

## Abstract

The study was conducted in order to comprehend the diverse feeding practice of common wild herbivores in Bangladesh National Zoo, Mirpur, Dhaka and Bangabandhu Sheikh Mujib Safari Park, Cox's Bazar, Chattogram. We collected data for Asian Elephant (*Elephas maximus*), Hippopotamus (*Hippopotamus amphibious*), Spotted Deer (*Axis axis*), Barking Deer (*Muntiacus muntjak*), Gaur (*Bos gaurs*) and Zebra (*Equus burchellii*). Through visiting zoo and safari park, feeding habit and feeding behavior was closely observed. Data collection was done through previously made open ended questionnaire, by face-to-face communication as well as via phone. We made an interactive conversation with animal caretaker, staffs and officers. At Bangladesh National Zoo, wild herbivores provided green grass, spinach, fruits, vegetables as roughage and maize bran, soybean meal, chickpea, salt, minerals, toxin binder, DCP were mixed together to form a concentrate mixture. To determine the nutritional value of concentrate mixture, feed samples were collected into zipper bag directly before providing to the animals. Concentrate mixture was analyzed at Animal nutrition laboratory, CVASU. The feed sample has 77.57% dry matter (DM), 3.79% crude protein (CP), 6.56% crude fiber (CF), 22.43% moisture and 18.4% ash. On the other hand, at Bangabandhu Sheikh Mujib Safari Park, they rely on nature for roughage supply and through grazing the wild herbivores maintain their intrinsic habit. Although the Asian elephants get extra vegetables, banana trees, ripen banana and Zebras get carrot treat. In some herbivores- maize bran, crushed corn, salt etc. is provided in a supplementary grain mixture. Zoo herbivores get inefficient opportunity of grazing compared to those herbivores in safari park.

**Keywords:** Wild herbivores, Feeding, Nutrition, Zoo, Safari Park.

## Chapter 1: Introduction

Bangladesh has a rich biological heritage of being located in the subtropical region at the confluence of the Indo-Himalayas and Indo-China sub-regions of the Oriental region (Khan et al., 2008). In an area of about 1,47,570 square km, Bangladesh has almost 34 species of amphibians, 109 species of reptiles, 301 species of resident birds, 176 species of migratory birds, 30 species of birds went extirpated, 120 species of inland mammals, and 3 species of marine mammals (Banglapedia., 2021). Wild fauna (amphibia to mammalia) of Bangladesh constitutes about 3.5% of the entire wildlife in the world (Khan et al., 2008; Islam et al., 2018).

Mostly people think about zoos and safari parks as places for relaxation and recreation only, but now these have become places for wildlife conservation (Khan et al., 2014). In safari parks, wild animals are accommodated to wander freely in an environment having resemblance to their natural dwelling and are observed by visitors riding in the park through specific vehicles. Whereas, in zoos, animals are kept in perimeters, completely different from their natural habitat (Pritchard et al., 2012). These are playing a vital role to enhance animal numbers through captive breeding (Khan et al., 2014). Threatened species are by and large incapable of surviving in their current, altered natural environments, many conservation programs require to preserve them through ex-situ conservation techniques (captive breeding) prior to reintroduction them into the wild. Captive breeding provides species with a benign and static environment (Robert et al., 2009). In Bangladesh, these are regarded as important tourism spot where different wild animals and birds are exhibited. Safari Park concept in Bangladesh considered as a revenue root for government. It is, however, resource to students as well as researchers (Hossen et al., 2014).

Herbivore is, a plant-eating animal, usually do not eat just any grower. For example, if a deer, which is wont to eat forbs and browse, is forced to eat large amounts of forage, it will possibly not perform as well as deer that eat forbs and browse. Depending on their mouth parts and the anatomical structure of their digestive system, there are different types of diet for herbivores. A sound understanding of what range herbivores eat and why will help the caretaker of animal to choose the feed resource wisely and enable the animals to live a healthy life (Lyons et al., 1996). In natural environment wild species have mediocre need for supplementary feeding as their free ranging habits enable them to pursue more nutritious grazing and therefore fulfill their

requirements. With the appearance of game forming wild animals have been restricted in limited areas and this has. In the zoo, their total feed requirements have to be met (Roosendaal, B., 1973). Feeding knowledge of wildlife is significant cause, the concept of biological carrying capacity (BCC) is an elementary principle of model wildlife management. In order to regulate wildlife population, wildlife managers' always focus on the quality, quantity and distribution of food, cover, water. These are the factors of environmental resistance limiting wildlife demography related with biological carrying capacity (Decker et al., 1998).

