ACADEMIC INN INTERNATIONAL

ISSN: 2663-9513 (Online) ISSN: 2663-9505 (Print)

South Asian Journal of BIOLOGICAL RESEARCH

open access

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To cite the article: J.A.Ityavyar, J.O.Bukie, G.O. Yager and O. A. Jaiyeola (2019) Hematology and minerals characteristics of nile rats fed different diets in captivity, *South Asian Journal of Biological Research*, 2(2): 68-75.

Link to this article: http://aiipub.com/journals/sajbr-191118-031140/

Article QR

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HEMATOLOGY AND MINERALS CHARACTERISTICS OF NILE RATS FED DIFFERENT DIETS IN CAPTIVITY

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A R T I C L E I N F O
Article Type: Research
Received: 13, Nov. 2019.
Accepted: 28, Nov. 2019.
Published: 30, Nov. 2019.

Keywords:
Nile rats, Captivity, Hemoglobin, Minerals and Metabolites.

A B S T R A C T
Nile rat (Arvicanthis niloticus) is a wildlife species with potential for domestication. This study investigated the hematological and mineral characteristics of Nile rat, in captivity fed different diets. Four hundred Nile rats, obtained from the wild in Benue State, Nigeria, were subjected to different feeding trials. The different feeds were: grower's mash, Sorghum seeds; Guinea grass; Yam peels and Cassava tubers. Parameters investigated were: red blood cell count, white blood cell count, and hemoglobin, pack cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin Concentration as well as minerals and metabolites composition. The results obtained indicated that the Levels of Pack cell volume and hemoglobin were significantly higher (α0.05) in the rats fed with growers mash while white blood cells were highest in those fed with sorghum seeds while minerals and metabolites composition was observed not to be significantly different (α0.05). This study concluded that Nile rat can be reared in captivity, having preference for sorghum seeds and growers mash feeds respectively. Investment in Nile rat domestication is recommended as a complementary measure for ensuring food security and conservation of biological resources in Nigeria.

1. INTRODUCTION

Arvicanthis niloticus also known as African Grass Rat, Kusu, Nile Rat, and Yonguh, are animals that live in colonial burrows, they require some degree of ground cover, such as short bushes, trees, rocks, or termite mounds, under which they may nest. A variety of African habitats, including dry savannah, sub-desert, coastal scrub, open woodlands, grasslands and cultivated areas, provide such protection. Exact altitudinal data not reported, but Arvicanthis niloticus is not believed to exist at high altitudes, they are basically tropical and terrestrial animals (Refinetti 2004).

The extinction of species resulting from human activities throughout the world have caused great concern in the scientific community and among the general public (Houston 1995). The disappearance of biological species has been described as a loss of flora and fauna together with their agricultural, economic and other values. It is described as a loss of medical cures not discovered, as a loss of the earth's genetic diversity, as a threat to the global climate and the environment for human existence and as loss species that have as much inherent right to exist as does Homo sapiens (Houston 1995). Research in medicine frequently depends on the availability of species. So little is known about most of the wildlife that there are possibilities of major discoveries being made in human medicine as a result of investigation on other animals (Ayeni and Ajayi 1992). According to Ayodele and Lameed (1999) wild animals have made unparallel contribution the field of medical research. In 1996, U.S.A. alone utilized 62,783 primates (consisting of new and old-world species) and half a million rhesus during the 6 peak years of polio vaccine production a decade earlier (IUCN 1970). Also in the year 1977 alone, 18 million individual of wild rats and mice were used for research in pharmacology and physiology in the U.S.A. (Zeng 1985). This study was conducted to evaluate the effect of feed type (diet) and sex on the hematology and minerals characteristics of captive-reared Nile rats.

2. MATERIALS AND METHODS

2.1 Experimental site and Arvicanthis niloticus

The experiment was set up in the Animal House of the Department of Wildlife and Range Management, University of Agriculture, Makurdi, Benue State, Nigeria.

