentrate urine.

The camel's ability to concentrate its urine enables it to tolerate water and plants with a high salt content. Camel is capable of secreting urine with a salt content higher than that of sea water.

Hump: the camel hump contains fat which is convertible to about 40 litres of water; optimum utilization of this source would necessitate the use of oxygen.

Feed Resources

Most camels are raised in arid areas with scanty and unreliable rainfall. These areas are for the most part considered unsuitable for raising crops. Forage growth is usually very sparse and large grazing areas are therefore needed per animal. There are mainly three sources of feed for the camel: grazing or browsing, dry fodders from cultivated and uncultivated plants, and readymade concentrates made out of various grains and grain by-products. The dry fodder consists of dry straw and stalks of rice, wheat, etc.

The fodder grasses and herbs found in arid and semi arid areas grow, flower, fruit and lignifies extremely quickly, providing adequate protein and carbohydrates for only a month or so in a year. Thorn and fodder bushes, which utilize more water owing to their larger root systems, are nutritionally more valuable. Camels consume many different kinds of plant. They can utilize hard, thorny plants like acacia, which are alleged to be among their favorite species. Camels are capable of ingesting thorns up to 1 cm long.

Feeding and feeding habit

Based on the feeding habit, the camel is grazer as well as browser. Camels can live exclusively on a fibrous, low quality diet due to the long retention of feed particles in the fore stomach; they can also live on highly selective leaves as the browsers do.

Camels have very efficient system of recycling the urea generated in the urinary system. About 90-96% of the urea generated in the body is recycled in the camel when they are faced with low protein diet condition.

Generally, equal amount of time is required for grazing/browsing and ruminating. When the feed is sufficiently availability about six hours grazing/browsing is enough to get enough feed for the day. Another six hours are required to chew the cud.

Ideally, camels should be allowed to feed for 6–8 hours a day, with a further 6 hours being allowed for rumination.

If the camels are let free they do not feed during the heat of the day. During this time they mostly chew the cud and take rest and forage during the night or when the temperature is tolerable.

Nutritional physiology

The one-humped camel possesses remarkable abilities to exploit the scanty feed and water supplies found in its natural habitat, the arid and semi-arid areas.

Mobility

Fore stomach motility in camels' results in an effective mixing of fluid and particles. Each cycle starts with a strong contraction in the canal between compartments C2 and C3. This is followed by a single rapid contraction in C2 which is then followed by a short relaxed phase. Comparative studies have shown that the basic pattern of movements of the fore stomach compartments is different from those of the other ruminants. Motility (movement) pattern in camel stomach are by the following order:

Strong contraction in the canal between C2 and C3

This followed by single rapid contraction in C2, which then followed by short relaxed phase

Then, contraction of C1 when C2 relaxes

The strong contractions push food round C1 in anti clockwise direction, squeezing out fluid, which is absorbed in the glandular sac region. The flow of digesta through the canal between C2 and C3 occurs during contraction of C2.

The motility contraction cycle begins with contraction of C2 and takes 1.8 - 2 minutes. After contraction of C2, the muscular contraction proceeds to the caudal sac of C1, passes to the cranial sac, and back and forth between the cranial and caudal sac approximately 6 - 8 times before C2 again contracts. The canal relaxes shortly before each C2 contraction. Contraction along the length of C3 takes place all the time and these movements are peristaltic movements.

A typical motility cycle lasts for about three to four minutes, including a short period when it is inactive. Filling of C2 with food decreases the number of contractions per cycle but increases the period at which they take place. During eating and rumination forestomach motility is frequent, but during the resting periods long pause in motility (up to 20 min) may occur.

i) **Movement of the digested food**

The contents of C1 and C2 pass to C3 when the strong contraction of C2 causes an expansion of the connecting canal. The movements of the canal

are therefore responsible for the flow of the partly digested food from the fore stomach to the lower part of the gastrointestinal tract.

ii) **Retention time**

The time that feed particles remain in the fermentation chamber of C1 and C2 is important because it is responsible in the large part for the amount of fiber digested. Retention time is the time that feed particles remain in the fermentation chamber of C1 and C2. In the fore stomach of camels small particles, large particles and fluid are retained for 41, 57 and 14 hours respectively.

