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Management of nutrition in captive Asian elephants

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Abstract
Nutritional management with proper supplement of mineral and vitamins are not only protecting the animal from metabolic disorders but also defend from infectious diseases. They may also enrich the immune system to shield the unpleasant situations. Looking to the important of captive elephant, their health monitoring, disease diagnosis and nutritional management as well as concern veterinary officers. The most common non-infectious disease has been ruled out in captive elephants owing to mineral and vitamin deficiencies followed by metabolic disorders. Therefore to overcome such diseases burden is important, it will not only ruled out the possibilities of non-infectious diseases, but sometimes important for avoiding infectious disease by supplementary the nutritional food and regular balance diet to captive elephants.

Keywords: Asian elephants, nutrition, management, vitamin, deficiency

1. Introduction
Elephants are known as the largest terrestrial animal on the earth and can live in a variety of habitat whilst naturally found in Asia (*Elephas maximus*) and Africa (*Loxodonta africana*). The Asian elephants spread over the Indian sub-continent including India, Bangladesh, Bhutan, Burma, China, Cambodia, Indonesia, Malaysia, Nepal, Sri Lanka, Thailand and Vietnam etc. They are enlisted under the threatened species of schedule-I of Wildlife Protection Act 1972. Taming of elephants in captivity in India began with Indus Valley Civilization for multifaceted assets. In the recent past, potentials of Asian Elephants have been also utilizing in the National Parks and Tiger Reserves for the success of wildlife conservation programme as they helps in the visit of distant places where vehicle mobility is not possible. Even for searching of apex species, restraining of wild animals for health monitoring, diseases diagnosis and other forest management oriented works, the assistance of captive elephants has been utilizing since wildlife conservation programme was launched in India.
(Shrivastav, 2015) [17]. Elephants live in a herd and cooperate with each family member for their survival and struggle for the existence. Some time they becomes problematic leading to stress, behavioral changes and limitations of feed availability, thus suffers with nutritional deficiencies and metabolic diseases. Hence, their nutritional management is the need of hours for better understanding of their strength and ability.

2. Elephants: Digestive system
The digestive system of the elephant is similar to that of the domestic horse (Clauss, 2007) [7]. The saliva composition, which plays an essential role during initiation of digestion in mammals. Saliva is mainly released by the three major glands (parotid, submandibular, and sublingual). Salivary enzymes, i.e., lysozyme and peroxidase**,** in both elephant species are lacking. Urea, glucose, and creatinine are present in the saliva of African elephants, but, sodium and albumin are absent. (Boehlke *et al*. 2016) [3]
The elephant has a separate distensible pharyngeal pouch that terminates into sphincter from which it can control the flow of food or fluid into the esophagus (Shoshani, 2000) [16]. The liver is large, and there is no gall bladder. (Fowler, 1986) [9]. Total length of intestine in Asian elephant (33 m) is longer than African elephant (19.6 m) In elephants, enzymatic digestion of grasses and browses material even takes place in the small intestine. Stomach and esophagus of elephants are similar to those in mono-gastric species like human and pig (Owen-Smith, 1988) [14].

Aswegen (1994) [1] observed, in elephants, mucosa of the stomach bears endocrine cells that are immunoreactive to gastrin, somatostatin, chromogranin A and serotonine. In the stomach, absence of glucagons cells and presence of immune-reactive endocrine cells are in contrast to other mammals. Auboiron (1995) [2] studied that, those animals in which gut bacteria hydrogenate dietary fatty acids before lipid absorption have a lower proportion of polyunsaturated fatty acids in their body lipids. Similarly, Asian elephants seem to have a lower proportion of polyunsaturated fatty acids in their spermatozoa and blood cells than African elephants due to longer retention of the ingesta in a longer small intestine with bacterial activity (Clauss *et al.*, 2003) [4].

