



Feeding of Elephant

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Generally male elephants are heavier than the females. Asian female (cow) elephant can attain a maximum weight of 3700 kg and a height of 2.4 meters while their males (bulls) reach 5000 kg in weight and 3.2 meters in height. The African elephant is larger than the Asian elephant, cows reaching up to 4000 kg and the bulls 6400 kg in weight (Fowler and Miller, 1999).

Elephants like other large animals have difficulty in losing excess body heat through skin surface. Elephant ear when viewed with infrared thermography, showed a remarkable rate of heat dissipation up to 70W at an atmospheric temperature of 32°C, allowing to shed almost 100% of the total heat when maximally vasodilated and flapped gently (Willer *et al.*, 2000).

Feeding Habit

Elephants under natural habitat are continuous feeders, spending on an average 12 to 20 hours a day for eating. The digestive system of elephant is suited to adapt to their continuous feeding habit. The main reasons for the continuous feeding may be the lower efficiency and the shorter time spent in the gastrointestinal tract of elephants. Elephants feed on a wide variety of plants ranging from grasses, tree leaves, twigs, barks of trees, roots, fruits and even flowers (Moss, 1988). They have a

unique way of eating. The grasses will be held by their short brittle stems, kick until the base is dislodged, remove the dirt and dust knocking it loose against their knees. Some grass will come out by their roots and they will bite off the part that is palatable and drop the rest. They eat in a steady rhythmic pattern. First twisting their trunk around a bunch of vegetation pulling to one side and ripping the bunch free, thus placing it in the mouth and immediately reaching for more as they chew. Elephants are also very careful at removing the thorny branches and manipulating them with their trunks, tusks and feet to remove the bark from larger branches or to bend the thorns in one direction before placing them in their mouths.

Elephants test small samples of leaves if they contain high concentration of saponins, phenolics and other plant toxins (Cheeke, 1999). Young immature leaves have higher levels of chemical defenses than mature leaves that are above the normal reach of herbivorous animals. Hence, they usually push over the trees to get access to the leaves.

Elephants also eat soil rich in minerals. Sodium, calcium and phosphorus deficiencies were the reasons attributed to the soil eating.

Digestive Organs

The prehensile organs of the elephant are the mouth, the proboscis and the lower lip. The teeth have a specialized and complex structure that allows the teeth to sear the toughest plants because of the front and back movements. They have a total of six sets of teeth by the time they reach 55 to 60 years. They have two incisors (tusks) and four molars, one on each side, upper and lower. Teeth measure approximately 4 inches wide and 12 inches long. They are made of dentine and wear down layer by layer from the grinding of the food. The ones that replace the worn out teeth move forward from the back and not up from the bottom. Each new molar is larger than the last and it also carries more ridges, which aids in grinding food (Schmick, 1997).

The stomach is a simple cylindrical sac situated on the left side with the spleen attached and with a number of transverse, nearly circular folds projecting inwards from the cardiac wall which is essentially a storage organ (Anauthsubramaniam, 1992; Eltringam, 1997). The folds disappear when the stomach is distended. The small intestine is reported to be 21.5 feet long according to Evans (1910) while Schmick (1997) reported that the small intestine is approximately 80





feet, the appendix 5 feet, large intestine, 21 feet and the rectum, 13 feet in length. The main compartment of large intestine is the enlarged caecum and colon, which is not separated from each other. Most of the digestion takes place in the caecum, which acts as a fermentation chamber where cellulose in the food is broken down by the microorganisms such as bacteria and protozoa. These microbes are acquired by coprophagy. The starches, soluble polysaccharides cellulose and protein digested or fermented in the colon (Spinage, 1994). The length of the tract per unit weight is less in elephants when compared to that of other herbivores (Benedict, 1936), which is another reason for the continuous, feeding behavior of elephants.

Dry matter consumption

Bhaskaran Nair and Ananthasubramaniam (1979) reported that the dry matter (DM) consumption of elephants fed chopped (30 cm) palm leaves ranged from 4.1 to 5.1 % of body weight while it was only 1.5 to 2.1% when fed as whole. Lower DM consumption of 1.5 to 2.1 was observed for Asian elephants and 1.4 to 1.6% of body weight for African elephants (Roehrs *et al.*, 1989). Higher DM consumption of 6 to 8% of body weight was reported by Eltingam (1997).

Rate of passage

The food residue begins to pass out of the body through the intestinal tract of elephants in 24 hours after feeding and completely disappears from the body in 50 hours (Benedict, 1936 and Bhaskaran Nair and Ananthasubramaniam, 1979). It is also reported that the rate of passage of ingesta measured using markers, ranged from 21 to 24 hours in Asian elephants and 10 to 18 hours in African elephants.

Nutrient Digestion

The food is mixed with copious amounts of saliva to soften the coarse food and ease the passage to the stomach. About 70% of digestive tract contents are found in the caecum and proximal colon. These segments harbour anaerobic microorganisms and fungi, which can ferment plant cell wall carbohydrates, simple sugars, starches and protein. The products of fermentation are the volatile fatty acids, the molar proportion of acetate, propionate and butyrate being 75:12:10, respectively.