Studying herbivore's feeding is important because, they are often an important source of revenue through ecotourism (Barnes et al., 1999; Ogutu et al., 2002). While economic factors have driven research in domestic animal nutrition, no such factors exist to encourage the studies of nutritional requirements of zoo animals (Allen et al., 1995). Wild animals are forced to make considerable adjustments to captivity in all aspects of life, and limitations of domesticated animal models should be recognized and explored. There exists a dire need to enhance utilization of knowledge on food habits of wild animals acquired by field biologists, in effort to flourish zoo animal husbandry (Kawata, K., 2008).

### **Objectives:**

- To find out the variations of the diets of zoo and safari park's herbivores in Bangladesh.
- To develop insight about feeding practices of wild herbivores in zoo and safari park.

## Chapter 2: Materials and Methods

### 2.1. Study location:

The study was carried out in two different areas of Bangladesh. Due to easy access to following zoo and safari park those locations were chosen. One of them is Bangladesh National Zoo, Mirpur, Dhaka and another one is Bangabandhu Sheikh Mujib Safari Park, Dulahazra, Cox's Bazar, Chattogram. The study was conducted for 60 days, from 5, September 2021 to 5, November 2021.

### 2.2. Study Population:

There are 6 common herbivores species in Seikh Mujib Safari Park and Bangladesh National Zoo during the study period. These are Asian Elephant (*Elephas maximus*), Hippopotamus (*Hippopotamus amphibious*), Spotted Deer (*Axis axis*), Barking Deer(*Muntiacus muntjak*), Gaur (*Bos gaurs*) and Zebra (*Equus burchellii*).

**Table 1: Common herbivores population at Bangabandhu Sheikh Mujib Safari Park and Bangladesh National Zoo.**

Species	No. of animals at Bangladesh National Zoo, Mirpur,Dhaka	No. of animals at Bangabandhu Seikh Mujib Safari Park, Cox's Bazar, Chattogram
1.Asian Elephant ( <i>Elephas maximus</i> )	5	6
2.Hippopotamus ( <i>Hippopotamus amphibious</i> )	13	10
3. Spotted Deer ( <i>Axis axis</i> )	326	48
4. Barking Deer( <i>Muntiacus muntjak</i> )	9	12
5. Gaur ( <i>Bos gaurs</i> )	3	9
6. Zebra ( <i>Equus burchellii</i> )	7	4

The study was carried out on the feeding management of eleven (11) Asian elephants, twenty three (23) Hippopotamus, three hundred seventy four (374) Spotted Deer, twenty two (22) Barking Deer, twelve (12) Gaur and eleven (11) Zebra in total.

### **2.3. Data collection:**

An open-ended questionnaire was established in order to collect data from Bangladesh National Zoo, Mirpur, Dhaka and Bangabandhu Seikh Mujib Safari Park, Cox's Bazar, Chattogram. Through visiting the places and observing wild herbivores- their preferences were noticed. After interviewing the animal caretakers and staffs more detail data about the feeding practice was noted down (figure 1.1).

### **2.4. Feed sample collection:**

Using random sampling techniques, the feed samples were collected from Zoo (figure 1.2). Approximately 250 grams of concentrate were preserved in a zip lock plastic bag and stored in -20°C for further chemical analysis.

### **2.5. Preparation of sample:**

Dried concentrate mixture samples were subjected to grinding to make it homogenous. Later on, it was mixed properly and exposed to shade tend cool down for analysis.

### **2.6. Proximate Analysis of sample:**

Chemical analyses of the samples were carried for dry matter (DM), crude protein (CP), crude fiber (CF), moisture and ash is done in the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chattogram , Bangladesh.