Recently, by the IImberger (2014) [11], a metagenomic survey of the fecal microbiota of a breast- and a plant-fed Asian elephant was done which reveals high diversity of glycoside hydrolase family enzymes. They observerd that, GH2 family enzymes (ß-galactocydase) is most likely linked to the breast-feeding and the high contents of lactose in the mothers' milk. But, metagenome sequencing in other age group of elephants revealed a very high GH diversity including bacteroidetes and firmicutes which are mainly responsible for the degradation of cellulose in hind gut of elephant.

The young elephant calves eating the stool of their mother or other adult females by which the young one's digestive system develops to its full potentials. The elephants have well developed caecums which help them to derive the benefit of microbial digestion of the ingesta. Elephants pick up these healthy microorganisms from the dung of their mothers (Sarma, 2011) [15]. After absorption of nutrients through small intestine, undigested excreta defecate by elephants up to 20 times daily, with 4 – 6 boluses per defecation (Sukumar, 1990) [18].

3. Suggested Guidelines for Feeding By Central Zoo Authority

Concentrates should not be fed as the first meal of the day. First meal of the day may be cultivated cereal fodder. Concentrates may be fed during noon/afternoon. High moisture feed may be fed any time, particularly during night.

1. Elephants are very prone to obesity. Body condition should be regularly monitored. Each animal should be fed individually (at least concentrate portion).
2. Grasses should be the main component of elephant diet. Leguminous fodder may be included in the diet of young animals to increase the protein content of the diet. Low calorie roughages like reed grass banana stem may be fed ad lib.
3. For sub-adult should include pulse and cereals in 2:1 ratio, which could be supplemented with 100 g of common salt and 50 g of rock salt. For adult elephants, the ratio of pulses: cereals could be just reverse at 1:2
4. Growing animals require more protein and other nutrients in comparison to adult animals. Hence, proportion of concentrates should be higher in the diet of growing elephants.
5. A calf diet may contain 30% of concentrates on dry matter basis, whereas, 10% of concentrates in the diet of adult elephant is sufficient of meet nutrient requirements.

Table 1: Requirement of Green fodder and concentrates

S. No.	Body weight (kg)	Green fodder (25% DM)	Concentrates (90% DM)
1.	500	35 kg	3 kg
2.	1000	70 kg	4 kg
3.	1500	90 kg	5 kg
4.	2500	135 kg	5 kg
5.	3000	165 kg	5 kg
6.	3500	200 kg	5.5 kg
7.	4000	225	6 Kg

3.1 Feeding of orphaned neonates

Birth weight of Asiatic elephant ranges from 90-110 kg. They are dependent on milk unto 2 years of age and often suckle till the age of 4 or 5 year.

Table 2: Composition of the Asian Elephant cow's milk

Contains	Mainka *et al.*, 1994	Milk formula (Enfamil)
Total solid	19.7%	12.5%
Fat	7.6%	3.7%
Protein	3.4%	1.5%
Sugar	8.7%	7.0%

Colostrum feeding is very important. If the calf has been rejected within 24 hours of birth and have not suckled colostrums, severe immune-compromise would happen. Bovine milk contains fatty acids which are longer in chain length. Elephant milk contains several shorter chain fatty acid which are similar to coconut (Das, 2013) [8]. Till 3 month of age fed should be 2 hourly intervals, gradually shifted to a 3 hourly interval, 4-6 months of age solid foods are introduced, barley+ oat+ shredded coconut, shifted to cereals+ coconut, at 5 years of age the keeper should encourage the calf to eat green grasses.

3.2 Nutritional care of Musth Elephant

When in musth, the mahouts cool the elephant by spraying water on its body. After musth, elephants are provided with a special diet, to improve their health. 3kg of gingelly and Jaggery mixed together can be fed to the elephant after musth, to improve its health. While under medication, the animal must not be allowed to work. Another mixture consisting of gingelly, a certain variety of fish, small onions can be given for five days. This helps in improving vigour. Gingelly must be used in small quantities only, otherwise it can raise body temperature. (Shrivastav, 2015) [17].

