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# Comparison of cortisol level in Asian elephants of different tiger reserves of Madhya Pradesh

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**Abstract**
The park elephants of different tiger reserves including Kanha, Panna and Bandhavgarh were incorporated for the assessment of cortisol levels in male, female and sub-adults groups. Overall cortisol level obtained 234.2 ng/g, 250.8 ng/g, 232.2 ng/g in Kanha tiger reserve, Panna tiger reserve and Bandhavgarh tiger reserve respectively. Out of 30 elephants, male and female shows no difference in level of cortisol however age wise assessment of cortisol level shows calves have least stress rather than adults and sub-adults.

**Keywords:** Fecal cortisol, park elephants, stress evaluation, tiger reserves, central India

## 1. Introduction
The Asian elephant an endangered species occurs in south and south-east Asia, with a population estimated between 40,000 and 50,000 individuals (IUCN, 2008) [9]. Elephant populations have continued to decline for centuries in most of their range, especially in south-east Asia, due to loss, degradation, and fragmentation of their habitat, and poaching (Sukumar, 2003 and Vidya, 2005) [15, 19]. However, the south Indian populations in the Western Ghats are increasing in some areas due to effective conservation measures (Bhaskaran, 2013) [1]. Although elephants are an integral part of culture and civilization, still hundreds of elephants are being killed every year due to conflicts with humans. About 14,000 to 16,000 (22% to 30%) Asian elephants live in captivity (Vidya, 2005) [19], and these elephants are used extensively for logging, patrolling, tourism, and religious activities. Captive populations continue to decline due to failure in reproduction, diseases, and poor husbandry practices (Brown, 2004 and Kumar, 2014) [3, 10]. Traditionally mahouts (elephant trainer, rider, and keeper) manage the captive elephants, however the skills and quality of mahouts have declined due to reduced monetary benefits which affect the welfare and management of captive elephants (Vanitha, 2011) [16]. Further, increased use of non-traditional or unskilled and inexperienced mahouts leads to physiological and psychological stress, which in turn makes the animals violent, and these violent animals could cause human casualties (Varma, 2009) [17]. In India, no detailed information is available on the physiological responses of captive Asian elephants with reference to various husbandry practices and working conditions except one study in three Indian zoos (Kumar, 2014) [10]. We hypothesize that poor welfare conditions and husbandry practices including different working conditions have a direct impact on the physiological status of captive Asian elephants, especially resulting in an increase in stress hormones. Glucocorticoids, the stress hormone, are released in the system to increase fitness through energy generation for the short-term; however a prolonged higher concentration of stress hormones is known to affect reproduction, immunity and growth (Charbonnel, 2008) [4]. Faecal cortisol metabolites have been identified as an indicator of stress in animals as it provides more accurate assessment of long term glucocorticoids over a time period, rather than other excretory or secretory products (Harper and Austad, 2000) [8]. However, many captive and wild populations of endangered species keeping without taking care of their social behaviour and basic instincts thus stress condition evolved leading to aggression effects metabolism. Thus, faecal cortisol metabolites being useful to identify factors affecting animal well beings in captivity (Bayazit, 2009) [2]. The Asian Elephants (*Elephas maximus*) have strong affinity to acquire taming characters hence they are utilizing for transportation and

vehicle for reaching distance places or forest hills. Captive elephants are known to be agility and active participation in wildlife health conservation programmes as they help in restraining as well as searching of big cats in the protected and non-protected forests areas (Shrivastav and Singh, 2017) [3]. However, extensive work load and restless conditions followed by shrinking feed resources and increased parasitic infections may lead to high rise of stress level in the captive elephants (Fowler and Mikota, 2006) [6]. It is also believed that stress may reduce diseases resistance as well as increase the aggression and non performing attitude in captive elephants (Millspaugh and Wasburn, 2004) [12]. Therefore, the present work is focused to analyse the functionaries and facts about stress conditions and their ill effects on body conditions.

