

Developmental Morphometry of the Body and Brain in Wild Spotted Helmeted Guinea Fowl: A Pre and Post-Hatch Study

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ABSTRACT

There are dearth of information on the developmental index of the body and brain of study in this wild species of avian in Nigeria. This work was aimed at providing baseline developmental indices in the body and brain of wild helmeted guinea fowl at pre- and post-hatch periods. Two hundred and ninety-four (294) fertilized eggs of wild helmeted guinea fowl were used for the study. Out of the total number, 196 egg were used for pre-hatch and 96 eggs were used for post-hatch studies. Eggs were purchased from National Veterinary Research Institute (NVRI) Vom and local breeders within Jos town and its environs. At pre-hatch period, 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 ± 0.809 g, 12.592 ± 1.305 g and 18.687 ± 1.647 g, respectively. The mean weight of the cerebellum on day 11 of incubation was 0.0038 ± 0.001 g. On day 23 pre-hatch, the mean weight was observed to be 0.0103 ± 0.001 g. The mean length of the whole brain of the helmeted guinea fowl on day 4 of incubation was 0.2074 ± 0.0232 cm. On days 10, 18, 22 and 26, the mean weights were 1.1180 ± 0.0041 cm, 1.4643 ± 0.0587 cm, 1.5191 ± 0.0596 cm and 1.6404 ± 0.0401 cm, respectively. 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. Brain weight increased proportionally with body weight, though it remained consistently lower

Keywords: Body, brain, developmental, wild, guinea, fowl



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INTRODUCTION

Guinea fowl, *Numida meleagris*, originated in Africa (Lever, 2005) and was first domesticated by ancient Egyptian from where the birds spread to other parts of the world such as France, Belgium, Canada, Australia where they are now produced commercially on a large scale (Robinson, 2000). The domesticated guinea fowl descended from the wild species of guinea fowl in Africa. The fowl derives its name from the Guinea part of the West coast of Africa. In Africa, guinea fowls are hunted as game birds, in England they are sometimes used to stock game reserves. It is believed that they might be more popular, where they are noted for their harsh and seemingly never-ending cry (Hanebrink, 1973a).

Guinea fowl production is associated with small-holder farmers in Africa and is described as a “poor man’s pheasant” (Aire, 1983). Some farmers keep guinea fowls out of curiosity and as “watch animals” for ground homestead because they excellent eye sight, a harsh cry, and shriek at the slightest provocation (Smith, 2000). In addition, they are kept for income generation and for control of snakes, mice, ticks other pests and also weeds (Agwunobi and Ekpenyong, 1999), thus, eliciting its production.

The increase in guinea fowl production has led to the development of informal traders who buy and sell the birds for breeding and consumption, especially during the festive seasons. Compared to chickens, its advantages are: low production cost, premium quality meat, greater capacity to scavenge for insects and grains, better ability to protect itself against predators, better resistance to common poultry parasites and diseases, for example, Newcastle disease. This indicates that there is potential for small-holder farmers to improve its production in order to increase house-hold protein supply, combat rural protein-energy malnutrition and increase income (Kusina *et al.*, 2000).

The brain whether in mammals or avian is a highly complex organ consisting of sensory and motor systems that constitute part of the nervous system. It is located in the head, protected by the skull and close to the primary sensory apparatus of vision, hearing, balance, taste and smell (D’Alessio and Frasch, 1996). Virtually, most of the brain structures found in mammals occur in birds, reptiles, amphibians, fishes and sharks. These structures have become more complex and sophisticated as the adaptive requirements of the animal changed (Shepherd, 2006).

Development of the body and the brain is an important requirement for the survival of birds because it controls the entire body and most importantly, plays a vital role in skeletal movement, flight, coordinate internal organs and auditory- visual precision (Snell, 2001). Various part of the brain are concerned with sensori-motor (extra pyramidal) effects on the use of limbs (movement), sight (eye) and auditory (ear) (Sheibel and Tomiyasu, 1980). The survival of birds, depends on their hearing ability, sight, and precision to correctly identify, process the most important information at every point in time so as to engage their muscular activity (Shreesh and Eric, 2011).

However, basic information on the anatomical developmental of both body and brain of the helmeted guinea fowl (HGF) is not fully available. Information obtained may go a long way to explain some of its peculiar behaviours. The weight and length were taken aimed at providing baseline information on some basic indices of the body and brain development at pre- and post-hatch periods. To study the developmental morphometry of the body and brain in wild spotted helmeted guinea fowl at pre and post-Hatch.

Objectives

- (i) To obtain the Developmental Morphometry of the Body and Brain in wild spotted helmeted guinea fowl at pre and post-hatch
- (ii) To obtain a baseline index for both brain and body in wild spotted helmeted guinea fowl at pre and post-hatch

MATERIALS AND METHODS

Experimental design

Two hundred and ninety-four (294) fertilized guinea fowl eggs were purchased from National Veterinary Research Institute (NVRI) Vom, Jos, Plateau State, Nigeria and other local breeders within Jos and its environs. 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. One hundred and ninety six (196) eggs (out of which twelve eggs were picked per day for twenty eight days) for pre-hatch study were collected from days one, two, three, four, five, up to day twenty eight (28) which is the last day for pre-hatch collection. A small 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. For post-hatch study, ninety-six (96) eggs (out of which twelve eggs were picked from day 1, 10, 19, 28, 37, 46, 55 and day-61) were allowed to hatch into young ones referred to as keets and were removed from the incubator from day one post-hatch and kept in a cage.

Extraction of embryo

This was done at pre-hatch using a scapel blade and clean transparent dish. The blunt side of the scapel 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.

Extraction of brain

At pre-hatch, scapel blade and rat tooth forceps were used for extraction of the brain. At post-hatch, the keets were

ethanized using Nembutal at 40 mg/b.wt. Thereafter, decapitation was made and the heads fixed in 10 % buffered formalin for 3 – 5 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 is 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. Extracted brains were fixed in 10 % buffered formalin.