Nutritional care of Pregnant Elephant

Table 3: Proposed minimum nutrient concentration (DM basis) in elephant diets

S. No.	Nutrient	Maintenance, breeding, early pregnancy	Late pregnancy	Lactation	Growth of juveniles
1.	Crude protein%	8-10	12	12-14	12-14
2.	Lysine%	0.3	0.4	0.4-0.5	0.5-0.6
3.	Ca%	0.3	0.5	0.5	0.5-0.7
4.	P%	0.2	0.3	0.3	0.3-0.4
5.	Mg%	0.1	0.1	0.1	0.1
6.	K%	0.4	0.4	0.5	0.4
7.	Na%	0.1	0.1	0.1	0.1
8.	S%	0.15	0.15	0.15	0.15
9.	Iron, ppm	50	50	50	50
10.	Cu, ppm	10	10	10	10
11.	Mn, ppm	40	40	40	40
12.	Zn, ppm	40	40	40	40
13.	Co, ppm	0.1	0.1	0.1	0.1
14.	I, ppm	0.6	0.6	0.6	0.6
15.	Se, ppm	0.2	0.2	0.2	0.2
16.	Vitamin A, IU/Kg	3,000	3,000	3,000	3,000
17.	Vitamin D, IU/Kg	800	800	800	800
18.	Vitamin E, IU/Kg	100	100	100	100
19.	Thiamin, ppm	3	3	3	3
20.	Riboflavin, ppm	3	3	3	3

Adult maintenance, 8% CP, Breeding bull, pregnant cow (1st two-thirds of pregnancy), 10% CP First year of lactation, 14% CP, 2nd year of lactation, 12% CP Weanling, 14% CP, 3-year-old, 13% CP, 4-year-old to 12-year-old, 12% CP (Clauss, 2007) [7]

3.4 Geriatric care

3.4.1 Observation of teeth

Asian elephant get more problems than Africans on the whole life, mainly because of teeth transition. Asian elephants teeth as they get older they tend to fill up the mouth creating mastication issues at the plain of occlusion, that's where the teeth meet on the cutting face. The bigger the teeth there seems to be less space inside the mouth for chewing and moving food around, now if the teeth are bent like the elephant to the left, the cutting edges are less effective and that means less nutrition to the elephant, which normally only has a 45% digestion rate (Clauss, 2007) [7].

African elephants tend to have less tooth problems because the teeth transition is different and the teeth are cast with less root attached making them easier to remove when it is time to fall out.

3.4.2 Observation of feacal bolus length

Elephant becomes older the size of the boluses can have a critical effect on its health, slow gut transit time, large bolus, lack of exercise an elephant can develop colic and have real trouble with stomach pains. At this point should not introduce too many fibrous plants like palm or banana tree trunks; it has a way of binding and blocking (Sarma, 2011) [15]

4. Nutritional deficiency diseases

1. Calcium-Vitamin D Metabolism Imbalance

> Rickets (In young calves), fibrous osteodystrophy (adult female) Osteomalacia (adult)**,** hypocalcaemia tetany in Elephants

2. Iron deficiency anemia in Elephants

> Deficiency of iron due to inadequate iron in the diet and lack of access to iron- containing water or soil, anaemia may also occur secondary to other diseases such as gastrointestinal parasitic infections, liver fluke infection and salmonellosis in elephants. Iron deficiency anaemia has been reported in both growing and adult elephants.

3. Scurvy in Elephants (Vitamin C deficiency)

> It has been reported that, compared to cows' milk, elephant milk contains four times the level of vitamin C.

4. Vitamin E - Selenium Deficiency

5. Zinc Deficiency (Nutritional dermatitis)

Zinc deficiency in elephants has been associated with possible secondary immune deficiency and epidermal lesions such as hyperkeratosis and vesicles

5. Common metabolic disorders reported in captive Asian Elephants

1. Glucose-insulin ratio and leptin foot and musculoskeletal conditions, reproductive acyclicity, obesity, stress
2. Protein Excess in Growing Elephants
3. Fatty acid imbalance

6. Conclusion

Nutritional management of captive elephants is very important for their health and survival of other wild species. So it is necessary to keep healthy and happy environment for elephants in captivity.

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