The dry matter (DM) digestibilities reported for elephants are lower than that of the other herbivores fed similar diets. African elephants registered lower DM digestibility than Asian elephants fed the same diet under captivity (Reichard *et al.*, 1982). Free ranging elephants digest diets to a greater degree than the captive elephants. A study conducted in Asian elephants fed palm leaves *ad libitum* showed DM digestibility of 45.8% and when the feed was restricted to 75 % of *ad libitum* fed, DM digestibility was 51.5%

(Ananthasubramaniam, 1979). Crude protein digestibility recorded by the above author was 89%. The crude fibre digestibility was 18.5% and the apparent digestibility of energy in palm leaves was 54.9 and 56.7%, respectively, when fed *ad libitum* and when feed was restricted to 75%. It is also reported that Asian elephants showed higher digestibility of cell wall constituents than the African elephants.

Nutrient requirements

Since horses show close similarity to elephants when compared to the other herbivores, scientists are using the NRC standards for horses for feeding elephants. Dietary crude protein requirement of horses range from 8% for mature animals and up to 15% for young growing animals and is found to be almost adequate for elephants. Ananthasubramaniam (1979) recommended the nutrient requirements of Indian elephants based on the work done in the College of Veterinary and Animal Sciences, Mannuthy. Nutrient requirements expressed per unit of metabolic body size (body weight in kg 0.73) and are given below.

He also reported that when palm leaves are fed as the sole feed for adult elephants, they are likely to suffer from phosphorus deficiency. Phosphorus must be supplemented at the rate of 30g and 60 g respectively, for the young and adult elephants. He also reported the vitamin B₁₂ content of elephant blood as 16.94 and 18.05 microgram /100 ml for the young and adult elephants, respectively.

Mineral requirements of elephants were also found to be similar to that of horses. Calcium requirement for tusk growth was found to be 8 to 9 g and for lactating cow elephant, 60 g per day. Elephants prefer sodium rich water and soil.

Black Rhino and elephants under captivity have higher vitamin E requirement and elephants deficient in vitamin E developed cardiac lesions similar to Mulberry heart disease. Under natural habitat of these animals, they are continuous feeders and bile is continuously getting mixed with the feed while under captivity, they are fed as meals and thus require more quantity of bile in short period of time. Insufficiency of bile due to the absence of gall bladder reduces the digestion and absorption of fat and fat-soluble vitamins in these animals. Because of this, water-soluble vitamin E preparations are better absorbed than the fat-soluble forms (Papas *et al.*, 1991). Ingestion of seeds and kernels containing linoleic acid while leaves contain linolenic acid. Rapid degradation of unsaturated fatty acids occurs in stored feed. Thus elephants and rhino under captivity have higher requirements of vitamin E (Dierenfeld, 1994).

Feeding schedule of working elephants suggested by Ananthasubramaniam (1979)





Roughage (palm leaves, coconut-leaves, bamboo leaves, grass, etc.) - 150-200kg

Concentrate

Horse gram	-	5 kg
Ragi	-	7 kg
Rice	-	3 kg
Min. mixture	-	00 g
Jaggery	-	50 g
Drinking water	-	Average 250 litre

Proposed feeding schedule of elephants in the different zoo of Kerala (Yalakki, 2001)

Cooked rice	-	6 kg
Coconut leaves/ palm leaves	-	100 kg
Grass	-	50 kg
Salt	-	100 g
Plantain	-	3 kg
Banana	-	2 kg
Sugar cane	-	kg / week
Jaggery	-	2 kg
Asafoetida	-	100 g / month

Feeding of orphan elephant calves

The composition of the milk of Asian and African elephants as reported by Robbins (1983) is given below.

Fat droplets in elephant milk are smaller than that of cow's milk. Feeding of cow's milk to elephant calves below one month of age develop severe diarrhoea and even end up in death. Hence diluted cows milk (1:1) along with added vitamin C should be fed at intervals of 2 to 3 hours, for a total of 4 to 5 litres a day. A grain mixture is usually recommended after 6 months of age. A mixture of diluted milk, fine ragi powder, glucose, vitamin and mineral is found to be useful. Another mixture containing milk powder - 50g, cooked rice - 500g, sugar - 200g and water - 8.5 litres is also recommended.

Fatty acid of elephant milk fat comprised of capric and lauric acids (82%) while in cow's milk, palmitic and oleic acids are the predominating acids. By the end of the first month, undiluted milk can be given with the saturated fatty acids. Maximum daily milk intake will be at about 9 months of age and the consumption is 20 litres per day. Weaning at the age of one year is done by adding cereals into the milk and gradually introducing them to the natural browses and hay. Healthy calves gain approximately 31 kilograms / month during their first year of life.

Standard rations for young calves

Feeds	6 m-1 y	1 - 3 y	3 - 6 y
Ragi	4 kg	4 kg	6 kg
Horse gram		1 kg	1 kg
Salt	30 g	50 g	50 g
Jaggery	100 g	100 g	200 g
Green fodder	15.25 kg	25 - 50 kg	50 - 90 kg

References

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Sl. No.	Type of animal	DM (g)	DCP (g)	TDN (g)	DE kcal	ME kcal	Calcium (g)
1.	Maintenance - adult (2500 - 6000 kg)	108	6	58	278	237	0.5
2.	Growing elephants (500 to 3500 kg)	142	7	70	335	279	0.6

Feeding of orphan elephant calves

Sl. No.	Type of elephant	Water (%)	Fat (%)	Protein (%)	Sugar (%)	Ash (%)	Energy (kcal/g)
1.	African	82	5.0	4.0	5.3	0.7	0.88
2.	Asian	82.3	7.3	4.5	5.2	0.6	1.12