## 2. Materials and methods

### 2.1 Selection of animals

Faecal samples were collected from 30 elephants including both the sex (male 14 and female 16) and different age group (calves 9, sub-adults 9, and adults 12) of elephants with the help of mahout and wildlife veterinary physician. Prior to collection of biological samples, history, physical and clinical observations along with feeding schedule in addition to body temperature, heart rate and respiration rate were recorded for comparing the stress levels in each elephant. Although there was not report any of the male elephant in musth and no females were pregnant during the study period. All the individuals were healthy and no medical issues were observed. Elephants in these facilities were kept with natural flooring.

### 2.2 Collection of faecal samples

Total number of 30 elephants selected for collection of dung sample from different tiger reserves. Dung samples from Kanha tiger reserve were collected during elephant camp 2018. In Bandhavgarh, the samples were collected on alternative days between April and May 2019, while samples in Panna tiger reserve were collected in December and May 2019. Details of elephant age/sex, number of samples collected and other information are given in Table 1. Dung samples were collected between 7:00 to 9:00 a.m. Since no laboratory or freezer (-20 ◦C) was available in the locations, freshly collected samples were air dried the same day using an oven at 60 ◦C-80 ◦C, pulverized, and stored in sealed containers at 4◦C. These samples were shifted to the freezer (--20C) within a week and stored until further analysis.

**Table 1:** Collection of biological samples from captive elephants of different tiger reserves Madhya Pradesh

| Name of Tiger Reserve | No. of animals | Age | | | Sex | | Biological samples | |
|---|---|---|---|---|---|---|---|---|
| | | *Calves (<5 years) | *Sub-adults (5-15years) | *Adults (>15years) | Male | Female | Blood | Dung |
| Kanha Tiger Reserve | 10 | 03 | 03 | 04 | 04 | 06 | 10 | 10 |
| Panna Tiger Reserve | 10 | 03 | 03 | 04 | 03 | 07 | 10 | 10 |
| Bandhavgarh Tiger Reserve | 10 | 03 | 03 | 04 | 07 | 03 | 10 | 10 |
| Total | 30 | 09 | 09 | 12 | 14 | 16 | 30 | 30 |

(*Sukumar, 1985)

### 2.3 Physical Activities

Elephants in Kanha, Bandhavgarh and Panna are regularly used for patrolling activities in the forests. Some elephants are subjected to do patrolling inside the park for about 4-5 h, mostly carrying two persons on their back.

### 2.4 Faecal cortisol level analysis

Faecal cortisol level was assessed by using commercially available ELISA diagnostic kits (Cortisol Enzyme Immunoassay Kit, Detect X, and ARBOR ASSAYS) with the help of ELISA reader according to the manufacturer's instructions.

### 2.5 Statistical analysis of data

Statistical analysis of data was carried out by using standard statistical procedure and interpretations were based on the finding as suggested by Snedecor and Cochran (1967).

## 3. Results and discussion

The mean cortisol metabolites were observed from Kanha tiger reserve, Panna tiger reserve and Bandhavgarh tiger reserve (234.2±27.4, 250.8±16.8 and 232.2±19.6 ng/gm) respectively. The level of cortisol metabolites were observed non-significant ($p$>0.05). Faecal cortisol metabolites have been identified as an index of stress in animals (Bayazit, 2009) [2]. The study showed that housing and nutritional management practices in different parks are similar with more or less, where seasonal variations may influence the adverse situation. Chichilichi *et al.* (2018) [5] emphasize that the nutrients deficiency during dry season leading to elevated glucocorticoids in wild elephants. Subsequently cortisol levels found elevated in winter than rainy season implying that winter season have more stressful situation then rainy season. However, in the present study the samples were collected in the summer season and the results envisaged that non-significant yield of cortisol levels in elephants of different tiger reserves. (table 02). The mean cortisol metabolites were observed in males and females (245.67±22.71 and 229.61±44.14 ng/gm) respectively, which was found non-significant (table 02). The study shows that sex wise difference may observe with the state of musth in males and during pregnancy in females. Ghosal *et al.* (2013) [7] observe cortisol level decreases during musth conditions and they shows aggression due to suppression of testosterone hormones secretion by glucocorticoids. On the other hand, the cortisol levels increases during the advance pregnancy period may lead to indicator of pregnancy diagnosis.

