P-ISSN: 2304-3075; E-ISSN: 2305-4360
International Journal of Veterinary Science
www.ijvets.com; editor@ijvets.com

Research Article

Comparative Gross Morphology and Morphometric Investigations on the Alimentary Tract of Three Age Groups of Barn Owl (*Tyto alba*) Found in North-Central Nigeria

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Article History: Received: September 20, 2016 Revised: September 30, 2016 Accepted: October 22, 2016

ABSTRACT

The recent increase interest on the research of various aspects related to the barn owls (*Tyto alba*) is due to the unique features of the bird in keeping down rodent pests. By identifying the prey fragments in the pellets of indigestible matter that the bird regurgitates it is easy to tell of the diet it consumed to maintain its energy demand. This work seeks to fill the gap on information concerning the gross morphology and morphometric of the alimentary canal of the barn owl (*Tyto alba*) found in North-central Nigeria.

Fifteen apparently healthy Barn Owls of different age groups were used for this work. The live body weight of birds were taken and then euthanized by lethal injection. Dissection was done to gain access to different cavities of the bird for gross anatomic studies of the alimentary canal. The alimentary canal of the three age groups of birds studied presented similar morphological findings. The tongue appeared elongated and triangularly shaped with a pointed tip and a downward projection from the body with a cleft at the middle of the body. There was no crop. The stomach was cone shaped consisting of a cranial glandular compartment and a caudal muscular compartment. A 'U' shaped duodenum was clearly visible towards the right side of abdominal cavity, whereas the duodenal loop partly covered the jejunum and ileum. The vitelline diverticulum marks the end of the jejunum and the beginning of the ileum which is the shortest segment of the small intestine. The large intestine consists of two caeca (left and right) and a colorectum. The proximal parts of both caeca were ovoid in shape while the distal part is straight and tiny giving it a microphone or match stick shape. Morphometric measurements of the alimentary canal of the barn owl in the three age groups studied showed a significant difference at $P<0.05$ on the tongue; stomach and duodenum with emphasis on the adults and owlets. In summary, the decreasing order in length of the different segments of the gastrointestinal tract of the common barn owl studied was found to be: jejunum>duodenum>oesophagus>tongue>ileum>stomach> caecum> colorectum.

Key words: *Tyto alba*, Barn owl, Alimentary canal, Gross morphology, Morphometrics, North-central Nigeria

INTRODUCTION

Recently, there had been increased interest on the research of various aspects related to the barn owls (*Tyto alba*) due to the unique features of the bird and its importance to farmers being more effective than poison in keeping down rodent pests (Meryom *et al.*, 2009)

Barn owl (*Tyto alba*) has been known to be a twilight and nocturnal bird that hunt small vertebrates and are peculiar in their ability to display various adaptations that makes them effective under low light conditions (Owloski *et al.*, 2012). Sound localization capabilities of barn owls are unique (Payne, 1974 and Takahashi, 2010) and with specific feather design leading to silent flight displaced by this bird (Owloski *et al.*, 2012 and Bachmann *et al.*, 2007).

Diet consumed by barn owls can be known by simply identifying the prey fragments in the pellets of indigestible matter that the bird regurgitates (Taylor, 2004). It has been reported that this bird is usually more specialist feeders in productive areas and generalists in drier areas (Taylor, 2004) in order to meet up their energy demands.

Maintaining energy demanding processes like growth, excretion, reproduction and metabolism for optimal survival and ecological success among animals

Cite This Article as: Oyelowo F, I Usende, E Abiyere, A Adikpe and A Ghaji, 2017. Comparative Gross Morphology and morphometric investigations on the alimentary tract of three age groups of barn owl (*Tyto alba*) found in North-Central Nigeria. Inter J Vet Sci, 6(1): 7-12. www.ijvets.com

including the barn owls is a necessity (Karasov, 1986). As a result, animals have to take, process, and allocate energy, proteins, and other nutrients (Veloso and Bozinovic, 2003), from their food. Food conversion into metabolizable energy occurs in the alimentary tract, extending from the oral cavity to the anus (Lambert, 1998). Despite the wealth of information on the visual acuity (Owloski *et al.,* 2012), feed habits (Taylor, 2004), sound localization (Payne, 1971; Takahashi, 2010), feathering and silent flight (Owloski *et al.,* 2012 and Bachmann *et al.,* 2007) patterns of the barn owl, there is paucity of information on the gross morphology and morphometry of the alimentary canal of this bird.

Here, we set to investigate and give a full description of gross morphology and morphometry of the alimentary canal of barn owl (*Tyto alba*) found in North-central Nigeria.