#### **2.6.1. Calculation of Dry Matter (DM):**

After taking the weight of empty crucible, grinded concentrate mixture was measure and put on that crucible. After drying in hot air oven at 105°C for (48-72 hours) the crucible's weight with dried sample was measured again.

$$\% \text{ Moisture} = (W - W1) * 100 / W2$$

Here,

W = Weight of empty crucible

W1= Weight of crucible with dried sample

W2= Weight of sample

So, DM = 100 - %Moisture

### **2.6.2. Calculation of Crude Protein (CP):**

The sample (0.2gm) was digested with concentrated H<sub>2</sub>SO<sub>4</sub> and digestion mixture up to clear green residue. Then distillation with 40% NaOH to entrap NH<sub>3</sub> in 2% boric acid solution. After that, titration was done with 0.1N HCl solution.

$$\%CP = (A*B*0.014*6.25*100)/W$$

Here,

A= Volume of standard N/10 HCl solution

B= Normality of standard HCl solution

W= Weight of sample

### **2.6.3. Calculation of Crude Fiber (CF):**

The sample (2gm) was boiled in acid for 30 minutes with 1.25% H<sub>2</sub>SO<sub>4</sub> at constant volume. Then alkali boiling for 30 minutes with 1.25% NaOH at constant volume. Then burning in heater followed by ignition in muffle furnace for 4- 6 hours.

$$\%CF = (W-W1)*100/W2$$

Here,

W= Weight of crucible, crude fiber and ash

W1= Weight of crucible and ash

W2= Weight of sample

### **2.6.4. Calculation of Ash:**

Sample was dried and burnt in the electric heater within crucible at 150-200°C up to no smoke. Then ignition of dried sample in muffle furnace at 550-600°C for 4-6 hours up to white ash.

$$\% \text{ Ash} = (W-W1)*100/W2$$

Here,

W= Weight of crucible and ash

W1= Weight of crucible

W2= Weight of sample



**Figure 1.1:** Data collection from animal caretaker.



**Figure 1.2:** Feed sample collection from Bangladesh National Zoo, Mirpur, Dhaka.

### Chapter 3: Results

Bangladesh National Zoo's wild herbivores (large) are fed once in a day. Within 10:00 am all feed (concentrate mixture and roughages) are served. Sufficient water supply in different cages and cleaning of waterers is ensured daily by the ACTs (Animal Care Taker).

**Table 2 : Different amount of concentrate mixture and roughage supplies in Bangladesh National Zoo.**

Feed Ingredients	Asian Elephant	Hippopotamus	Spotted Deer	Barking Deer	Gaur	Zebra
	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/animal/day	Amount of feed(kg)/ animal/day
1. Concentrate Mixture	-	7	0.5	2	9.33	2.42
2. Chickpea	2.5	0.15	0.16	0.27	1.33	0.57
3. Green grass	70	40.38	3.07	4.05	50	21.43
4. Banana	6	0.03	1.0	1.0	1.67	-
5. Spinach	-	13.85	1.79	1.50	-	-
6. Vegetables (Gourd, Pumpkin, Cucumber)	28	4.62	1.15	1.00	1	-
7. Banana tree	100	-	-	-	-	-



**Table 3 : Concentrate mixture elements in large herbivores feed at Bangladesh National Zoo.**

Elements	Hippopotamus	Spotted Deer	Barking Deer	Gaur	Zebra
	Feed(kg)/ animal/day	Feed(kg)/ animal/day	Feed(kg)/ animal/day	Feed(kg)/day animal/day	Feed(kg)/ animal/day
Maize bran	5.30	0.43	1.5	6.9	1.82
Soybean meal	1.67	0.14	0.46	2.17	0.56
Salt	0.048	0.004	0.013	0.063	0.015
Vitamin	0.025	0.002	0.0067	0.03	0.0085
DCP	0.048	0.004	0.013	0.063	0.015
Toxin binder	0.002	0.0002	0.0006	0.0033	0.0009
Chickpea	0.15	0.16	0.27	1.33	0.57
<b>Total</b>	7.23	0.74	2.27	10.66	3