Camels can be successfully kept on grassland where the possibility to select high quality feed is very restricted. Under these conditions, camels may be confronted exclusively with slowly digestible fibrous material. The camels are able to increase their forestomach volume considerably and, thereby, achieve a much longer retention time of feed particles in their forestomach. This prolongation of the microbial digestion leads to an improvement of the slow utilization of fibrous material. Hence, camels are able to take advantages of both strategies of adaptation i.e. selective feed intake (if there is a choice to select) and utilization of slowly digestible cell wall constituents (if no feed of better quality is available).

N.B.: camels are more efficient in digesting fiber than true ruminants

iii) Adaptation to low protein diets

Camels are well adapted to diets that are low in protein due to their ability to recycle one of the end products of digestion, urea, very effectively. Recycled urea in reality is the same protein that is used more than once.

Camels are well adapted to diets that are low in protein due to their ability to recycle one of the end products of digestion, **Urea,** very effectively. The recycling rate of urea increases when camels are put under stress.

In other words, when protein contents in feed of camels is low with sufficient available energy for microbial growth, recycling and use of endogenous urea-N is high. Camels are capable of recycling 92–97% of the Urea is formed in the first and second stomachs on low protein diets. This process is effected in two ways, namely through the permeability of the rumenal mucosa, and through reabsorption in the kidney.

Urea is reabsorbed from the intestine and transferred back to the stomach for reconservation to protein. The return of urea from blood into the forestomach is beneficial only under nitrogen shortage conditions

Camels partially overcome the effects of diets that are low in protein by their ability to select high quality material. They can do this if they are given a wide choice of feed in dry grazing and browsing areas and allowed sufficient time to make their own choice.

Generally, the nutritional adaptation efficacy of the dromedary is due to more efficient fermentation in pre-stomach, high lipomobilization, high intestinal absorption and great urea recycling for protein synthesis.

N.B.: Lipomobilization the mobilization of the body reserves of lipids (fatty tissue) during malnutrition and the storage of fat during favorable periods.

Nutrient Requirement

No systemic work has been reported on the nutrient requirements of camel for growth, milk production, maintenance and work. Some of the major factors affecting nutrient requirements are: energy level of the feed and ambient temperature; inherent differences between male and female animals in given species; disease conditions and management conditions.

Camels on natural feed sources will normally take in enough minerals and vitamins for their needs. Where there are known deficiencies and no “salt cure” possible imbalances should be corrected by providing a mineral lick that contains the necessary elements or trekking camels to areas of the traditional mineral sources. Generally a daily ration of 142-gram salt may be considered the minimum quantity required to keep a full-grown working or milking camel in prime condition.

Feeding and Feed Preference

Feeding

The camel is much more efficient in digesting dry matter, fiber, cellulose and crude protein than other ruminants and domestic non-ruminants. Camels can

have a comparative advantage over other domestic species in the arid and semi-arid areas due to their size and legs, economy in the use and turnover of water, ability to stand high levels of salts in the feed and water and peculiarities in its digestive system.

Feed preference

Camels prefer to browse rather than to graze and its preferred diet when allowed free choice consists of about 35 % of leaves of leguminous and other trees and 65 % seeds, pods, flowers and twigs. Its ability to select high quality feed is helped by the long and grasping lips and mobile tongue.

The type of vegetation browsed / grazed varies from place to place depending up on the ecological system. Major plant groups eaten by camels include *Acacia species (Acacia tortilis, A. nilotica, A. melifera), Idigofera, Ziziphus,* and *Salvadora* etc. Therefore, the problem of camel nutrition is undoubtly be the availability of forage or brows plant.

Feeding behavior of different species

Species	Feeding time spent	Travel time spent
Camel	More	Less
Cattle	Less	More
Goat	Intermediate	Intermediate
Sheep	Intermediate	Intermediate

From the above table it can be deduced that camels should not be managed in the same herding unit as cattle. If labor is short, camels can be herded with goats and sheep for at least part of the year.