MATERIALS AND METHODS

Fifteen apparently healthy Barn owls of different age groups (five adults, five adolescents and five owlets) were used for this work. They were captured by local hunters at the Faculty of Veterinary Medicine, University of Abuja and immediately taken to the gross Veterinary Anatomy laboratory unit of the faculty where they were identified by a zoologist. The live body weight (g) of each bird in each group was measured using a bench top scale (Gallenkomp FA2104A, England) and was immediately euthanized by lethal injection with Ketamin (100mg/kg) and xylazine (10mg/kg) combination intraperitoneally (Usende *et al.,* 2016). Quick dissection was done to gain access to the oral, thoracic, abdominal and pelvic cavities of the bird for gross anatomic studies of the alimentary canal. Organs were noted *in-situ* and then were eviscerated. Photographs were taken before evisceration and afterwards using a digital camera (Samsung ES95, 16.2 megapixels). The digestive tracts were then collected for gross and morphometric studies. The location, shape, weight (g) and length (cm) of each segment of alimentary canal were considered for this study and were compared among age groups. For gross length morphometrics; the following parameters were taken using meter rule, thread and venier caliper:

i. *Length of oesophagus (LOO)*: measured from the glottis to where it joins the proventriculus at the bifurcation of the trachea.
ii. *Length of stomach (LOS)*: because there was no clear demarcation between a proventriculus and ventriculus, these organs were taken as a whole and name stomach. Measured from the caudal end of oesophagus to the cranial extremity of the duodenum.
iii. *Length of duodenum (LOD):* measured from the stomach outlet to the end of pancreatic loop at the duodeno-jejunal junction.
iv. *Length of jejunum (LOJ)*: measure from the duodeno-jejunal junction to the point of origin of the regressed vitelline diverticulum
v. *Length of ileum (LOI)*: measured from the point of the regressed vitelline diverticulum to the point of the ileocaecocolic junction.
vi. *Length of caecum (LOC):* measured from the ileocaecocolic junction to the blind end of the cecum
vii. *Length of colorectum (LOCR)* was measured from the point of the ileocaecocolic junction to the slight enlargement of the cloaca.

Data analysis

All data obtained from the three age groups were expressed as Mean±SEM (Standard Error of Mean) and subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) version 20.0. One-Way Analysis Of Variance (ANOVA) at 95% confidence interval (CI) was used to determine the level of significant difference in mean values among the three age groups of owl birds studied. Values of ($P<0.05$) were considered significant. Where there were differences in means, they were separated by Turkey's Honestly Significant Difference (HSD) (Kaps and Lamberson, 2004).

RESULTS

Gross morphology

The Tongue: The common barn owl (*Tyto alba*) studied has an elongated triangular shaped tongue with a pointed tip (apex linguae) and a downward projection from the body (horny papillae) located in the floor of the oral cavity. A cleft (laryngeal cleft) was noticed in the middle of the body of the tongue (Fig. 1-A and Fig. 2-B).

The Oesophagus: The esophagus was found to be a long, narrow and somewhat straight tube extending from the posterior end of the tongue, through the neck and thorax to join with the stomach at the abdominal cavity (Fig.1-C and Fig.3). It lies behind the trachea and heart . The oesophagus has two divisions at the point it enters into the thorax; the cervical and the thoracic division. The crop was absent in barn owl.

The Stomach: The stomach has the shape of a cone and consisted of a cranial glandular compartment (proventriculus) and a caudal muscular compartment (ventriculus), although not clearly distinct from each other when grossly observed (Figs. 1-E and Fig. 4A). However, when dissected, the glandular part can be differentiated from the muscular part (Fig. 4A and B). The muscular part was observed to have muscular folds in a wavelike manner (Fig. 4B-M) and the length and thickness of these folds increased with increasing age and most prominent in the adult.

The Small Intestine: The gross appearance of the small intestine was similar in all the three groups of barn owl studied and consists of duodenum, jejunum and ilium in that order. The 'U' shaped duodenum was clearly visible towards the right side of abdominal cavity, whereas jejunum and ileum were partly covered by the duodenal loop. The loop consists of a descending and an ascending limb and the pancreas sand-wished between them (Fig. 1-F and Fig. 5). Ventrally, the duodenum appeared as a bulged part of the small intestine. It starts from the antero-dorsal aspect of the ventriculus and ended at the terminal point of its ascending limb towards the anterior aspect of the abdominal cavity. The duodenum on its left side was related to the right side of the ventriculus and dorsally it covered the jejunum, caecum and ileum whereas, on the

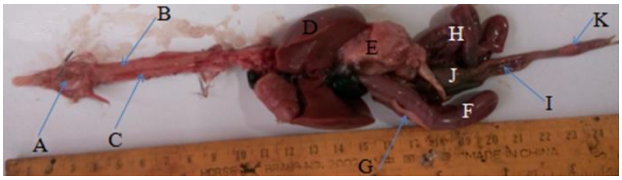

Fig. 1: Showing photograph of the GIT of common barn owl (*Tyto alba*) A=tongue, B=trachea, C=oesophagus, D= liver, E= stomach, F=duodenum, G=pancreas, H=jejunum, I= ileum, J= caecum, K=colorectum.