Dissection of the cerebrum from midbrain and cerebellum

The cerebellum is located on the dorsal portion of the brain stem with three peduncles: the restiform body connected to the medulla, the brachium pontis that connects cerebellum to the Pons and the brachium conjunctivum that connects cerebellum to the midbrain. These peduncles were severed using a scapel blade to expose the entire brainstem. The midbrain or mesencephalon is located just caudal to the level of chiasma opticum rostrally and at the level of ponto-mesencephalic region caudally. After the midbrain removal, the anterior portions left are the diencephalon and the cerebrum. At the boundary between the diencephalon and cerebrum, an incision was made revealing the cerebral hemispheres held together by the corpus callosum. Each hemisphere was freed by a transverse incision into the longitudinal fissure. These landmarks were cut across using the scapel blade to extract the midbrain. *Nomina Anatomica Avium* was used for anatomical nomenclature (Baumel *et al.*, 1993).

Gross anatomy and morphometry

Two hundred and ninety four (196 for pre-hatch and 98 for post-hatch) brain samples were used. The weights of the whole bird, brain, cerebellum and midbrain were taken using digital electronic balance; (Model JJ1000, Adventure QHAUS Corporation, Made in China). Length of the whole brain was taken using digital vernier caliper. Heights and lengths were all recorded in grams (g) and centimeter (cm), respectively.

Data analysis

Morphometric data on the whole body, brain, midbrain and cerebellum were analyzed using Statistical Package for Social Science (SPSS) version 17.0. In the analysis, the descriptive statistics was expressed as Mean \pm Standard Error of the Mean. Correlation analysis was also done using Pearson correlation to determine the relationship between values obtained in mesencephalon and cerebellum. Values of $P \leq 0.05$ were considered significant.

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 ± 0.809 g, 12.592 ± 1.305 g and 18.687 ± 1.647 g, respectively (Table 1). On days 4 and 7, there were no differences in the weight increase until day 10 which indicated a steady increase in weight to day 28 of incubation (Figure 1). 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 (Figure 2). There was no major increase in the brain weights except for days 13 to 28 (Figure 2). The mean weight of the cerebrum on day 5 was 0.010 ± 0.003 g. On days 23 and 28, their mean weights were 0.102 ± 0.074 g and 0.214 ± 0.121 g, respectively (Figure 3). From the chart, it shows that, increase in weight above 0.05 g and 0.20 g began on days 20 and 28 of incubation period, respectively (Figure 3). The mean weight of the midbrain of the helmeted guinea fowl on day 5 of incubation was 0.0004 ± 0.0003 g. On day 20, there was a drop in the mean weight of the midbrain to 0.0016 ± 0.0005 g which later went up to 0.0035 ± 0.0034 g on day 23 of incubation (Figure 4). The line graph indicated that on days 17 and 23, there was decrease in the mean weight of the midbrain during pre-hatch period (Figure 4). The mean weight of the optic lobe on day 8 of incubation was seen to be 0.0109 ± 0.0049 g. On days 17 and 26 of incubation, the mean weights were 0.0422 ± 0.0130 g and 0.0639 ± 0.0182 g, respectively (Figure 5). The graph indicated steady increase in the weights of the optic lobe (Figure 5). The mean weight of the cerebellum on day 11 of incubation was 0.0038 ± 0.001 g. On day 23 pre-hatch, the mean weight was observed to be 0.0103 ± 0.001 g (Figure 6). The weight, from the chart, increased steadily but stabilized slightly above 0.01 g on days 23 and 25 of incubation (Figure 6). The mean length of the whole brain of the helmeted guinea fowl on day 4 of incubation was 0.2074 ± 0.0232 cm. On days 10, 18, 22 and 26, the mean weights were 1.1180 ± 0.0041 cm, 1.4643 ± 0.0587 cm, 1.5191 ± 0.0596 cm and 1.6404 ± 0.0401 cm, respectively (Figure 7). The length increased steadily up to 1.0 cm on day 8 but on days 18 and 20, increment in length was not obvious. However, increment continued steadily after up to day 28 of incubation (Figure 7).

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 (Figure 8). The weight of the keets after hatching did not exceed 50.0 g until day 37 post-hatch. Thereafter, there was 50 %

Table 1: Mean weights of the helmeted guinea fowl embryo at days 4 - 28 pre-hatch (in gram), (n=7)

Days	Minimum	Maximum	Mean ± SEM
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, SEM; Standard Error of Mean

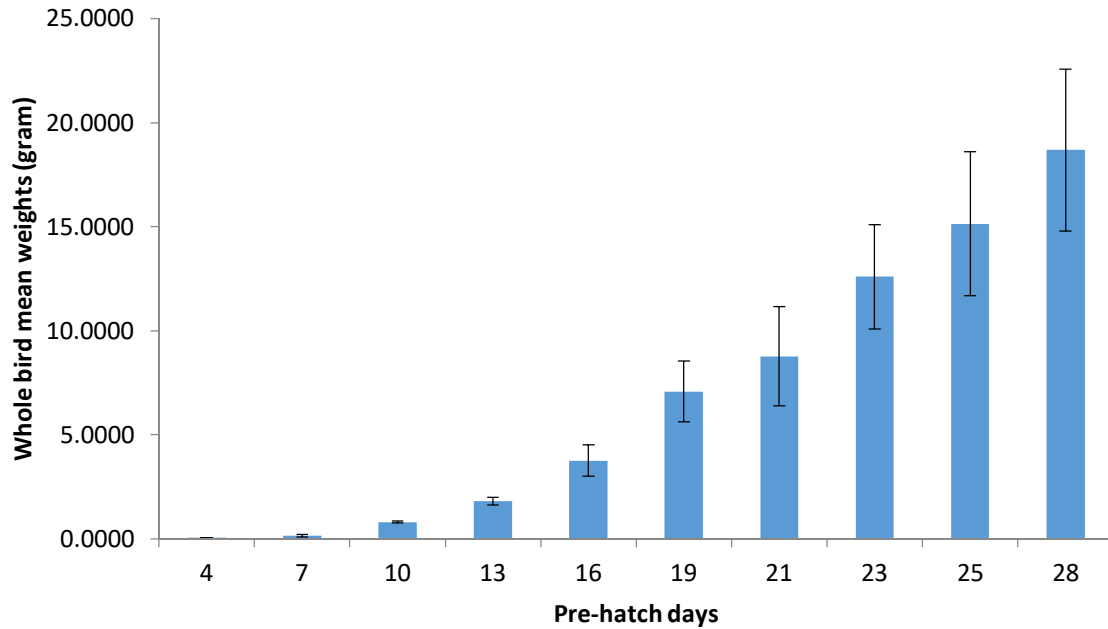


Figure 1: Mean weights of the helmeted guinea fowl embryo at days 4 - 28 pre-hatch (in gram).

