

## A HEMATOLOGICAL STUDY OF THREE PRIMATE SPECIES IN DHAKA ZOO

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The present research work was undertaken to study the sex and species variation significantly affected the blood values observed in Rhesus monkey (*Macaca mulatta*), Mandril (*Mandrillus sphinx*) and African green monkey (*Cercopithecus aethiops*). The values were obtained from 60 healthy animals of these species in Dhaka Zoo. All the animals were divided into three groups on the basis of species, and categorized into two groups on the basis of sex. The values of TEC, TLC, Hb, PCV, and DLC, observed in rhesus monkey were compared with the values obtained in Mandril and African green monkey. In the case of both male and female animals, TEC, TLC, Hb and PCV values obtained in Mandril and African green monkey were significantly lower ( $p < 0.01$ ) than the values obtained in rhesus monkey. The highest neutrophil count and MCV values were observed in male Mandril and male African green monkey, respectively. While comparing the values between male and female animals within same sex, TEC, TLC, Hb, PCV and MCHC values obtained in male animals were significantly higher ( $p < 0.01$ ) than the values observed in female animals. The highest neutrophil and eosinophil count were found in rhesus monkey and MCV values shown in Mandril, male animals were observed a significant higher values ( $p < 0.01$ ) than the values obtained in female animals.

**Keywords:** monkey, neutrophil, eosinophil

Wildlife is the integral part of ecosystem and conservation of wild animals has become mandatory for the environment (Meijaard *et al.*, 2006). Hematological investigation in veterinary practice has become a routine part of diagnostic evaluation for food and drug safety assessment and research studies. Complete blood counts (CBC) are commonly performed by the veterinarian as a presumptive diagnostic tool of various diseases of wildlife (Weiser, 1987;

Wallach and Boever, 1983). Primatological research often involves the selective collection of non-human primates specimens which enables accurate identification of species and understanding of evolutionary relationships, genomics of wild populations, population structure and dynamics, comparative anatomy and physiology, adaptation, behavior, parasites and diseases, economic importance, geographic and microhabitat distributions, and ecology of non-human primates, concerning endangered species, economically important species, habitat conservation, ecosystem analysis, pest and disease control, predator control, and domestication. Many nations have passed legislative bindings to protect and set aside safari parks and reserved wildlife zones in their territory (Jepson *et al.*, 2002).

Patho-physiology of blood is one of the determinant factors for assessing the condition of the health status of living individual (Kraemer, 1992). Hematological and biochemical analyses are also valuable tools for evaluating the patho-physiology of wildlife, both in diagnosing disease and clinical monitoring of the patient (Sato *et al.*, 2005). However, proper interpretation of these parameters requires appropriate reference values for each species to minimize the species differences. Additional factors such as sex or age may also affect the blood profile of primatological species (Ihrig *et al.*, 2001). Wildlife is the integral part of ecosystem and furnishes into its modern shape. Hematological values of non-human primates are influenced by age, sex, breed, climate, geographical location, season, day length, time of day, nutritional status, life habit of species, present status of individual and such other physiological factors (Buchl and Howard, 1997). The determination of hematological parameters is very important for correct disease diagnosis of human and domesticated animals including the

wild animals. The establishment of base line hematological data for animals is of basic importance for dealing with a series of practical situations including diagnosis and treatment of sick animals, improvement of therapies and experimentation (Fernie *et al.*, 1994). No previous data has been found regarding the hematological profile of primates- Rhesus monkey, Mandril and African green monkey in Dhaka Zoo. There has been no work on the normal hematological profiles of primate's Rhesus monkey, Mandril and African green monkey in Dhaka Zoo. Therefore, the present investigation was initiated to determine the normal hematological values of individual animal, among the species, and between the sexes in Rhesus monkey, Mandril and African green monkey.

## MATERIALS AND METHODS

A total of 10 male and 10 female from the three primates species, Rhesus monkey (*Macaca mulatta*), Mandril (*Mandrillus sphinx*) and African green monkey (*Cercopithecus aethiops*) with average body weight 15 kg of 8 to 10 years age in Dhaka Zoo were used for these study. All the animals were divided equally into 3 groups on the basis of species, and the animals of each species were divided on the basis of sex. Total erythrocytes count (TEC), total leukocyte count (TLC), hemoglobin (Hb), packed cell volume (PCV), differential leukocyte count (DLC), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) were determined after collection of the blood from the animals of all groups. Blood was collected aseptically with sterile syringe and needle from the cephalic vein of Olive Baboon, Hamadryan Baboon and Indian Langur. Immediately after collection, blood was transferred to sterile tube containing anticoagulant (4% sodium citrate solution) at a ratio of 1:10. The collected blood was used for different hematological parameters. Total erythrocyte count and total leukocyte count were performed as per technique described by (Shastry 1983). Hemoglobin (Hb) was estimated first after collection of blood. This test was done by Acid-Hematin method. The result was then expressed in gm percentage (gm %).