The Nile rats (*Arvicanthis niloticus*) were collected from the wild at Makurdi (derived Savannah), Gwer-west (Woodland), Guma (woodland and Savannah) and Kwande (Woodland), all in Benue state Nigeria in November and December 2016. Local hunters in these areas were recruited for the rat collection using various local devised traps. A total of four hundred (400) rats were collected during this period. However, rats with similar size and an average weight of 75.47±8.86 g (total of 300 rats) were selected and used for this study.

2.1.1 Experimental Rat Acclimatization

Collected rats were transferred to the Animal House of the Department of Wildlife and Range Management, University of Agriculture, Makurdi, Benue State, Nigeria and allowed to acclimatize for four weeks to enhance good health as specified by Suleiman and Shumake (1984). The rats were fed regularly and water provided *ad libitum*.

2.2 Hematological Parameters

This was done according to the methods used by Adeyi *et al*. (2012). Blood samples collected in EDTA tubes were used for hematological analysis. Parameters included: red blood cell count, white blood cell count, hemoglobin, pack cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration were investigated using an automatic hematological analyzer (ABX Pentra XL 80, France).

The differential white blood count was performed with an optical microscopy after hematological staining (fixation with May Grunwald and staining with Giemsa stain). Percentage lymphocytes, neutrophils, eosinophils, basophils and monocytes were determined.

3. RESULTS

3.1 Hematological Characteristics of Nile rats

The hematological profile of the male and female Nile rats followed a similar trend. There was no significant difference recorded in the amount of red blood cell count of the rats fed with growers mash, sorghum seed, yam peel, cassava tuber and guinea grass respectively in captivity (Table 1). Levels of Pack cell volume (PCV) and hemoglobin were significantly higher in the rats fed with growers mash. Level of white blood cells was highest in the rats fed with sorghum seeds. The levels of PCV, white blood cells and hemoglobin were however higher in the Nile rats after the feeding regime than the baseline. Statistical analysis however, showed no significant difference in the hematological parameters of the male and female Nile rats.

Table 1. Hematological parameters of Nile rats fed with different diets in captivity

		PCV (%)	RBC (x 10^{12}/L)	WBC (x 10^{9}/L)	Hb (g/dL)
Male	Baseline	29.00±1.41^{d}	7.90±0.42^{a}	2.50±0.42^{c}	9.25±1.06^{c}
	Cassava tuber	31.50±2.12^{c}	7.00±0.28^{a}	3.30±0.28^{c}	10.50±0.71^{b}
	Growers mash	38.00±5.66^{a}	6.75±0.64^{a}	3.75±0.64^{c}	12.65±1.91^{a}
	Sorghum seed	36.60±1.84^{b}	6.15±0.44^{a}	8.10±0.42^{a}	11.85±0.64^{b}
	Yam peel	35.30±1.56^{b}	6.18±0.53^{a}	6.15±0.78^{b}	10.80±0.28^{b}
	Guinea grass	34.20±2.26^{b}	6.05±0.92^{a}	3.25±0.07^{c}	10.90±0.42^{b}
Female	Baseline	28.00±1.41^{d}	7.35±0.78^{a}	2.50±0.71^{e}	8.60±0.99^{c}
	Cassava tuber	32.50±2.12^{c}	6.15±0.35^{a}	3.10±0.99^{d}	10.80±0.71^{b}
	Growers mash	42.00±2.83^{a}	8.10±0.28^{a}	4.45±0.78^{c}	14.00±0.99^{a}
	Sorghum seed	34.65±0.64^{b}	6.01±0.35^{a}	7.85±1.20^{a}	11.20±0.28^{b}
	Yam peel	35.40±1.41^{b}	6.41±0.20^{a}	7.65±2.76^{a}	11.30±0.57^{b}
	Guinea grass	34.75±4.88^{b}	6.10±1.41^{a}	5.95±4.17^{b}	12.15±2.33^{b}
Gender comparison	F-value	0.162	0.003	1.320	0.619
	P-value	0.70	0.96	0.27	0.45

^{abcd}Mean (±Standard deviation) in the same column for male and female Nile rats respectively having similar superscripts are not significantly different α0.05; *Parameter significant difference between the male and female rats α0.05; WBC = White blood cell count; RBC = Red blood cell count; Hb = Hemoglobin; PCV = Packed cell volume