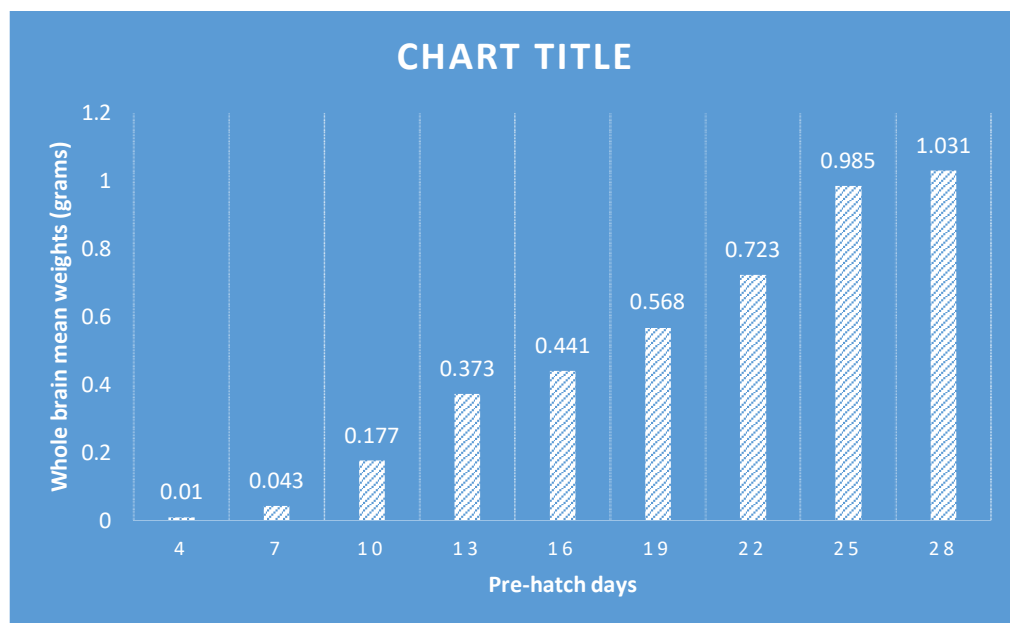


Figure 2: Mean weights of the helmeted guinea fowl whole brain at days 4 - 28 pre-hatch (in gram).

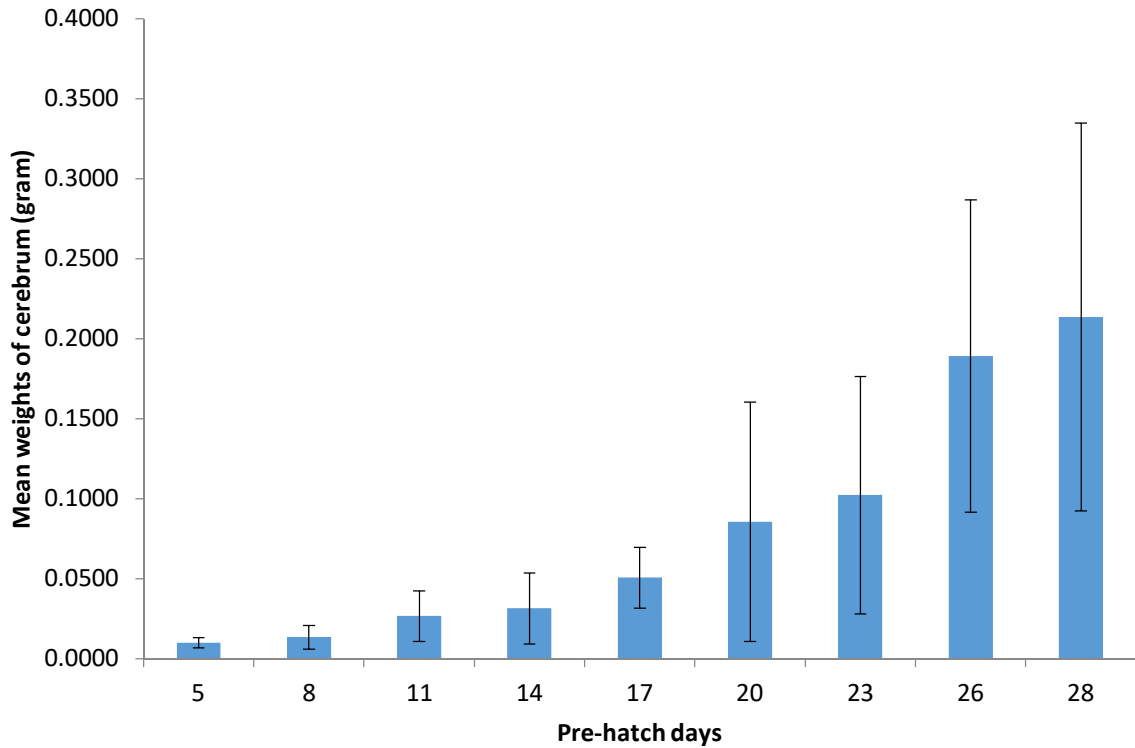


Figure 3: Mean weights of the helmeted guinea fowl cerebrum at days 5 - 28 pre-hatch (in gram)