CHAPTER SEVEN

Importance of Camel

The camel is a triple-purpose animal producing milk, meat and transport. Its comparative advantages over other domestic animals within the camels optimal environmental are important. Camel's milk is much more nutritious than cow's milk. It is heavy, sweet and normally drunk fresh. It is lower in fat and lactose, and higher in potassium, iron and Vitamin C.

The annual camel milk production in Ethiopia is estimated to be 75, 000 tones and it is often reported that surplus of camel milk is produced in the country during the rainy season.

Milk production

Camel milk is usually bluish–white in colour and may have a slightly salty and sharp test (slightly acid). Camel milk is a staple food of arid and semiarid pastoralists or agropastoralists and is richer in fat and protein than cow milk. Camels 'milk is generally opaque white. Most camel milk is drunk fresh and it is also consumed when slightly sour or strongly soured.

Camel milk cannot be made into butter in the traditional churning method. In Ethiopia, the milk is considered an aphrodisiac.

Camels can produce an adequate amount of milk in drought areas where other domestic animals have very low production. Camel milk is very similar to goat milk and compares very favorably with human milk.

Milk production occupies a tiny place (<1%), far behind the buffalo or even the goat and ewe. The dairy potential of camel appeared higher than that of the cow reared under the same climatic and feeding conditions.

In Ethiopia, the pastoralists get 4 to 5 liters of milk from camel. Generally, the annual camel milk production in Ethiopia often reported to be t surplus during the rainy season.

Camels are mainly used for milk production in Ethiopia because they withstand high temperature and water deprivation and have the ability to maintain milk production through the dry season.

Lactation length

Although the lactation period of the female camel may last up to 2 years, the suckling young are generally weaned much earlier, at any time between 3 and 18 months. Under traditional pastoral production systems the average lactation period is 12 months. Camel calves begin to graze when they are only a few weeks old.

Milk yield

There is a lack of information and even ignorance about the potential of camel as milk producer. Besides, there are many discrepancies in literature about the amount of milk that a lactating camel yields. Under traditional subsistence systems a camel gives about 4-6 liters of milk per day. Under improved management, camel can produce about 10 liters per day. Unlike other conventional species, the camel has not posed through processes of selection for improvement of milk production. A range of 1,000 to 3,300 liters

per lactation is reported in Africa. In Asia, 650 to 6,000 liters, or even more is reported.

Colostrum

Colostrum (the first milk) is white and slightly diluted as compared with the colostrum of cow. It was found that 3 hours post-partum Total solids (TS) averaged 30.4 %. The total solids declined to 18.4 % during the first two days of lactation.

In most countries where camels are kept, the colostrum is considered unsuitable for drinking. It is even considered as unsuitable for the calf and is milked onto the ground.

However, as colostrum contains large amounts of antibodies and is beneficial for digestion in the newborn calves, it is advisable to use it for the calves.

Milk composition

The general composition of camels' milk in various parts of the world varies greatly. This can be partly attributed to the inherited capabilities of the animals, but the stage of lactation, age, and the number of calving also plays a role. Camel milk constitutes total solids 11 –14 %, fat 3 –5 %, protein 2.7 – 5.4 % and lactose up to 5.5 %. The fluctuations in protein, fat and salt are determined by the amount of water drunk and by changes in pasture.

Test: normally it has a sweet and sharp taste, but sometimes it is salty. The taste is affected by the nutritional and environmental factors. The changes in taste are caused by the type of fodder and the availability of drinking water.

pH: fresh camels' milk has a pH between 6.5–6.7 (similar to the pH of sheeps' milk). When camel milk is left to stand, the acidity rapidly increases.

Water content: the water content of camel milk fluctuates from 84 – 90 %. The most important factor in camel's milk is its water content, because young camels and humans living in drought areas are in need of fluid to maintain homeostasis and thermo neutrality (at times of water deprivation it is an excellent food).

Water content of fodder would affect water content of milk. Thus, it would appear that the lactating camel loses water to the milk in times of drought. This could be a natural adaptation in order to provide nutrients and necessary fluid to the dehydrated calf.