3.2 White blood cells differentials of the rats

In the male Nile rats, the levels of MCV, MCH and neutrophils were higher in the groups fed with the different type of feeds than in the baseline (Table 2). On the other hand, monocyte was significantly lower in the groups fed with the different type of feeds than in the baseline. However, MCV was significantly lower in the male rats fed with cassava tuber than those fed the other feed types. Neutrophil was significantly higher in the male rats fed with growers mash. MCH and monocytes were not significantly different in the rats fed with the different feed regimes. There was however no significant difference recorded in the levels of MCHC, lymphocytes, eosinophils and basophils between the male rat groups fed with the different feed regime and the baseline.

Similarly, there was no significant difference recorded in the levels of MCHC, eosinophils and

basophils between the female rat groups fed with the different feed regime and the baseline. Levels of MCV and MCH were also not significantly different between the female rat's groups fed with the different feed regime. These were however significantly higher than the baseline. Female rats fed with yam peels had the highest level of lymphocytes while those fed with cassava tuber had the highest level of monocytes.

Statistical analysis also showed no significant difference in the white blood cells differentials of the male and female Nile rats.

Table2. White blood differentials (%) of Nile rats fed with different diets in captivity

		MCV (pf)	MCH (%)	MCHC (%)	Lymphocytes (%)	Neutrophil (%)	Eosinophil (%)	Basophil (%)	Monocytes (%)
Male	Baseline	36.20±0.57^{c}	11.25±1.34^{b}	32.35±1.34^{a}	68.50±0.71^{a}	23.00±1.41^{c}	2.50±0.71^{a}	0.00±0.00^{a}	6.00±1.41^{a}
	Cassava tuber	45.70±0.14^{b}	15.00±0.42^{a}	33.30±0.00^{a}	69.00±1.41^{a}	26.50±2.12^{b}	1.50±0.71^{a}	0.50±0.71^{a}	2.50±0.71^{b}
	Growers mash	56.10±3.11^{a}	18.65±1.06^{a}	33.25±0.07^{a}	65.00±4.24^{a}	33.50±2.12^{a}	1.50±2.12^{a}	0.00±0.00^{a}	0.00±0.00^{b}
	Sorghum seed	59.75±1.34^{a}	19.25±0.35^{a}	32.30±0.14^{a}	72.00±1.41^{a}	25.50±0.71^{b}	1.50±0.71^{a}	0.00±0.00^{a}	0.50±0.71^{b}
	Yam peel	57.20±2.12^{a}	17.95±0.21^{a}	31.50±0.85^{a}	69.50±12.02^{a}	26.50±12.02^{b}	3.00±1.41^{a}	0.00±0.00^{a}	1.00±1.41^{b}
	Guinea grass	55.15±7.28^{a}	16.65±2.62^{a}	33.05±0.78^{a}	68.50±7.78^{a}	26.00±2.83^{b}	2.00±0.00^{a}	0.00±0.00^{a}	1.50±0.71^{b}
Female	Baseline	35.65±1.48^{b}	10.95±1.20^{b}	31.20±1.27^{a}	68.50±2.12^{c}	24.50±2.12^{a}	2.00±0.00^{a}	0.00±0.00^{a}	1.50±0.71^{b}
	Cassava tuber	53.00±6.51^{a}	17.65±2.19^{a}	33.20±0.00^{a}	68.50±6.36^{c}	27.50±2.12^{a}	1.00±1.41^{a}	0.00±0.00^{a}	3.00±2.83^{a}
	Growers mash	51.80±1.70^{a}	17.25±0.64^{a}	33.35±0.07^{a}	66.50±4.95^{c}	25.50±2.12^{a}	1.00±1.41^{a}	0.50±0.71^{a}	1.50±2.12^{b}
	Sorghum seed	57.85±2.33^{a}	18.60±0.57^{a}	32.25±0.21^{a}	72.50±6.36^{b}	25.50±4.95^{a}	1.00±1.41^{a}	0.00±0.00^{a}	1.00±0.00^{b}
	Yam peel	55.30±0.57^{a}	18.05±0.35^{a}	32.15±0.07^{a}	76.00±2.83^{a}	20.00±2.83^{b}	3.50±0.71^{a}	0.00±0.00^{a}	0.50±0.71^{b}
	Guinea grass	54.00±7.64^{a}	17.95±2.47^{a}	33.00±0.28^{a}	68.50±4.95^{c}	26.50±0.71^{a}	0.50±0.71^{a}	0.00±0.00^{a}	0.50±0.71^{b}
Gender	F-value	0.069	0.248	0.147	0.346	1.257	1.200	0.000	1.256
comparison	P-value	0.80	0.63	0.71	0.57	0.28	0.30	1.00	0.28

