MORPHOMETRY OF THE WHOLE BODY AND BRAIN WEIGHTS OF THE WILD HELMETED GUINEA FOWL (*NUMIDA MELEAGRIS GALEATA*) AT PRE- AND POST-HATCH PERIODS

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ABSTRACT

This study was carried out to investigate the developmental morphometry of the whole body and brain weights of wild grey breasted helmeted guinea fowl in Nigeria. Domestication of this species of bird is in the increase but information on the development of the body and brain, and how it relates to the neurobiology of this bird is scanty, thus the need for this study. The mean weights of the whole embryo and brain of wild helmeted guinea fowl on day 4 of incubation were 0.040 ± 0.0021 g and 0.010 ± 0.004 g. On day 13, 23 and 28, their mean body weights were 1.951 ± 0.08 g, 12.592 ± 1.305 g and 18.687 ± 1.647 g, respectively. At post-hatch, the mean weights of the brain and whole body of helmeted guinea fowl keets at day 1 was 20.353 ± 1.1946 g. At days 10, 37 and 55, the mean weights were 30.089 ± 2.4275 g, 109.062 ± 4.5119 g and 244.401 ± 26.2049 g, respectively. Developmentally, on day 4 of incubation, embryo begins to for and brain weights increases with increase in body weight. The mean weight of the keet of helmeted guinea fowl was established at 20.353 ± 1.1946 g. Breeders can use this as a standard to ascertain the growth performance of keets.

Keywords: Morphometry, Body weight, Brain weight, Guinea fowl, *Numida meleagris galeata*

INTRODUCTION

The grey breasted helmeted guinea fowl (*Numida meleagris galeata*) is a native to Africa and belongs to the Order, Galliformes and Family, Numidae. It is widely distributed in the Guinea Savannah vegetation zone of Nigeria and estimated at 44 million in captivity (Ayeni, 1983; Baruwa and Solofuwe, 2016; Issaka and Yeboah, 2016).

In Nigeria, two types of guinea fowl species are found; *Numida ptilorhycha* that is indigenous to the Southern part while *Numida meleagris* is domiciled in the Northern part but is spreading to other small-holder farming areas (Ayorinde, 1987). Some people keep guinea fowl out of curiosity and as "watch animals" around homestead because they have excellent eye-sight, harsh cry and they shriek at the slightest provocation (Wanmi *et al.,* 2016). They are also kept for income generation (Gueye, 2000), and for the control of snakes, mice and ticks (Cactus, 2001) thus, encouraging its production. The increase in guinea fowl production has led to the development of informal traders who buy and sale the birds for breeding and consumption, especially during festive seasons (Fajemilehin, 2010).

The brain being part of the nervous system is made up of several parts (cerebrum, diencephalon, mesencephalon, pons, cerebellum and medulla oblongata) which all obtain information about the internal and external environment, analyze and respond to

information, store information and coordinate outgoing motor impulses to the viscera and skeletal muscles (Northcutt, 2001). Developmentally, in avian, the central nervous system develops from the neural plate, an epithelial sheet that arises from the dorsal ectoderm of the developing embryo (Hallonet *et al*., 1990). After neural tube closure, series of vesicles can be clearly distinguished morphologically at the anterior end indicate an anterior-posterior axis development (Joyner, 2002). The most anterior end of the neural tube gives rise to the procencephalon forebrain consisting of the telencephalon and diencephalon.

Several research has been done to study the development of the avian brain, which includes; structural organization of grey breasted helmeted guinea fowl a pre-hatch study (Wanmi *et al*., 2016), glial cells in the CNS of healthy Passeriformes birds (Medina *et al*., 2013) and the development of chicken cerebellar cortex (Akar and Sur, 2010). Despite these studies, there exist dearth of information on the histomorphogenesis of the grey breasted helmeted guinea fowl in Nigeria.

In this study, the variations in the developmental anatomy of the cerebrum in the grey breasted helmeted guinea fowl with regard to their developmental gross morphological structure and histogenesis was investigated. This may be helpful in the understanding of the neurobiology of this species of bird despite increase awareness on its domestication.