## RESULTS AND DISCUSSION

The results of present research work are stated and discussed meticulously to make a radical investigation on hematological parameters of three species of animals' viz. rhesus monkey, Mandril and African green monkey in Dhaka

Zoo. In this study, hematological value of rhesus monkey has been considered as standard value. The hematological values of different species are presented in the Table 1 and 2. The TEC, TLC, PCV, Hb, DLC, MCV and MCHC were found changeable among different species and between sexes.

### *Total erythrocyte count (TEC)*

Profiles of TEC have been shown in the Table 1. The highest TEC value was recorded in male rhesus monkey than in female. The TEC value was significantly higher ( $p < 0.01$ ) in Mandril than that of male African green monkey between these species. However, the value is lower than rhesus monkey in these species. The value of TEC was also significantly lower ( $p < 0.01$ ) in Mandril and African green monkey than in rhesus monkey among the female. The TEC value was significantly higher ( $p < 0.01$ ) in female Mandril than in female African green monkey. While comparing the results between male and female animals within same species TEC values were significantly higher ( $p < 0.01$ ) in males than in female animals (Table 2). Similar pattern of results among the species and sexes have been evaluated (Mitruka and Rawnsley, 1977). This difference of TEC value between the sex may be due to estrogens that have an inhibitory effect on the secretion of erythropoietin (EP), which is the major regulator of erythropoiesis and testosterone in the males that have a stimulatory action on the secretion of EP (Ghai, 1999).

### *Total leukocyte count (TLC)*

The parameters of TLC are shown in the Table 1. The highest TLC value was observed in male African green monkey among three species of male animals. This value is significantly higher ( $p < 0.01$ ) in African green monkey than in standard value, significantly higher ( $p < 0.01$ ) value of TLC was recorded in African green monkey than in Mandril comparing between these two species. For female, this value was significantly higher ( $p < 0.01$ ) in African green monkey than in rhesus monkey. Again the TLC value was significantly higher ( $p < 0.01$ ) in female Mandril compared to the value of female rhesus monkey. The values, which have been stated in Table 2, were compared between opposite sex within same species. It has been reported earlier that TEC values in male animals of rhesus monkey, Mandril and African green monkey were significantly higher ( $p < 0.01$ ) than the values obtained by female animals (Grana *et al.*, 1988). There is no such hormonal or genetic factor that is responsible for increasing TLC

**Table 1.** Hematological values of rhesus monkey, mandril and African green monkey

Events		Species					
		Rhesus Monkey		Mandril		African Green Monkey	
		Male n=10	Female n=10	Male n=10	Female n=10	Male n=10	Female n=10
TEC (x 10 <sup>6</sup> /μl)		6.00±0.031	5.62±0.283	5.18±0.022**	4.67±0.016**	4.59±0.027**	4.40±0.010**
TLC (x 10 <sup>3</sup> /μl)		11.15±0.020	10.29±0.040	11.56±0.053**	10.64±0.029**	13.23±0.043**	12.16±0.011* *
PCV (%)		43.00±0.577	41.50±0.341	35.50±0.453**	31.80±0.489**	37.80±0.416**	34.40±0.371* *
Hb (gm/dl)		13.72±0.028	12.31±0.034	11.49±0.031**	10.38±0.021**	12.20±0.019**	11.20±0.023* *
DLC	Neutrophil (%)	35.40±0.400	38.40±0.426	40.60±0.400**	37.80±0.416 <sup>NS</sup>	31.90±0.233**	25.70±0.260* *
	Lymphocyte (%)	57.60±0.520	54.60±0.426	53.70±0.300**	54.60±0.733 <sup>NS</sup>	64.60±0.476**	66.70±0.260* *
	Eosinophil (%)	3.50±0.223	3.70±0.152	3.00±0.258 <sup>NS</sup>	4.10±0.27 <sup>NS</sup>	2.10±0.233**	4.20±0.133*
	Monocyte (%)	3.50±0.223	3.30±0.152	1.70±0.152**	3.00±0.258 <sup>NS</sup>	1.40±0.163**	2.60±0.221 <sup>NS</sup>
	Basophil (%)	0.00±0.00	0.00±0.00	1.00±0.00**	0.30±0.152 <sup>NS</sup>	0.00±0.00 <sup>NS</sup>	0.80±0.133**
MCV (μm <sup>3</sup> )		71.64±0.800	67.71±6.756	68.23±0.974*	68.01±1.092 <sup>NS</sup>	82.33±0.960**	78.04±0.834 <sup>NS</sup>
MCHC (%)		31.96±0.419	29.68±0.276	32.42±0.642 <sup>NS</sup>	32.59±0.351**	32.42±0.356 <sup>NS</sup>	32.59±0.351**