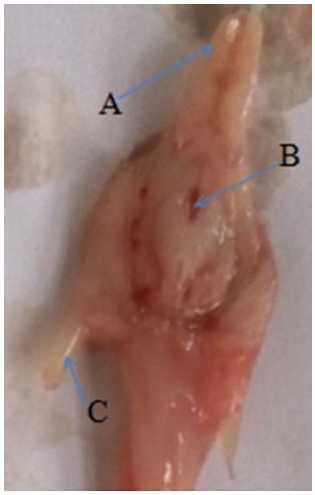

Fig. 2: Showing photograph of the tongue (ventral view) of common barn owl (*Tyto alba*) A= apex linguae, B=laryngeal cleft, C=horny papillae.

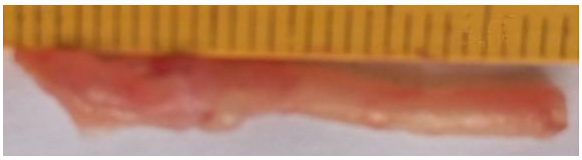

Fig 3: Photograph of the oesophagus of common barn owl (*Tyto alba*)

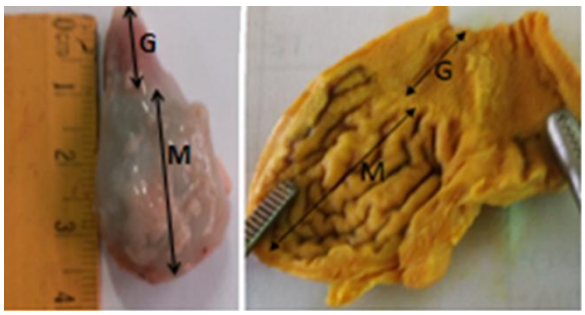

Fig 4: Showing photograph of the stomach Exterior (a) and Interior (b) views of common barn owl (*Tyto alba*) G=glandular portion, M=muscular portion.

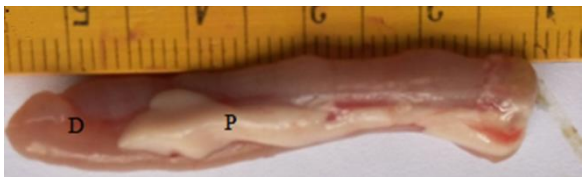

Fig 5: Showing photograph of the duodenum and pancreas of common barn owl (*Tyto alba*) D=duodenum, P= pancreas

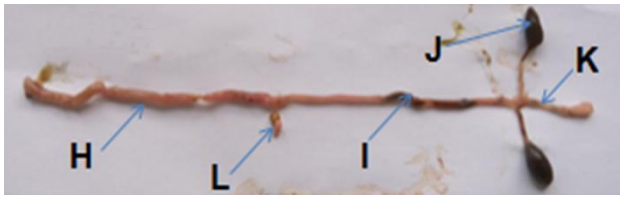

Fig. 6: Showing photograph of the GIT of common barn owl (*Tyto alba*) H=jejunum, I= ileum, J= caecum, K= colorectum, L= vitelline diverticulum

right side it was in contact with the right lobe of liver and lateral body wall. The jejunum which is arranged in coils (jejunal loops) (Fig. 1-H and Fig. 6-H) was the longest segment of the small intestine and was suspended by mesentery to the dorsal part of abdominal cavity. It takes its origin from the caudal end of the duodenum where the bile and the pancreatic ducts are located and ends at the ileocaeco-colic junction (the junction where the small intestine, the two caeca and the colon meets). The vitelline diverticulum (Fig. 6-L) marks the end of the jejunum and the beginning of the ileum in all the three age group of barn owl studied. The shortest segment of the small intestine (ileum) (Fig. 6-I) extends from the vitelline diverticulum to the initial segment of the large intestine

The Large intestine: The large intestines of barn owl studied consist of two caeca (left and right) and a colorectum in all the three age groups. The two caeca were blind pouches that extend along the line of the small intestine towards the liver having proximal and distal part, and were closely attached to the small intestine along their length by mesentery. The proximal part is ovoid in shape while the distal part is straight and tiny giving the caecum a microphone shape or match stick shape (Fig. 1-J and Fig. 6-J). This finding is unique in this bird and consistent among the three age groups. The colorectum is the terminal segment of the intestine, it begins at the ileocaecocolic junction and ends with the cloaca. It is short and straight (Fig. 1-k and Fig. 6-k).

Morphometrics

Results of the live weight and morphometric measurements of the alimentary canal of the barn owl in the three age groups studied are presented in tables: 1 and 2 and also in charts: 1 and 2. The mean live weight increased with age with significant difference.