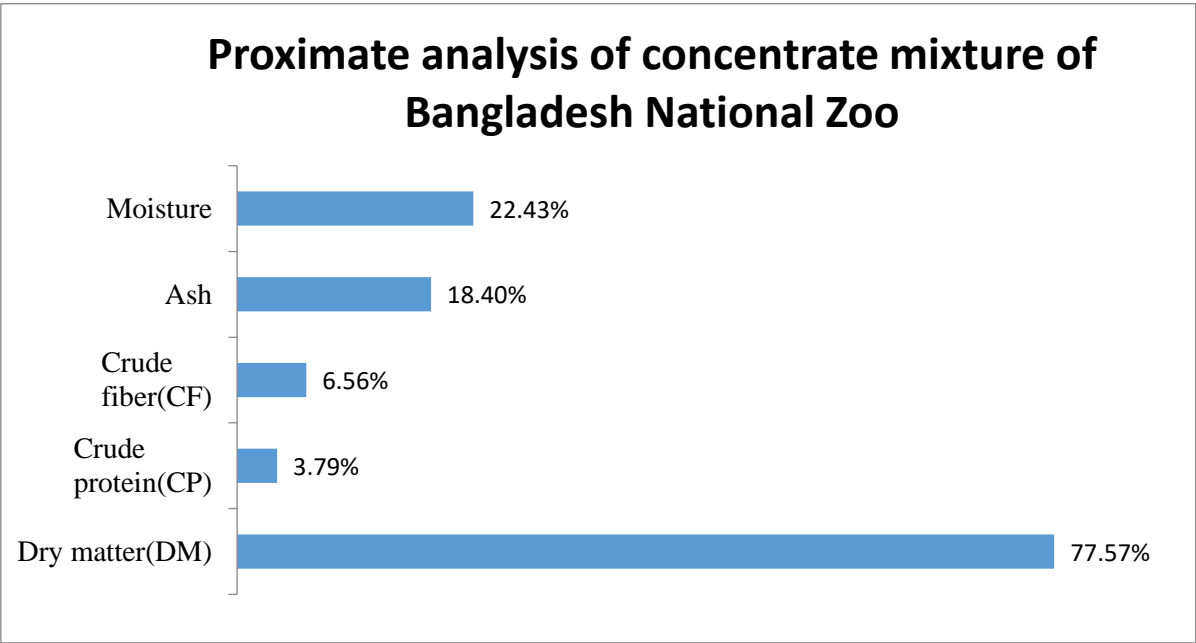
In Bangabandhu Sheikh Mujib Safari Park, all wild herbivores (large) are provided extra concentrate feed supply from the authority. They are kept in a huge area. Where they have sufficient roughages to consume by grazing. In terms of one 10 months old Elephant baby they supply Lactogen 1 (350 grams with 2 litter clean water) and provide it 7 times in a day (3 hours interval). It also consume 50 ripe bananas/day and very small amount of Gruel. Among these animals only Hippopotamus prefer water loving grass, which are provided directly by the stuffs. Elephants are more likely to have low land grasses only. Others prefer slidely higher area grasses. Commonly Durba (*Cynodon dactylon*) and Para (*Brachiaria mutica*) grasses are available in every enclosure in safari park. Specific grass or any other roughages cultivation is not done there. Though all animals get opportunity to graze freely and maintain their natural activity of grazing. Sometimes monthly vitamins and toxin binders are added with feed. Both in zoo and safari park deworming is done in every 3 months and the helminthicide is generally mixed with concentrate mixture or through fruit is given to the animals.

**Table 4 : Different amount of roughage supplies in Bangabandhu Sheikh Mujib Safari Park.**

<b>Ingredients</b>	<b>Asian Elephant</b>	<b>Hippopotamus</b>	<b>Spotted Deer</b>	<b>Barking Deer</b>	<b>Gaur</b>	<b>Zebra</b>
	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ animal/day	Amount of feed(kg)/ Animal/day
1.Green grass	Low land grazing	50	Graze in 3 acre	Graze in 0.5 acre	Graze in 70 acre	Graze in 100 acre
2.Vegetables (Gourd, Pumpkin, Cucumber, Cowpea)	30	-	-	-	-	-
3.Banana tree	250	-	-	-	-	-
4.Fruit	5 (banana)					2.5 (carrot)

**Table 5 : Different amount of concentrate supplies in Bangabandhu Sheikh Mujib Safari Park.**

<b>Elements</b>	<b>Asian Elephant</b>	<b>Hippopotamus</b>	<b>Spotted Deer</b>	<b>Barking Deer</b>	<b>Gaur</b>	<b>Zebra</b>
	Amount of feed(kg)/ animal/ day	Amount of feed(kg)/ animal /day	Amount of feed(kg)/ animal/ day	Amount of feed(kg/ animal/ day	Amount of feed(kg/ animal/ day	Amount of feed(kg/ Animal /day
1.Maize bran	10	12	2	1	3.89	7.5
2.Crushed Corn	-	-	-	-	0.55	1.25
3. Salt	0.20	0.40	-	-	0.10	0.075
4.Molasses	0.5	-	-	-	-	-



**Figure 2.1:** Proximate analysis of concentrate mixture provided to wild herbivores at Bangladesh National Zoo, Mirpur, Dhaka.

Through chemical analysis the concentrate mixture which is provided to herbivores in Bangladesh National Zoo is found out containing 77.57% dry matter (DM), 3.79% crude protein (CP), 6.56% crude fiber (CF), 22.43% moisture and 18.4% ash.