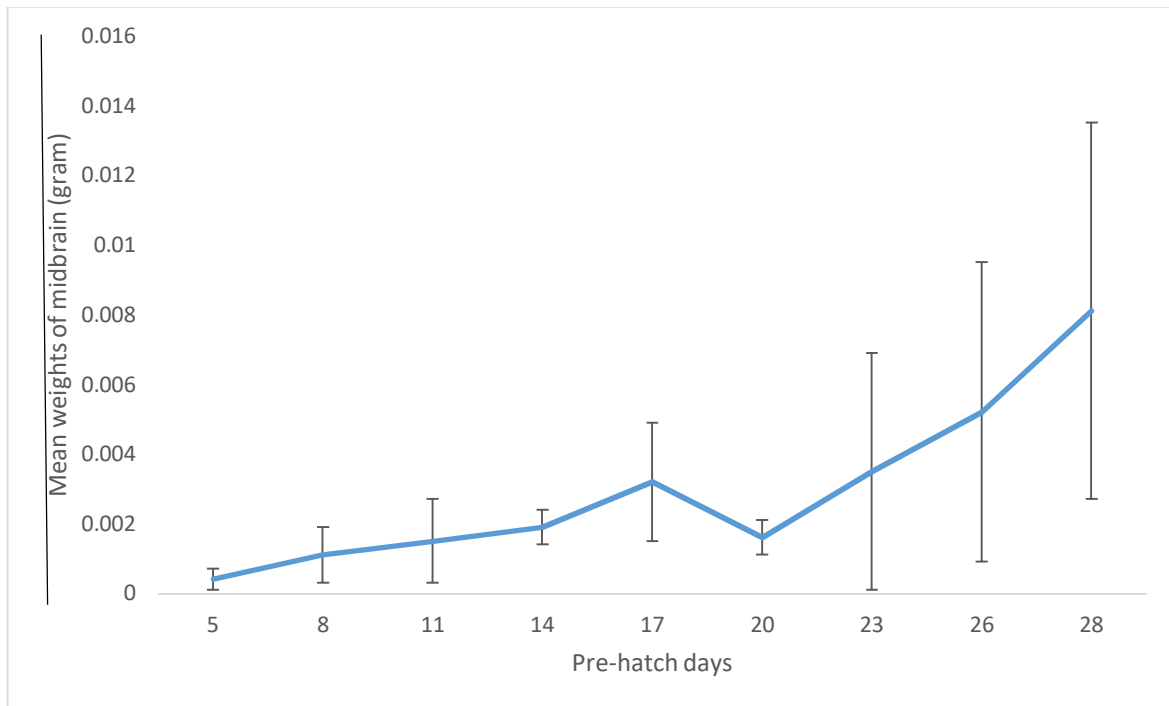


Figure 4: Mean weights of the guinea fowl embryo midbrain at days 5 - 28 pre-hatch (in gram).

increase in the weight of the keets to 100.0 g at day 37. Subsequently, the weights increased steadily and at day 61, the weight was 250.0 g (Figure 8). 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

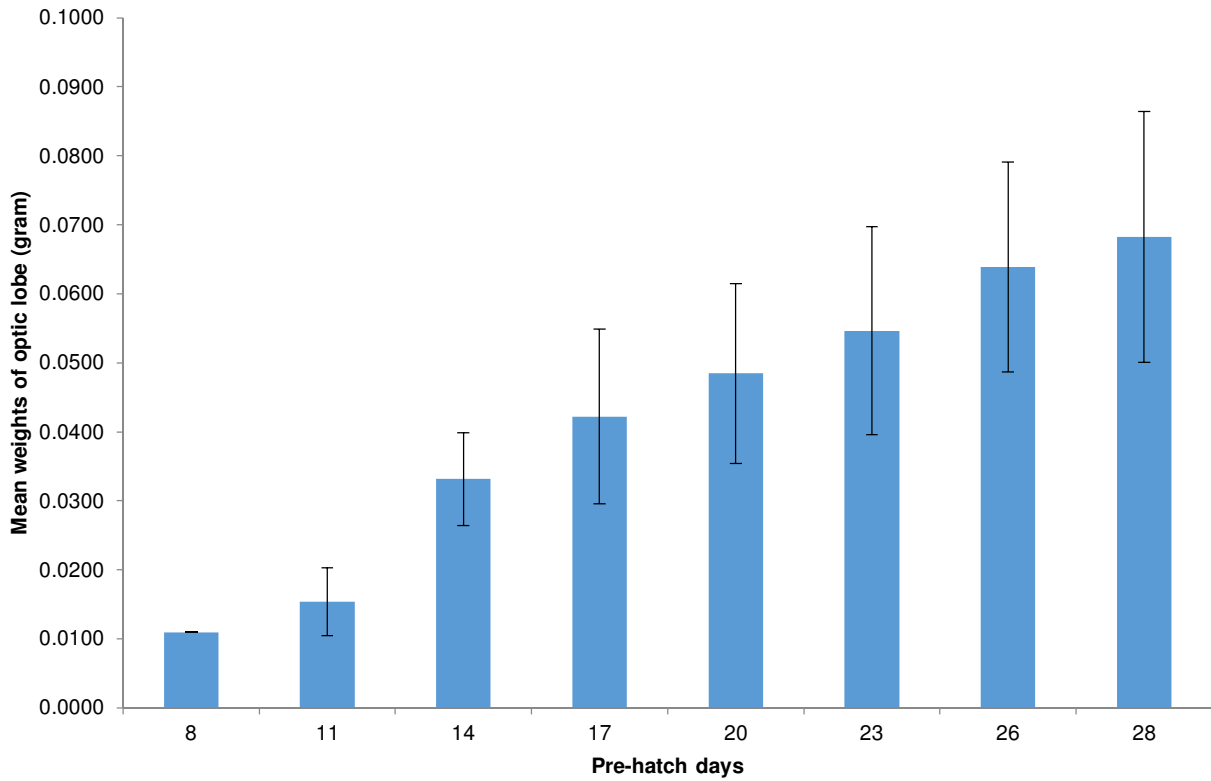


Figure 5: Mean weights of the guinea fowl embryo optic lobe at days 8 - 28 pre-hatch (in gram).