^{abcd}*Mean (±Standard deviation) in the same column for male and female Nile rats respectively having similar superscripts are not significantly different α0.05; *Parameter significant difference between the male and female rats α0.05; MCV = mean corpuscular volume; MCH = Mean corpuscular hemoglobin; MCHC = The Mean Corpuscular Hemoglobin Concentration*

3.3 Minerals and Metabolite Characteristics of Nile rats

In both the male and female Nile rats, levels of potassium, calcium and phosphorus were not significantly different between the baseline and those fed with growers mash, sorghum seed, yam peel, cassava tuber and guinea grass respectively in captivity (Table 3). Male rat fed with cassava tuber was significantly higher in the level of sodium. On the other hand, female rat fed with cassava tuber had the lowest sodium level. However, male rats fed with yam peel diet had the highest serum chloride level than those fed with growers mash, sorghum seed, and guinea grass and cassava tuber respectively in captivity. Female rats fed with guinea grass diet had the highest chloride level. Statistical analysis also showed no significant difference in the serum levels of minerals and metabolites between the male and female Nile rats.

Table 3. Minerals and metabolite composition of the blood of Nile rats fed with different diets in captivity

		Sodium (mEq/L)	Potassium (mEq/L)	Calcium (mg/dL)	Phosphorus (mg/dL)	Chloride (mmol/L)
Male	Baseline	100.45±4.03^{c}	3.05±0.07^{a}	8.15±1.34^{a}	3.50±0.14^{a}	97.05±1.91^{a}
	Cassava tuber	120.75±1.34^{a}	3.35±0.21^{a}	7.60±0.42^{a}	4.55±0.78^{a}	78.85±7.57^{d}
	Growers mash	100.25±13.51^{c}	3.75±0.07^{a}	9.10±0.14^{a}	3.00±0.57^{a}	83.55±8.56^{c}
	Sorghum seed	103.75±2.05^{c}	3.55±0.64^{a}	8.35±0.64^{a}	3.70±0.28^{a}	77.75±7.71^{d}
	Yam peel	109.90±6.08^{b}	4.20±0.71^{a}	8.1±1.41^{a}	3.0±0.57^{a}	100.0±28.85^{a}
	Guinea grass	98.70±26.30^{c}	4.40±0.14^{a}	8.60±1.70^{a}	4.10±0.57^{a}	90.10±5.23^{b}
Female	Baseline	111.80±2.12^{a}	3.15±0.35^{a}	7.45±0.78^{a}	3.60±0.42^{a}	77.40±2.55^{c}
	Cassava tuber	84.15±9.55^{b}	3.25±1.91^{a}	7.20±4.38^{a}	4.10±0.99^{a}	101.90±4.81^{b}
	Growers mash	110.90±0.42^{a}	4.00±0.99^{a}	8.60±1.13^{a}	3.30±0.57^{a}	96.75±8.98^{b}
	Sorghum seed	105.30±2.97^{a}	3.55±0.49^{a}	8.20±0.57^{a}	3.15±0.21^{a}	77.85±7.71^{c}
	Yam peel	109.40±10.75^{b}	4.20±0.00^{a}	8.60±0.28^{a}	4.25±0.35^{a}	91.55±4.88^{b}
	Guinea grass	118.80±3.68^{a}	4.25±0.49^{a}	9.50±1.70^{a}	3.55±0.78^{a}	107.70±3.82^{a}
Gender comparison	F-value	0.308	2.820	0.074	0.003	0.008
	P-value	0.59	0.12	0.79	0.96	0.93

^{abcd}Mean (±Standard deviation) in the same column for male and female Nile rats respectively having similar superscripts are not significantly different α0.05; *Parameter significant difference between the male and female rats α0.05.