MATERIALS AND METHODS

Experimental Design: A total of seventy four (74) fertilized grey breasted helmeted guinea fowl eggs purchased from National Veterinary Research Institute (NVRI) Vom, Jos, Plateau State, Nigeria and other local breeders within Jos and its environs were used for this study. The eggs were transported to a hatchery, still in Jos and incubated using their standard incubation guide. During incubation, the eggs were turned regularly (minimum of three times) each day for the first 24 days according to a modified method of Nobo *et al*. (2012). At pre-hatch sampling, picking of eggs began on day; 4, 7, 10, 13, 16, 19, 21, 23, 25 and 28 which was the last day of incubation. At post-hatch, immediately after hatch, sacrifice of young guinea fowl (keets) was made on days; 1, 10, 19, 28, 37, 46, 55 and day 61.

Extraction of Embryo: This was done at pre-hatch using a scalpel blade and clean transparent dish. The blunt side of the scalpel blade was used with the egg held on the palm, and a gentle tap made on the egg until a crack was formed. Then, the crack was gently widened manually and the embryo collected in a transparent dish following the procedure of Salami (2009).

Extraction of Brain: At pre-hatch stage, because the entire skull is soft and pliable, scalpel blade and rat tooth forceps were used for extraction of the brain. At post-hatch stage, the keets were euthanized using Nembutal at 40 mg/body weight. Thereafter, decapitation was done and the heads fixed in 10 % neutral buffered formalin for 3 days. After proper fixation, a dissection was made at the angle of the beak up to the level of the occipital bone. The upper portion of the dissected area was pulled off gradually using the rat tooth forceps until the entire brain was exposed. The cranial nerves were severed to ease the lifting of the brain from the cranium.

Morphometric Study: A total of 145 fertilized eggs (65 eggs for pre-hatch study and 82 eggs were allowed to hatch its keets for post-hatch study). An opening was made on the large air space area and the entire egg dropped into a labeled container of 10 percent buffered formalin for proper fixing (Gosomji, 2014). The whole body and brain weights were taken in grams using digital electronic balance (Model JJ1000, China).

Data Analysis: Morphometric data on the whole body, brain and were analyzed using Statistical Package for Social Science (SPSS) version 17.0. Descriptive statistics was done and the results expressed as mean ± standard error of the mean.

RESULTS

Pre-Hatch Morphometry: The mean weight of the whole embryo of the helmeted guinea fowl on day 4 of incubation was observed to be 0.040 ± 0.0021 g. On days 13, 19, 23 and 28, their mean weights were 1.951 ± 0.08 g, 7.080 ± 0.809g, 12.592 ± 1.305 g and 18.687 ± 1.647 g, respectively (Table 1).

Table 1: Mean weights (g) of the helmeted guinea fowl embryo at days 4 – 28 incubation (n=7)

Days	Weights (g)		
	Minimum	Maximum	Mean
4	0.0164	0.1671	0.040 ± 0.0021
7	0.0709	0.2400	0.148 ± 0.005
10	0.5034	0.9652	0.805 ± 0.065
13	0.7121	2.6244	0.373 ± 0.108
16	1.1306	5.5191	3.753 ± 0.555
19	3.0974	9.3138	7.080 ± 0.809
21	5.5941	11.5214	8.771 ± 0.941
23	6.0395	14.9034	12.592 ± 1.305
25	7.2809	18.1108	15.140 ± 1.467
28	9.1085	21.5106	18.687 ± 1.647

n = number of birds used per day

The mean weight of the whole brain on day 4 of incubation was 0.010 ± 0.004 g. On days 13, 19 and 28, the mean weights were 0.373 ± 0.108 g, 0.568 ± 0.164 g and 1.031 ± 0.122 g, respectively (Table 2).

Table 2: Mean weights (g) of the whole brain at days 4 – 28 of incubation (n=7)

Days	Weights (g)		
	Minimum	Maximum	Mean
4	0.004	0.016	0.010 ± 0.004
7	0.021	0.062	0.043 ± 0.015
10	0.071	0.246	0.177 ± 0.065
13	0.190	0.499	0.373 ± 0.108
16	0.212	0.570	0.441 ± 0.115
19	0.222	0.694	0.568 ± 0.164
22	0.509	0.828	0.723 ± 0.112
25	0.750	1.225	0.985 ± 0.176
28	0.815	1.131	1.031 ± 0.122

n = number of birds used per day

Post-Hatch Morphometry: At post-hatch morphometric studies, the mean weight of the helmeted guinea fowl keets at day 1 was 20.353 ± 1.1946 g. At days 10, 28, 37 and 55, the mean weights were 30.089 ± 2.4275 g, 51.0443 ± 5.1568 g, 109.062 ± 4.5119 g and 244.401 ± 26.2049 g, respectively (Table 3).