Values indicate mean ± SE of 10 animals. Row wise means with superscripts \*\* and superscript \* vary from rhesus monkey value significantly at 1% (p<0.01) and 5% (p<0.05) level of significance within the same sex.

**Table 2** Hematological values of rhesus monkey, mandril and African green monkey

Events		Species					
		Rhesus Monkey		Mandril		African Green Monkey	
		Male n=10	Female n=10	Male n=10	Female n=10	Male n=10	Female n=10
TEC (x 10 <sup>6</sup> /μl)		6.00±0.031	5.62±0.283**	5.18±0.022	4.67±0.016**	4.59±0.027	4.40±0.010**
TLC (x 10 <sup>3</sup> /μl)		11.15±0.020	10.29±0.040**	11.56±0.053	10.64±0.029**	13.23±0.043	12.16±0.011**
PCV (%)		43.00±0.577	41.50±0.341 <sup>NS</sup>	35.50±0.453	31.80±0.489**	37.80±0.416	34.40±0.371**
Hb (gm/dl)		13.72±0.028	12.31±0.034**	11.49±0.031	10.38±0.021**	12.20±0.019	11.20±0.023**
DLC	Neutrophil (%)	35.40±0.400	38.40±0.426**	40.60±0.400	37.80±0.416**	31.90±0.233	25.70±0.260**
	Lymphocyte (%)	57.60±0.520	54.60±0.426*	53.70±0.300	54.60±0.733 <sup>NS</sup>	64.60±0.476	66.70±0.260**
	Eosinophil (%)	3.50±0.223	3.70±0.152 <sup>NS</sup>	3.00±0.258	4.10±0.27 <sup>NS</sup>	2.10±0.233	4.20±0.133*
	Monocyte (%)	3.50±0.223	3.30±0.152 <sup>NS</sup>	1.70±0.152	3.00±0.258**	1.40±0.163	2.60±0.221*
	Basophil (%)	0.00±0.00	0.00±0.00 <sup>NS</sup>	1.00±0.00	0.30±0.152**	0.00±0.00	0.80±0.133**
MCV (mμ <sup>3</sup> )		71.64±0.800	67.71±6.756**	68.23±0.974	68.01±1.092**	82.33±0.960	78.04±0.834 <sup>NS</sup>
MCHC (%)		31.96±0.419	29.68±0.276**	32.42±0.642	32.59±0.351 <sup>NS</sup>	32.42±0.356	32.59±0.351 <sup>NS</sup>

In the table values indicate mean ± SE of 10 animals for each parameter. Within the same species row wise values with superscripts\*\* and superscript\* vary at 1% (p<0.01) and 5% (p<0.05) level of significance, respectively.

values in male than in females (Rogers *et al.*, 2005), but physiological factors such as fright and emotional disturbances have an immediate effect on the increase of leukocyte numbers and can produce changes that often induce an inadequate interpretation (Jain *et al.*, 1986; Fernie *et al.*, 1994).

#### **Packed cell volume (PCV)**

The values of PCV have been shown in Table 1. In case of male animals, the highest PCV value was recorded in rhesus monkey. The lowest value was revealed from the Mandril which is significantly lower ( $p < 0.01$ ) than the rhesus monkey, other two species, the value was significantly higher ( $p < 0.01$ ) in African green monkey than in the case of Mandril. It is notable that the PCV value of female was the highest in rhesus monkey among the three species. PCV value was significantly higher ( $p < 0.01$ ) in African green monkey than in Mandril. This result was agreeable with findings of earlier scientists (Rollins *et al.*, 1990; Stanley and Cramer, 1986). They recorded the highest values in male than in female. The genetic difference between men and women is mainly the sex chromosome; the Y chromosome might have certain effects on this blood production process. It has positive impact in increasing the concentration of RBC in circulating blood and subsequently raises PCV (Viteri *et al.*, 2002).