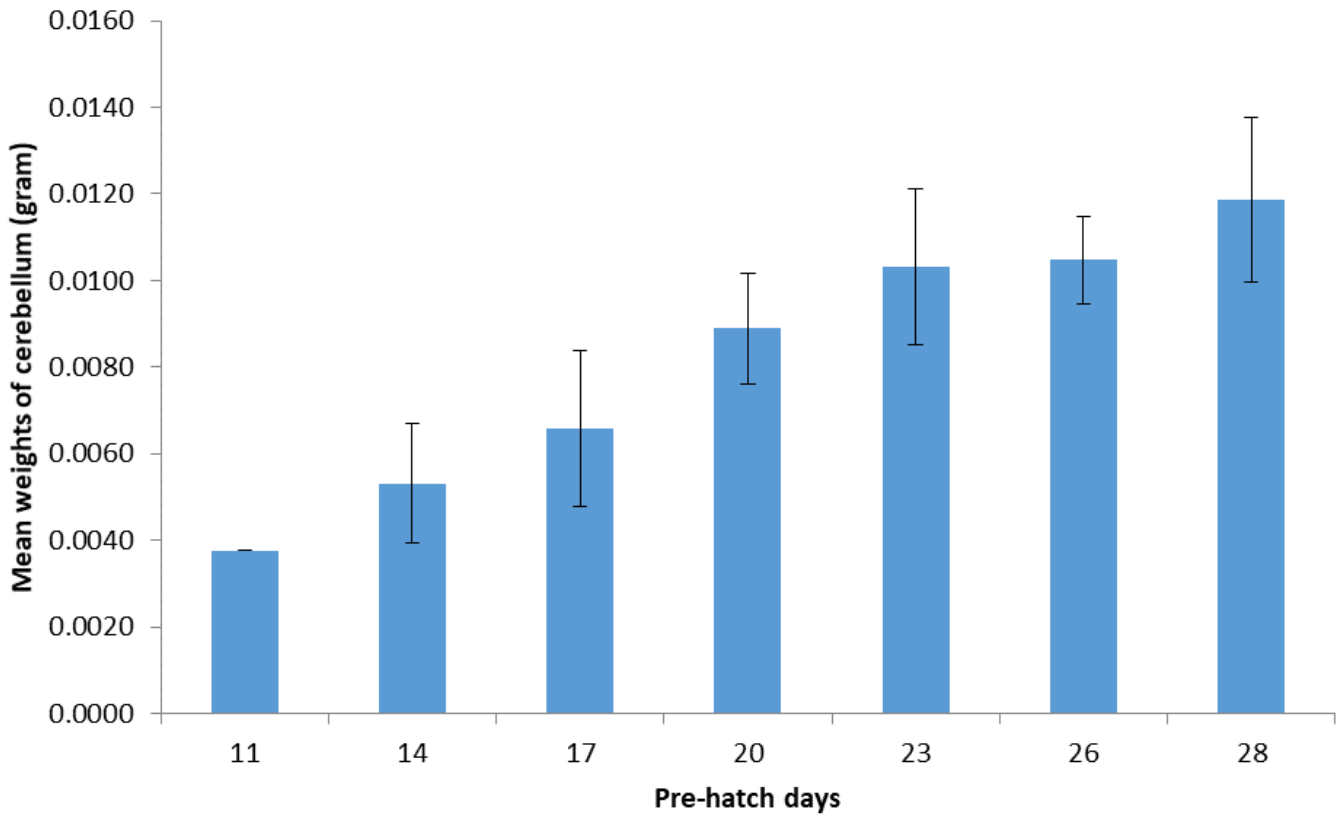


Figure 6: Mean weights of the guinea fowl embryo cerebellum at days 11 - 28 pre-hatch (in gram).

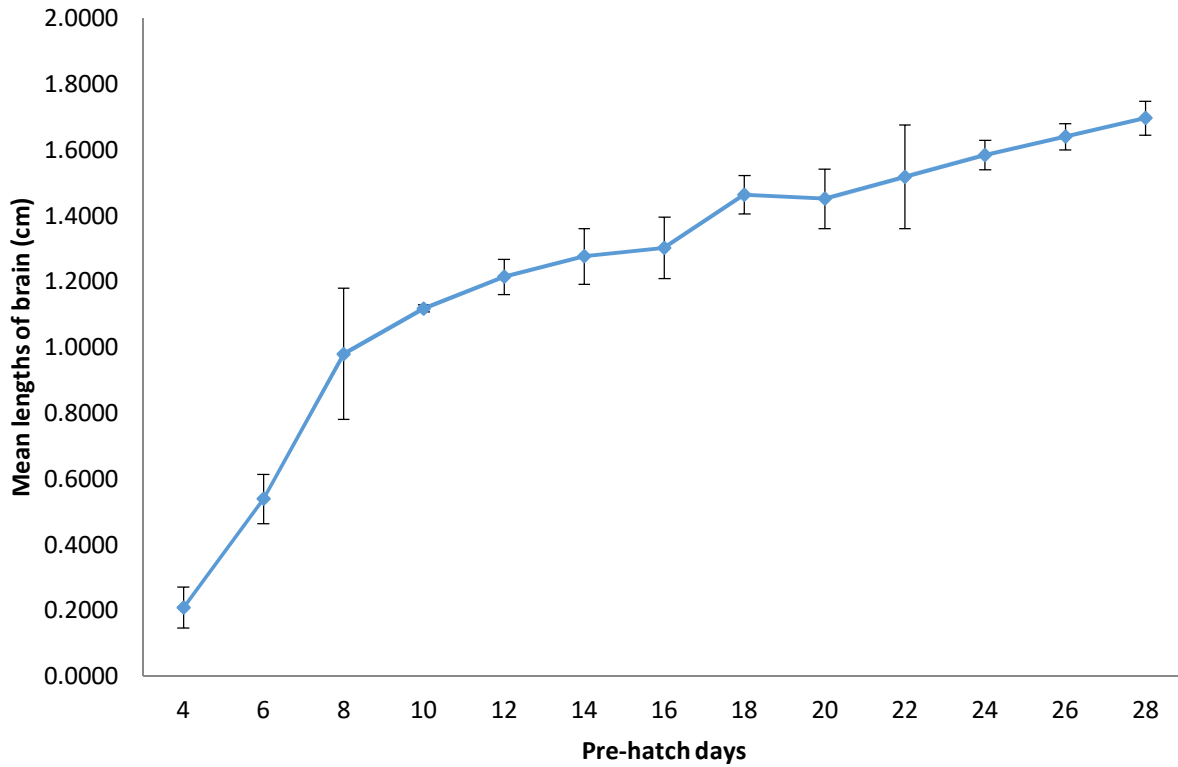


Figure 7: Mean lengths of the guinea fowl brain during days 4 - 28 pre-hatch (in centimeter)