Table 3: Mean weights (g) of the keets at days 1 – 61 post-hatch (n=7)

Days	Weights (g)		
	Minimum	Maximum	Mean
1	15.6310	23.8730	20.353 ± 1.1946
10	22.0401	40.6876	30.089 ± 2.4275
19	29.7056	56.7143	39.459 ± 3.9338
28	36.2681	73.6180	51.443 ± 5.1568
37	99.6375	122.3617	109.062 ± 4.5119
46	120.3519	241.6019	176.431 ± 17.3070
55	167.4311	359.1862	244.401 ± 26.2049
61	187.6307	357.3647	207.261 ± 23.6299

n = number of birds used per day

The weight of the keets after hatching did not exceed 50.0 g until day 37 post-hatch. Thereafter, there was 50 % increase in the weight of the keets to 99.637 g at day 37. Subsequently, the weights increased steadily and at day 61, the weight was 250.0 g (Figure 1).

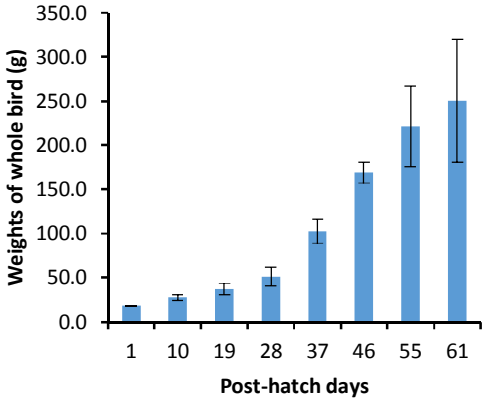

Figure 1: Mean weights (g) of the keets at days 1 – 61 post-hatch

The mean weight of the whole brain post-hatch at day 1 was 0.9418 ± 0.0171 g representing 4 % of the total weight taken out of 61 days of post- hatch. On days 7 and 37, their respective mean weights were 1.0559 ± 0.0278 g and 2.1646 ± 0.0261 g (Table 4).

Table 4: Mean weights (g) of the brain at days 1 – 61 post-hatch (n = 7)

Days	Weights (g)		
	Minimum	Maximum	Mean
1	0.8780	0.9748	0.9918 ± 0.0171
7	0.9700	1.1194	1.0559 ± 0.0278
13	0.9418	1.3206	1.1395 ± 0.0513
19	0.8737	1.3740	1.1322 ± 0.0967
25	1.0881	2.1170	1.5716 ± 0.1385
31	1.546	2.1841	1.8935 ± 0.0957
37	2.0347	2.2480	2.1646 ± 0.0261
43	2.1184	2.5682	2.3658 ± 0.0573
49	2.2831	2.5610	2.5021 ± 0.1255
55	2.3407	2.6134	2.5037 ± 0.0400
61	2.4350	2.7362	2.6133 ± 0.0420

n = number of birds used per day

DISCUSSION

The result this study showed that the mean weight of the embryo of the helmeted guinea fowl between days 4 and 7 of incubation indicated had no differences in their weight increase, but as from day 10 of incubation, there was a steady increase in weights of the embryo. This steady increase in the weights of the embryo during the incubation period indicated that, growth and development was taking place thereby increasing the whole weight of the embryo. The mean weight of the whole brain on day 4 was lower than that of the whole embryo of the same day. The brain weights increase as the body weights increase but the mean weight of the brain was lower than that of the body. This is in agreement with Portman and Stingelin (1960) who stated that brain weight always increased as the body weight increased, and that galliformes had the lowest values which were not constant and could vary in birds of the same body weight.

During post-hatch study, the mean weight of the helmeted guinea fowl keet on days 1, 28 and 61 increases respectively, and the increase in weight on day 61 graphically was 250.0 g. These findings varied from those of Fajemilehin (2010) who reported higher values in all three varieties at weeks 4 and 8 post-hatch with the pearl variety having the least. Nobo *et al*. (2012) in their study on the body weight, feed intake and conversion rate during keets growth at weeks 4 and 8 post-hatch reported higher values with weight gain at day 28 to be 380.0 g. These variations might be having some influence due to the nature of feed and the environmental condition, though both were under intensive management system. It was observed that the mean weight of juvenile Japanese quail was higher than the mean weight of the helmeted guinea fowl at day 37 and lower than those from day 46 post-hatch and above (Igado and Aina, 2010).