## Chapter 4: Discussion

Through our study we find out that, in Bangladesh National Zoo only chickpea (*Cicer arietinum*) is provided as supplementary diet to the captive elephants and the roughage choices are- elephant grass (*Ochlandra* sp.), banana tree (*Musa* sp.) , spinach (*Spinacia oleracea*), ripe banana and in vegetables (Gourd, Pumpkin, Cucumber etc.) are generally supplied (Table-2). In 2008, through a research Vanitha state that- captive Asian elephants in Tamil Nadu, India were provided with (i) cut fodder of green grass and browse (leaves of trees and shrubs) as stall feeding, (ii) supplementary diets of grains, millets and pulses in boiled form (Vanitha et al., 2008) which is somewhat different than the feeding management in Bangladesh National Zoo. Tamil Nadu Forest Department's captive Elephants are supplied- elephant grass (*Ochlandra* sp.), sugarcane (*Saccharum officinarum*), banyan tree leaves (*Ficus bengalensis*), coconut leaves (*Cocos nucifera*), bamboo leaves (*Bambusa arundinacea*) etc. as roughage and for an adult elephant they ensure 19 kg supplementary grain/day/elephant which consists of cooked rice, finger millet, horse gram and lentil (Vanitha et al., 2008). At Saint Louis Zoo, USA they serve hay, tree, shrubs, carrots, apples, and bananas; less-commonly melons, pineapples, pears, celery, parsley, lettuce, cabbage, tomatoes, potatoes, onions, and beets, salt, minerals to their captive elephant (stlzoo.org., 2021) which actually have some similarities with the type of diet stocked in Bangladesh National Zoo. After conducting the study, we can see at Bangabandhu Sheikh Mujib Safari Park, Bangladesh- supplementary grain, molasses, green grass, Banana tree, salt, gourd, cucumber, pumpkin, cowpea is given (Table 3, 4) to their free ranging elephants. They are also open for loose grazing if they want to. At other safari parks like- San Diego Safari Park, USA elephants are provided around 57 kg feed/day/animal , which is less than other elephants because they do not need to find their feed and burn calories. They offer hay, herbivore pellets, acacia browse, celery, cucumbers, and lettuce daily (sandiegozoo.org., 2021).

According to our study, Bangladesh national zoo captive hippos eat grain supplements, salt, grass, gourd, pumpkin, spinach (Table 3,4) where in 2021 Andrea Boldt uphold that- captive Hippopotamus eat a combination of different plants including hay, alfalfa and lettuce. On special occasions, hippos may get pumpkins or melons as a treat. Zoos provide hippos with special vegetarian pellets that fulfill their nutritional needs (Andrea Boldt et al., 2021). San Diego Wildlife Alliance Nutrition (SDWAN) state that, Hippos always graze and forage on land;

consume negligible amount of aquatic plants. They spend whole day in water, night on land grazing 5-6 hours. Usually remain near (1-3 km) to home watercourse during nighttime feeding. Short creeping grass species are preferable for hippos because that can be grasped with lips. Plant species in diet include: *Cynodon*, *Panicum*, *Heteropogon*, *Sporobolus*, *Themeda*, *Digitaria*, *Eriochloa*, *Tragus*, *Brachiaria*, *Urochloa*, *Chloris*, *Setaria*, *Cyperus* . They consume approximately 1-1.5 % of body weight per day. Adult hippo consume 25-40 kg vegetation/day. At Bangabandhu Sheikh Mujib safari park there is no vegetation for hippos, that's why water loving grasses are artificially provided 50kg/animal/day with maize bran 12 kg/animal/day (Table 4,5).

In 2012 Khadha aver that- Central Zoo, Jawalakhel, Nepal they provide 259 gm corn,100 gm soybean meal, 400 gm wheat bran, 0.2 gm minerals, 200 gram hay,200 gram leaves and 2.5kg grass/deer/day (Khadka, B., 2012). In Bangladesh National Zoo, Dhaka they serve 430 gm maize bran, 140 gm soybean meal, 160 gm chickpea, 60 gm vitamin & minerals, 3.07 kg green grass, 1.79 kg spinach, 1.15 kg vegetables/deer/day (Table 2,3). They approximately calculate this, on the basis of average 50kg weight/deer.