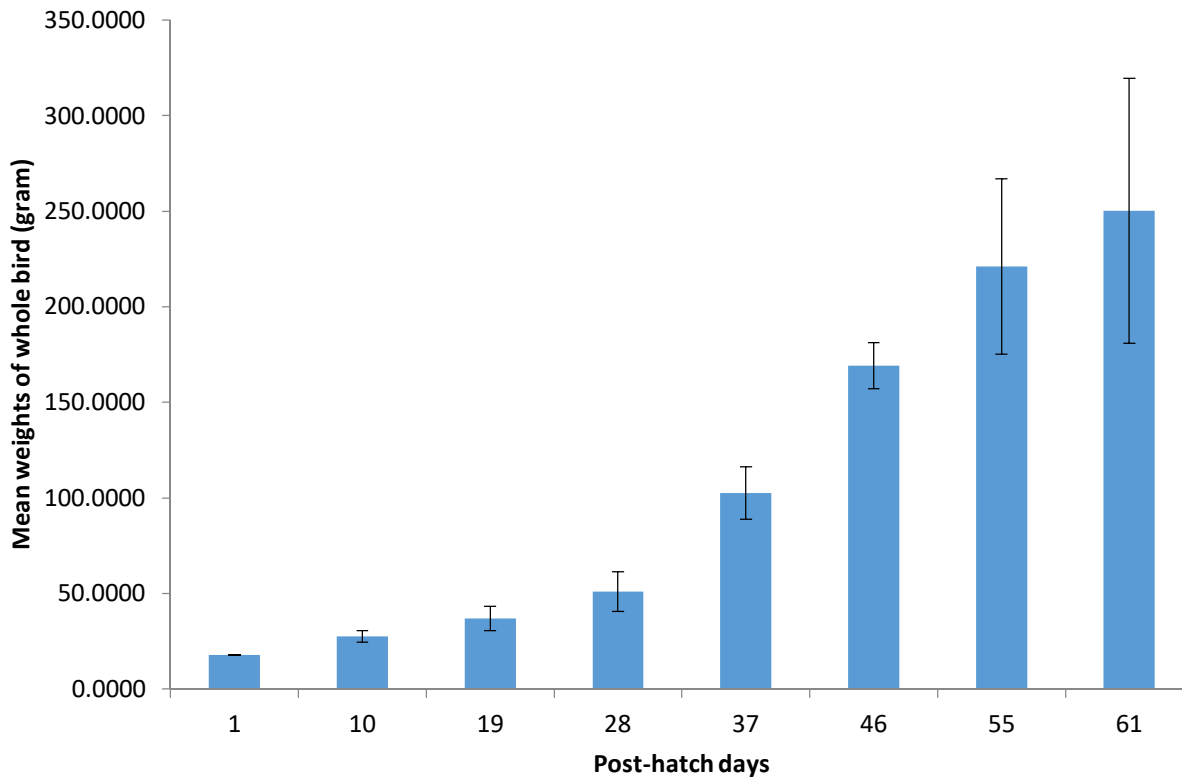


Figure 8: Mean weights of the keets at days 1- 61 post-hatch (in gram)

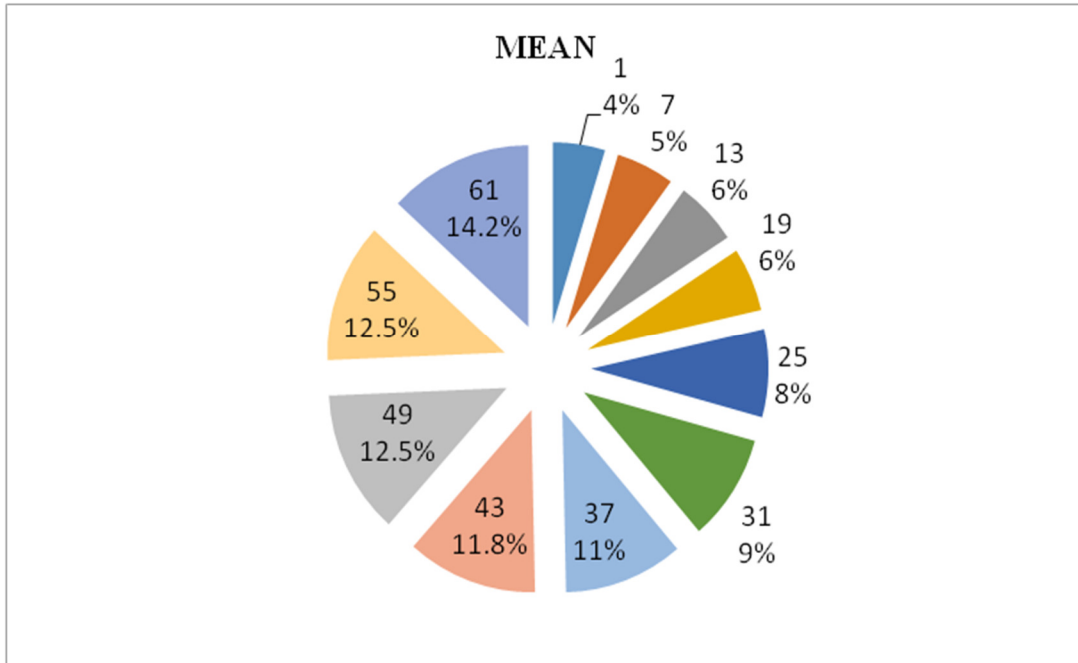


Figure 9: Pie chart illustrating the percentage of the brain mean weights at days 1- 61 post-hatch