Conclusion: Embryo formation starts from day 4 of incubation and brain weights increased with increase in body weights in the wild helmeted guinea fowl. The mean weight of the keet of helmeted guinea fowl was established at 20.353 ± 1.1946 g. Breeders can use this as a standard to ascertain the growth performance of keets.

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REFERENCES

AKAR, S. and SUR, E. (2010). The development of chicken cerebellar cortex and the determination of AgNOR activity of the Purkinje cell nuclei. *Belgian Journal of Zoology*, 140(2): 214 – 222.

AYENI, J. S. (1983). The biology and utilization of helmeted guinea fowl (*Numida meleagris galeata* Pallas) in Nigeria. II, Food of helmeted guinea fowl in Kainji Lake basin area of Nigeria. *Tropical Agriculture of Ecology*, 21(1): 1 – 10.

AYORINDE, K. L. (1987). *Characteristics and Genetic Improvement of the Grey Breasted Helmeted Guinea Fowl, Numida meleagris galeata Pallas in for Growth and Meat Production.* Ph.D. Thesis, University of Ibadan, Nigeria.

BARUWA, O. I. and SOFOLUWE, N. A. (2016). Profitability and resource use efficiency of guinea fowl (*Numida meleagris*) production under tropical conditions.

Journal of Livestock Science, 7: 97 – 106.

CACTUS, R. (2001). *Guinea fowl assortment*. Av ailable in: *<htttp://www.cactusranchgamebirds.com/guineaf.html.* Accessed: 10th December, 2001.

FAJEMILEHIN, S. O. K. (2010). Morphostructural characteristics of three varieties of grey breasted helmeted guinea fowl in Nigeria. *International Journal of Morphology,* 28(2): 557 – 562.

GOSOMJI, I. J. (2014). *Morphogenesis of the Gastrointestinal Tract of the Helmeted Guinea Fowl (Numida meleagris galeata).* M.Sc. Thesis, Ahmadu Bello University, Zaria.

GUÈYE, E. F. (2000). The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. *Outlook on Agriculture*, 29(2): 129 – 136.

HALLONET, M. E., TEILLET, M. A. and LE DOUARIN, N. M. (1990). A new approach to the development of the cerebellum provided by the quail-chick marker system. *Development*, 108(1): 19 – 31.

IGADO, O. O. and AINA, O. O. (2010). Some aspect of the neurometrics and oculometrics of the Japanese quail (*Coturnix coturnix japonica*) in Nigeria*. Journal of Morphological Science,* 27(3-4): 133 – 135.

ISSAKA, B. Y. and YEBOAH, R. N. (2016). Socio-economic attributes of guinea fowl production in two districts in Northern Ghana. *African Journal of Agricultural Research*, 11(14): 1209 – 1217.

JOYNER, A. L. (2002). Establishment of anterior-posterior and dorsal-ventral pattern in the early central nervous system. Pages 107 – 126. *In:* ROSSANT, J. and TAM, P. P. L. (Eds.), *Mouse Development.* Academic Press, San Diego.

MEDINA, F. S., HUNT, G. R., GRAY, R. D., WILD, J. M. and KUBKE, M. F. (2013). Perineuronal satellite neuroglia in the telencephalon of New Caledonian crows and other Passeriformes: evidence of satellite glial cells in the central nervous system of healthy birds? *Peer Journal*, 1: p.e110. https://doi.org/10.7717/peerj.110

NOBO, G., MOREKI, J. C. and NSOSO, S. J. (2012). Feed intake, body weight, average daily gain, feed conversion, ratio and carcass characteristic of helmeted guinea fowl fed varying levels of phane meal (*Imbrasia belina*) as replacement of fishmeal under intensive system. *International Journal of Poultry Science*, 11(6): 378 – 384.

NORTHCUTT, R. G. (2001). Changing views of brain evolution. *Brain Research Bulletin*, 55(6): 663 – 674.

PORTMAN, A. and STINGELIN, W. (1960). The central nervous system. *In:* MARSHALL, A. J. (Ed.). *The Comparative Biology of Birds*. Academic Press, New York.

SALAMI, S. O. (2009*). Studies on the Onset of Osteogenesis in Grey Breasted Guinea Fowl (Numida Meleagris galeata).* Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria.

WANMI, N., ONYEANUSI, B. I., NZALAK, J. O. and ALUWONG, T. (2016). Structural organization of the optic lobe of the grey breasted helmeted guinea fowl (*Numida meleagris galeata*) at pre-hatch study. *Journal of Biology and Life Science*, 7(2): 26 – 40.