Dryden & G.M reported that for deer ~4–9% diet protein is adequate for maintenance and 16–22% for production (Dryden & G.M et al., 2011) where in National Zoo, Bangladesh the amount of CP provided through dry ingredients is 3.79% (figure 2.1). Concentrate mixture should be supplemented with a balanced mineral mixture 2% (Dryden & G.M et al., 2011) which is maintained 1% in zoo but in safari park Deers depend on grazing and only maize bran concentrate is supplied regularly.

Gaurs have extremely variable diets. They are herbivores, but it can consume an immensely wide variety of plants. They are grazers of grass, and browsers of leaves and shrubs (animalsnetwork.org., 2021). Gaur generally depends on fruits, leaves, young shoots, bark and flowers, with a preference for leaves (87%). In summer gaur also consumed the bark of cashew (*Anacardium occidentale*) and teak (*Tectona grandis*) trees. (Gad, S.D. and Shyama, S.K et al., 2009). Different types of foods they eat are fruit, grass, leaves, stems, seeds, flowers, and more.

While they do show preference for some types of plants over others, this usually varies by season. In the wild they eat a wide variety of vegetation. Because of this, zookeepers feed them pellet feed, hay, and a wide variety of plants (animalsnetwork.org., 2021) where in our country at zoo, grains with banana and vegetables are provided. On the other hand safari parks allow them to depend on grazing mainly and only provide maize bran, crushed corn.

Research shows that- grass is the main source of energy for Zebra. 90% of their diet is just grass the 10% can be herbs, roots, aquatic vegetation, leaves, or legumes (equinedesire.com., 2021). Zoo food is completely diverse from what zebras eat in the wild. While wild zebras graze throughout the day, in captivity they usually only eat once a day. The reason they don't have to feed throughout the day is that the Timothy hay (special zoo food) is higher in nutrients. They are also fed special pellets which contain added nutrients and supplements to keep them healthy. Zoos also provide a salt lick, which they can lick on whenever they please. In the wild, zebras feast on a lot of grass rich in salt. They are also often given treats like carrots, apples, and sugar cubes (africafreak.com.,2021).Through this study we discovered that at National Zoo, Zebras are feed on green grass and concentrate mixture, but no timothy hay and pellets are not provided. Though salt, minerals, toxin binders are provided regularly (Table 2,3). For Zebras CP content of the diet is maintained lower than 5% (equinedesire.com., 2021) which is nearly 4% in National Zoo, Bangladesh. Zebras at the San Diego Zoo, USA and the San Diego Zoo Safari Park are fed hay, alfalfa, and carrots (sandiegozoo.org., 2021) where in Bangabandhu Sheikh Mujib Safari Park carrot treat and whole day grazing in a huge area is ensured properly (Table 4).

## Conclusion

There is no doubt that, the feeding practice in Zoo and Safari Park is greatly different from each other. We collected data for Asian Elephant (*Elephas maximus*), Hippopotamus (*Hippopotamus amphibious*), Spotted Deer (*Axis axis*), Barking Deer (*Muntiacus muntjak*), Gaur (*Bos gaurs*) and Zebra (*Equus burchellii*). In zoo there is no opportunity to rely on nature for the roughage supply of wild herbivores. Though in wild their natural is to find their own feed through grazing, this behavior is unimpaired at safari park. Compared to safari park the enclosure area is smaller, more gathered and chaotic. Wild herbivores can graze in day time as much as they prefer but proper planned plantation can make their feeding management more efficient. Due to some lacking in feeding practice, special treats for safari park animals are not ensured in our country where in zoo supplementary nutrition is absolutely to the point. Comparing these two areas it can be said that- considering wild animals well-being the safari park maintain a good feeding practice and in zoo, feed ingredients are perfectly balanced, which fulfill the requirements of those animals at captivity.

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## **Biography**

Myself, Mir Nishat Tasnim Tania, daughter of A. T. M. Golam Kibria and Khurshida Begum. I was born on 10<sup>th</sup> October, 1997. My home district is Rangunia, Chattogram. I passed my Secondary School Certificate examination in 2013 and gained GPA 5.00. I have completed my Higher Secondary Certificate in 2015 from Bangladesh Women's Association Girl's High School & College, Chattogram, where I achieved GPA 5.00. As my father worked for Bangladesh Forest Department, from my childhood I had a hidden desire to work with Wildlife. I keep interest in volunteering, blood donation, painting, recitation, anchoring, photography etc. other than my academic. In future I would like to work for the well being of animals and peruse my dream career as a practitioner & researcher.

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