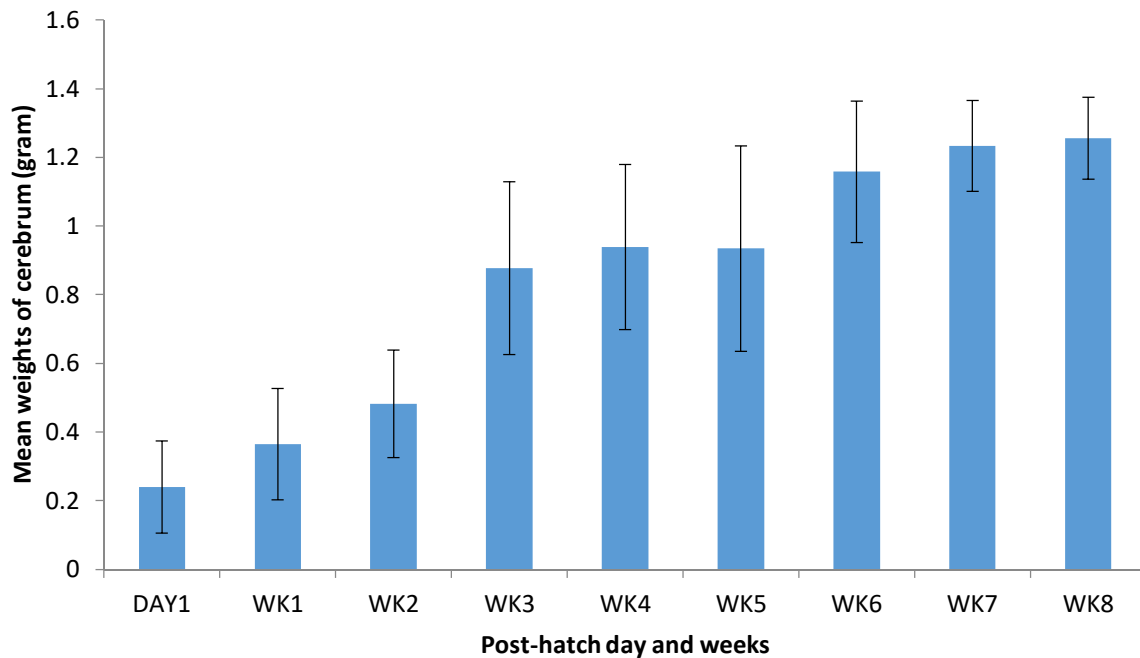


Figure 10: Mean weights of the of guinea fowl cerebrum day 1 and weeks 1 - 8 post-hatch

weights were 1.0559 ± 0.0278 g and 2.1646 ± 0.0261 g (Figure 9). Percentage wise, days 25, 31 and 61 had 8 %, 9 % and 14.2 % increase in mean weight of the brain post-hatch (Figure 9). The mean weight of the cerebrum at day 1 post-hatch was 0.2406 ± 0.1341 g. At weeks 3 and 6 post-hatch, the mean weights of cerebrum were 0.8772 ± 0.2509 g and 1.1578 ± 0.2059 g, respectively. It was

observed that at week 5, more than half of the mean weights of the cerebrum did not exceed above 1.0 g and was less than 1.40 g at week 8 post-hatch. The mean weights between weeks 3 and 4 were relatively stable above 0.8 g (Figure 10). The mean weight of the midbrain of the helmeted guinea fowl at days 1, 43 and 61 post-hatch were 0.0418 ± 0.0081 g, 0.1448 ± 0.0556 g and

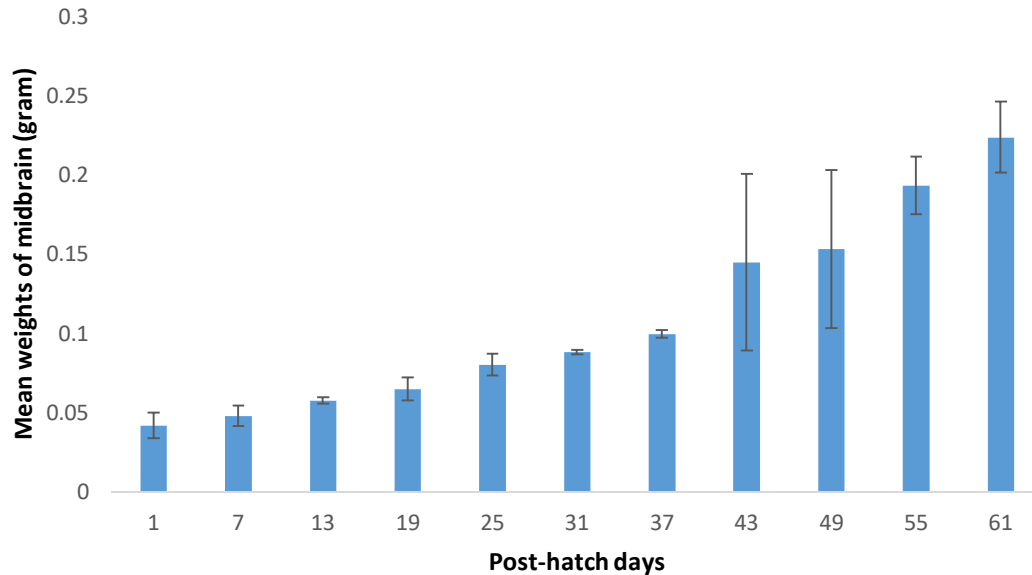


Figure 11: Mean weights of the guinea fowl midbrain at days 1 - 61 post-hatch (in gram)

Table 2: Mean weights of the guinea fowl optic lobe at days 1- 61 post-hatch (in gram) (n=7).

Days	Minimum	Maximum	Mean \pm SEM
1	0.1241	0.1752	0.1530 \pm 0.0067
7	0.1387	0.2014	0.1625 \pm 0.0089
13	0.1604	0.2446	0.1729 \pm 0.0095
19	0.1500	0.2050	0.1861 \pm 0.0069
25	0.1698	0.2510	0.2046 \pm 0.0140
31	0.1814	0.2974	0.2503 \pm 0.0431
37	0.2097	0.3027	0.2637 \pm 0.0138
43	0.2738	0.3494	0.3104 \pm 0.0100
49	0.2836	0.3604	0.3264 \pm 0.0110
55	0.2886	0.4003	0.3438 \pm 0.0147
61	0.2981	0.4009	0.3778 \pm 0.01360

n; number of birds used per day, SEM; Standard Error of Mean

Table 3: Mean weights guinea fowl cerebellum at days 1 - 61 post-hatch (in gram), (n=7).