4. DISCUSSIONS

Results showed that feeding of Nile rats with growers mash, yam peel, cassava tuber, sorghum seed and guinea grass in captivity can improve the levels of pack cell volume (PCV), white blood cell count and hemoglobin in the rats. Knowledge of the hematological characteristics has been described as an important tool that can be used as an effective and sensitive index to monitor physiological and pathological changes in livestock (Zhou *et al*. 2009). Similarly, hematological parameters are routinely used for the evaluation of the physiological environment and husbandry stressors (Rainza-Paiva *et al*. 2000). The role of the Red blood cells (erythrocytes) has been identified as a carrier of hemoglobin while the hemoglobin reacts with oxygen and carries it in the blood to form oxy-hemoglobin during respiration (Johnston and Morris 1996; Chineke *et al*. 2006). The white blood cell (WBC) or the white corpuscles are responsible for the defense activities of the blood. According to Ayoola (2011), lymphocytes, which function in the production of antibodies and chemical substances serves as defense against infection. Therefore, major functions of the white blood cell and its differentials are to fight infections, defend the body by phagocytises against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response (Etim *et al*. 2014). Increased blood parameters of the Nile rats in captivity as observed in this study shows that the Nile rats did physiologically well in captivity, regardless of the type of feed administered. Therefore, the Nile rats could be used as laboratory models like common laboratory rats.

However, levels of PCV and hemoglobin were highest in the Nile rats fed with growers mash while the white blood cell count was significantly higher in those fed with sorghum seeds. Reduced PCV level has been associated with inability of the body to meet the iron required due to dietary deficiency (Matteli *et al*. 1994; Idowu *et al*. 2005) Packed cell volume has also been related with anemia; the loss of packed cell volume occurs as a result of specific conditions such as anemia (Henry 2011).

Hemoglobin is the red pigment in the red cell, reacting with oxygen and carrying it in the blood to form oxy-hemoglobin during respiration (Johnston and Morris 1996; Chineke *et al*. 2006). Loss in the hemoglobin and red blood cells was also associated with anemia. Unlike the other feeds used to feed the Nile rats in captivity, the grower's mash was composed as a balanced diet with the inclusion of essential minerals including iron. On the other hand, the other diets (yam peel, cassava tuber, sorghum seed and guinea grass) are plant material with no dietary supplement. Also, the white blood cells are considered as one of the basic components of blood and present in peripheral blood (Goldsby *et al*. 2002) to provide defense against germs, parasites and tumours as well as other diseases (Junqueira and Carneeiro 2003). Higher white blood cells however, represent increased body immunity and defense system. This study therefore, showed that feeding the Nile rats with sorghum seeds could boost their immunity by increasing the level of white blood cells. However, to reduce anemia and promote the health of the Nile rats in captivity, there is the need to provide dietary supplements to the Nile rats when feeding them with plant materials during domestication.

5. CONCLUSION AND RECOMMENDATIONS

This study has shown that wild Nile rat, *Arvicanthis niloticus* can be domesticated and reared in captivity. Nile rat preferred food was observed in this study to be sorghum seeds and growers mash respectively. The five different feed types were observed to produce different serum biochemical characteristics on Nile rats in captivity. Although, this study did not test the feeding preference of the Nile rats with respect to the onset of diabetics, higher serum glucose level in the Nile rats fed with sorghum seed in captivity could also suggest an onset of diabetics. It is therefore highly recommended that dietary supplements be given to the Nile rats when feeding them with plant materials during domestication. Also, further research should be carried out on the reproductive success of these Nile rats in captivity.

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