The mean cortisol metabolites were observed in calves, sub-adults and adults (189.99±92.96, 280.89±19.29 and 266.83±37.11 ng/gm) respectively (table 03). The level of cortisol metabolites showed significantly higher ($p$<0.05) in sub-adults and adults than to calves. Our findings were similar to Stead *et al.* (2000) [14], who reported higher levels of glucocorticoids in juvenile African elephant kept in the small enclosures compared to large areas. However, park elephants in different tiger reserves are reared in semi captive habitats but sub-adults are confined to training them for wildlife conservations activities might be the factor for increase the stress levels compared to adults in the present study.

**Table 2:** Park and sex wise Cortisol concentration of captive elephants in different tiger reserves

| S. No. | Tiger Reserve | (Mean±SE) | | Total (N=30) |
|---|---|---|---|---|
| | | Male | Female | |
| 1. | Kanha tiger reserve (N=10) | 265.33± 22.49 | 187.50± 56.21 | 234.20± 27.4 |
| 2. | Panna tiger reserve (N=10) | 252.28± 22.32 | 262.00± 36.05 | 250.80 ± 16.80 |
| 3. | Bandhavgarh tiger reserve (N=10) | 219.42± 23.36 | 168.70± 76.80 | 232.20± 19.60 |
| Total (N=30) | | 245.67±22.71 | 229.61± 44.14 | 239.60± 12.20 |

**Table 3:** Age wise cortisol concentration of park elephants in different tiger reserves

| S. No. | Tiger Reserve | **Age of the park elephants** (Mean±SE) | | | ***P*-value** |
|---|---|---|---|---|---|
| | | **Calves** | **Sub-adult** | **Adult** | |
| 1. | Kanha tiger reserve (N=10) | $220.00^{ab}$ ± 90.18 | $173.33^{b}$ ±96.10 | $272.67^{ab}$ ±21.49 | $p<0.00001$ The result is significant at $p<0.05$ |
| 2. | Panna tiger reserve (N=10) | $176.66^{b}$ ±92.6 | $290.00^{a}$ ±12.70 | $277.00^{ab}$ ±54.46 | |
| 3. | Bandhavgarh tiger reserve (N=10) | $173.33^{b}$ ± 96.10 | $272.67^{ab}$ ±21.49 | $246.00^{ab}$ ±35.52 | |
| | Total (N=30) | $189.99^{b}$ ± 92.96 | $280.89^{ab}$ ±19.29 | $266.83^{ab}$ ±37.11 | |

The faecal cortisol level was highest in Panna (250.8±16.8 ng/gm), moderate in Kanha (234.2±27.4 ng/gm), and the lowest in Bandhavgarh (232.2±19.6 ng/gm). Though the overall non-significant ($p>0.05$) faecal cortisol concentration in elephants was observed but the disease manifestation and physical working environment were expressing different stress levels. However, no remarkable findings were recorded in the present study to correlate the park wise assessments of cortisol levels in elephants. Chichilichi *et al.* (2018) [5] have estimated faecal cortisol in free ranging captive Asian elephants of Odisha by using non-invasive faecal cortisol analysis and found location wise non-significant concentration of cortisol. They have also studied the seasonal variation showing significant differences between location wise cortisol levels only in winter. This emphasized that cortisol levels are affected by weather conditions along with locality. Laws *et al.* (2007) [11] observed that cortisol levels increases during transportation of elephants from one place to another. It is found elevated when the elephants are introduced in the new herd. In the present findings parasitic infestation has elevated as a factor that is responsible for evaluation of stress levels.

## 4. Conclusion

The present study indicates that fecal Cortisol (non-invasive) estimation can be used to assess physiological stress associated with various husbandry practices, age, sex which could be used to guide the management of captive elephants.

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