Fat and fatty acids: the milk fat is different from that of other animals. When left standing, fat is distributed as small globules throughout the milk. The fat globules are very small (1.2–4.2 microns in diameter).

Protein: Milk protein content of camel milk ranges from 2 to 5.5 percent and the total protein in camel milk is similar to that of cow milk. Camel milk casein was found to be poor in crude protein when compared with cow milk.

Milk from the dehydrated camel has a severely decreased protein percentage. This demonstrates the direct effect of drinking water on the composition of milk. It must be stressed that protein content of the feed will also directly affect that of milk.

Minerals: Camel milk is rich in chloride. Although milk from the dehydrated camel showed decrease of fat, protein and lactose content, that of sodium and chloride increased. This would account for the salty taste. The total ash

content of camel milk varies greatly, and the lowest percentage of ash was found in the milk produced by dehydrated camel.

Both concentrations of calcium phosphate and magnesium decline in the milk of dehydrated camel. However, these concentrations are still adequate for human nutrition.

Vitamins: camel milk is rich in vitamin C, which is three times that of cow milk. Vitamin C is important from the nutritional stand point in areas where fruit and vegetables containing vitamin C are scarce. Vitamin C content of camel milk varies between 5.7 mg percent. As lactation progresses the vitamin C content increases.

Vitamin B_1 and Vitamin B_2 concentrations are adequate for human's consumption, but Vitamin A content has been reported to be as little as 0.037 mg percent.

Young camels can derive their nutritional and water requirements entirely from milk in times of water restriction.

Milking frequency

Milking frequency vary from as little as once every 2 – 3 days as often as six times a day.

Meat production

The camel meat production represents about 0.7 % of the world meat production (FAO, 2006), but information's are quite difficult to collect as the main part of the camel meat data comes from the informal market.

Traditionally, camel meat consumption is not common in a subsistence system, because the size of the carcass needs to be shared between a wide numbers of people. However, the urbanization has increased the camel meat demand in most of the arid countries.

The male dromedary carcass can weigh 400 kg or more, while the carcass of a male Bactrian can weigh up to 650 kg. The carcass of a female camel weighs less than the male, ranging between 250 and 350 kg. The brisket, ribs and loin are among the preferred parts, but the hump is considered a delicacy and most favored.

In the horn of Africa, where camel fattening is traditional, the carcass weight is up to 300 kg.

Meat quality

The best camel meat comes from young male camels. It is regarded as a delicacy in the Arabian diet, and is gaining popularity in arid lands where it is difficult to herd sheep, cattle and goats. It is reported that camel meat tastes like coarse beef, but older camels can prove to be tough and less flavorful.

Power source

The camel is used for pack saddle, draught and race. As a pack animal, it is able to walk at 4-5 km/h for 10 hours with 150 to 300 kg on the back. The

camel is commonly assigned to agricultural works i.e. ploughing, carting, sowing, and its performances are similar to horse. The racing camel can run 50 to 100 km per day at the speed of 10-12 km/h. In short race (10 km), the best runners can reach 34 km/h with a maximum of 40km/h.

Hide and wool

In spite of its large size and weight the hide of the camel appear to be of little commercial value. This is partly due to the method of slaughtering which involves flaying along the back line. It is mostly collected by poorer women of town (Darfur). But in some place like Egypt and Middle East camel hide is used to manufacture tourist items. Camels also produce wool and hair that could be use for the manufacture of tent, cloths, blankets and cloaks. This often adds considerably to the subsistence economy of camel-owning societies. Hair growth tends to be unevenly distributed over the body, being often confined to the shoulders and hump in the dromedary. Dromedary hair is little commercialized compared to bacterian and new-world camels. In tropical area, absence of variation in temperature results in very little wool growth.

Other uses of camels

In addition, camel also used for:

Source of cash from sale,

Social solidarity, strengthening relationship among pastoralists since they are used for payment of bride price, blood compensation and simple gift,

Cultural and social roles- sacrificial animal -prestige and

Manure