Days	Minimum	Maximum	Mean \pm SEM
1	0.0810	0.1162	0.1037 \pm 0.0043
7	0.1050	0.1162	0.1092 \pm 0.0015
13	0.0953	0.1564	0.1244 \pm 0.01073
19	0.0974	0.1542	0.1489 \pm 0.1209
25	0.1273	0.1674	0.1478 \pm 0.0053
31	0.1557	0.2501	0.2062 \pm 0.0126
37	0.2071	0.2617	0.2420 \pm 0.0097
43	0.2054	0.2728	0.2536 \pm 0.0110
49	0.2127	0.2968	0.2651 \pm 0.0107
55	0.2470	0.3108	0.2902 \pm 0.0080
61	0.2579	0.3114	0.2998 \pm 0.0074

n; number of birds used per day, SEM; Standard Error of Mean

0.2236 \pm 0.0224 g, respectively. The chart indicated that the midbrain at days less than 37 weighed below 0.10 g, and thereafter, increased progressively (Figure 11). The mean weight of the optic lobe of the helmeted guinea fowl at day 1 post-hatch was 0.1530 \pm 0.0067 g, and this was less than that of the cerebrum but higher than that of the midbrain. At days 25 and 43, their mean weights were

0.2046 \pm 0.0141 g and 0.3104 \pm 0.0100 g, respectively. The optic lobes from days less than day 31, had their mean weights at about 0.2500 g, while at day 61, the mean weight was below 0.400 g (Table 2). The mean weight of the cerebellum at day 1 post-hatch was 0.1037 \pm 0.0043 g and at day 31 post-hatch it was 0.2998 \pm 0.0074 (Table 3). The mean lengths of the whole brain at post-hatch were

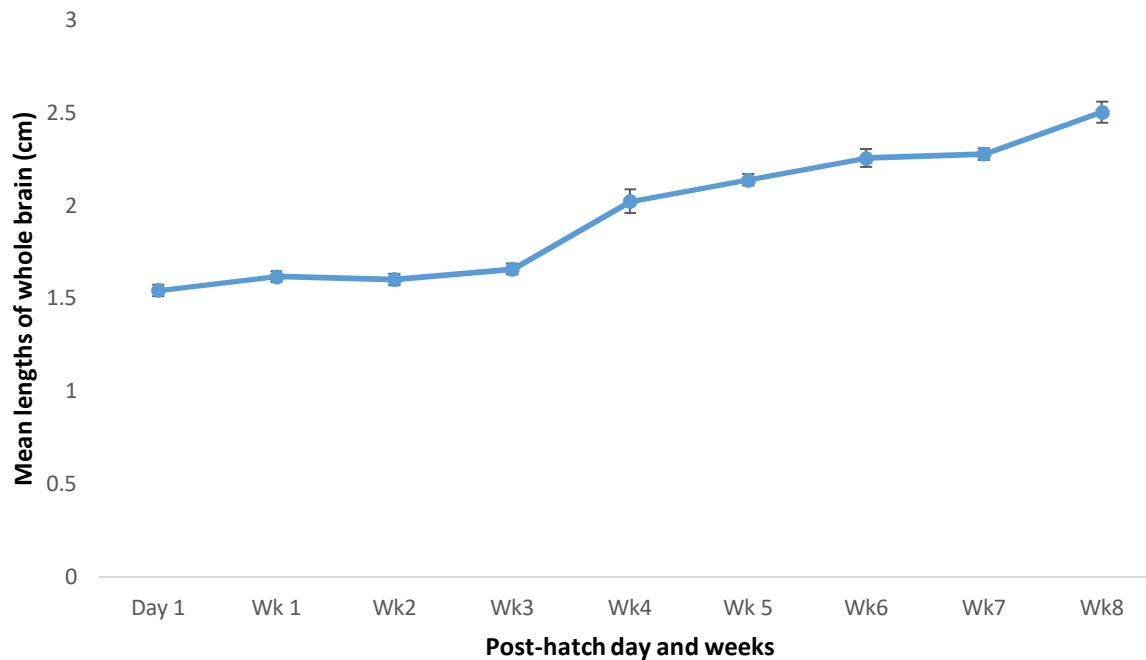


Figure 12: Mean lengths of the guinea fowl brain at day 1 and weeks 1- 8 post-hatch (in centimeter)

1.5406 ± 0.0321 cm and 2.0206 ± 0.0634 g at day 1 and week 4, respectively. It was observed that, the mean length of the whole brain exceeded 2.00 cm, only at week 4 and above (Figure 12).

DISCUSSION

From this present study, the result showed that the mean weight of the embryo of the helmeted guinea fowl between days 4 and 7 of incubation indicated 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 is 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 increases 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. The mean weights of the cerebrum and optic lobe on the first day, were found to be high while the midbrain was the least. This is in agreement with the findings of Wanmi (2012) in the domestic pigeon where he recorded a forebrain weight that was consistently higher in the female and male domestic pigeons (*Columba livia domestica*), making up 67.13 % of the total brain weight. This increase in the weight of the forebrain was attributed to the lengthening nature of the cerebral

hemisphere, which covered almost three quarters of the entire length of the brain.

During post-hatch study, the mean weight of the helmeted guinea fowl keet on days 1, 28 and 61 were 20.353 ± 1.1946 g, 51.443 ± 5.1568 g and 207.261 ± 23.6266 g 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. Moreki *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 week 4 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 and above (Igado and Aina, 2010).

The mean weight of the cerebral hemispheres post-hatch was highest followed by optic lobe, cerebellum and midbrain in that order. This order of decrease in the individual parts of the brain still conformed to the earlier observed pattern in the pre-hatch. The length of the helmeted guinea fowl brain did not exceed 2.5 cm at week 8 post-hatch.

The mean length of the brain was lower than the sum of the mean length values for cerebellum and cerebrum. These differences could be as a result of the shape of the brain in which the rostral portion of the cerebellum projects between the caudal poles of the hemispheres resembling an outline of a card symbol of a spade (Baumel, 1975).

Conclusion

Brain development and body evaluations has been used in various species of animals to estimate age at either prenatal or postnatal developmental period of life. In this study, the brain weight increased proportionally with body weight, though it remained consistently lower.

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Authors' contributions

All authors contributed meaningfully up to the submission of this article.

Ethical considerations

Ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been checked by all the authors.

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