#### **Hemoglobin (Hb)**

Hemoglobin concentration found in this study has been presented in Table 1. The highest Hb concentration was recorded in male rhesus monkey than the males of Mandril and African green monkey. The concentration of Hb was significantly higher ( $p < 0.01$ ) in African green monkey than in Mandril comparing these species. The concentration of Hb was also higher in rhesus monkey than in other two species among the female animals. African green monkey has been shown significantly higher ( $p < 0.01$ ) Hb value than in the case of Mandril. The Hb values of gender discrimination in the same species have been shown in the Table 2. The results obtained in the present study are in the line with the result obtained (Stanley and Cramer, 1986). Hb concentrations are lower in the females due to presence of estrogens which have an inhibitory effect on erythropoiesis but androgens in males have a stimulatory effect on erythropoiesis (Ghai, 1999). In the adult after menstruation, females suffer from iron deficiency that also decreases Hb concentration (Rushton *et al.*, 2001).

#### **Differential Leukocyte Count (DLC)**

Parameters of DLC among the male and female animals of rhesus monkey, Mandril and African green monkey are shown in the Table 1. Among the males of three species, the highest neutrophil count was observed in Mandril and this value is significantly higher ( $p < 0.01$ ) than in standard value. Among three species of female animals African green monkey possessed the higher lymphocyte percentage which is significantly higher ( $p < 0.01$ ) than in rhesus monkey. Among the males, African green monkey presented of lymphocyte which is significantly higher ( $p < 0.01$ ) than in standard value, and also in other species which is significantly higher ( $p < 0.05$ ) than in rhesus monkey. However, among males, African green monkey revealed of eosinophil which is significantly lower ( $p < 0.01$ ) than the standard value. Overall results of eosinophil percentage showed significance variance among the three species. While considering female animals, the highest eosinophil count was recorded in African green monkey. Among three species of animals, rhesus monkey and Mandril possessed the higher monocyte percentage and basophil percentage respectively. Comparing the values within male and female animals (Table 2), neutrophil and lymphocyte count were significantly higher ( $p < 0.05$ ) in male animals than in female animals. Physiological factors like fright and emotional disturbances have an immediate effect on leukocyte count and can influence an inadequate interpretation (Jain *et al.*, 1986).

#### **Mean Corpuscular Volume (MCV)**

Mean Corpuscular Volume is shown in the Table 1. For male animals, the highest calculated MCV value was obtained in the blood of African green monkey. The MCV parameter was significantly higher ( $p < 0.05$ ) in rhesus monkey than in Mandril. In case of female, the highest MCV value was recorded in African green monkey among three species. This value was significantly higher ( $p < 0.01$ ) than in rhesus monkey while comparing with the MCV of Mandril, this value was found higher but it was statistically insignificant. The value in male is higher than in female which is a sex linked variation in all mammals. Female possess estrogens which has a negative effect on erythropoiesis while male possess testosterone that have a positive effect on erythropoiesis (Ghai, 1999). The result of this experiment revealed similarity with the earlier observation (Grana *et al.*, 1988).

### **Mean corpuscular Hemoglobin Concentration (MCHC)**

MCHC value obtained by using PCV and Hb has been presented in the Table 1. In case of male the obtained MCHC values were compared between species and between sexes. It was revealed that the value for all sexes and species were almost same. There were noticeable variations among the species. MCHC values obtained by males of three species were significantly higher ( $p < 0.01$ ) than the values observed in females. It is difficult to explain why MCHC is higher in male than in female but it may be assumed that the acceleratory effect of testosterone in erythropoiesis is more conspicuous in male than in females. The pattern of these research findings is similar to that of previous scientists (Melville *et al.*, 1997).

### **CONCLUSION**

For proper management, feeding, breeding, prevention and treatment of diseases; it is highly desirable to know the normal physiological values of the wild life as there is a scarcity of previous established data regarding the non-human primates. In addition, these animals can be used as a “disease model animal” of various devastating highly contagious disease like AIDS and their treatment (Rust, 2001). It may be concluded that these data of zoo animals will provide valuable diagnostic indices for the wildlife which aid them for conservation as well as proper diagnosis and treatments of endangered species and also will provide a clue for the future researcher.

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