DISCUSSION

Gross morphology

In the present study, the tongue of the common barn owl which is located in the floor of the oral cavity was observed to be elongated, triangular in shape with a pointed tip (*apex linguae)* and a downward projection from the body (*horny papillae*). The tongue also has a cleft (*laryngeal cleft)* at the middle of the body. These findings (apex liguae, horny papillae and laryngeal cleft) were in agreement with the recent findings of Farouk and Hassan (2015) on the tongue of laughing dove but such findings were not observed by Khalid *et al.*,(2014) on the tongue of black francolin.

Table 1: Weight of the various segments of the GIT of common barn owl

Parameter	Owlet (Mean±SEM)	% per segment	Adolescent (Mean±SEM)	% per segment	Adult (Mean±SEM)	% per segment
Body weight	64.6±14.24[a]		331.61±5.46[b]		380.29±3.14[c]	
Total Weight of GIT	11.39±2.40[a]	17.79	20.39±0.86[b]	6.15	22.38±0.53[c]	4.87
Tongue	0.36±0.10[a]	0.56	0.81±0.32[b]	0.24	0.9±0.99[b]	0.26
Oesophagus	1.08±0.29[a]	1.67	2.07±0.61[b]	0.62	2.09±0.82[b]	0.51
Stomach	4.05±1.30[a]	6.27	6.15±0.47[b]	2.39	7.93±0.12[c]	1.62
Duodenum	2.65±0.75[a]	4.1	4.90±0.43[b]	1.48	4.91±0.26[b]	1.21
Jejunum	1.74±0.42[a]	2.7	3.73±0.25[b]	1.12	3.79±0.20[b]	0.94
Ileum	0.27±0.65[a]	0.40	0.36±0.66[a]	0.11	2.19±0.17[b]	0.19
Caecum	0.35±0.90[a]	0.73	0.38±0.29[a]	0.12	0.39±0.55[a]	0.08
Colorectum	0.89±0.50[a]	1.38	0.18±0.77[a]	0.05	0.18±0.85[a]	0.07

n=5, N=15, SEM= Standard error of mean, Level of Significance at P<0.05, % per seg = (Segment/Body weight) *100%. Weight was measured in grams (g). (Mean±SEM) along the same horizontal row with different superscript are statistically different

Table 2: Length of the various segments of the GIT of common barn owl

Parameter	Owlet (Mean±SEM)	% per segment	Adolescent (Mean±SEM)	% per segment	Adult (Mean±SEM)	% per segment
Total Length of Git	56.92±5.90[a]		64.92±0.60[b]		68.47±0.98[b]	
Tongue	5.80±0.23[a]	11.31	8.32±0.10[b]	12.5	8.40±0.10[b]	13.27
Oesophagus	9.62±0.23[a]	9.55	9.62±0.23[a]	14.45	9.64±0.36[a]	14.25
Stomach	3.39±0.48[a]	6.61	5.38±0.21[b]	8.09	5.56±0.94[b]	8.78
Duodenum	10.36±1.09[a]	20.20	12.00±0.17[b]	18.43	12.26±0.00[b]	18.98
Jejenum	14.94±2.25[a]	29.13	15.80±1.21[a]	26.50	17.62±0.89[b]	24.96
Ileum	5.56±0.40[a]	10.84	5.66±0.79[a]	7.72	7.40±0.66[b]	11.69
Caecum	3.68±0.53[a]	7.71	4.62±0.17[a]	6.94	4.64±0.11[a]	7.33
Colorectum	3.57±0.51[a]	6.28	3.54±0.21[a]	5.35	3.50±0.34[a]	4.83

n=5, N=15, SEM= Standard error of mean, Level of Significance at P<0.05, %per seg = (Seg.lenght/Total GIT Lenght)*100%. Length was measured centimeter (cm). (Mean±SEM) along thesame horizontal row with different superscript are statistically different

The esophagus was observed to be the first part of the alimentary canal after the tongue connecting the laryngeal part of the pharynx with the stomach and was divided into the cervical and thoracic portions. It was pale red in color and lied dorsal to the trachea throughout its length. Similar findings have been reported by Hamida *et al.,* (2013) on black winged kite (*Elanus caeruleus)* and also by Mostafa *et al.,* (2012) on common quail (*Couturnix couturnix*). The crop was absent in barn owl which is in agreement with the findings of Lei, (2015) that reported absence of crop in Grey-backed shrike (*Lanius tephronotus*). However, this was contradicted in a study by Mostafa *et al.,* (2012) where crop was observed to be present in common quail.

Anatomically, the present study reveals that the stomach has a thicker and powerful ventricular wall with muscular folds compare to the proventriculus. This difference could be as a result of diet. This observation was similar to that of Denbow (2000) and Taylor (2000). The length and thickness of the folds increased with increasing age and was most prominent in the adult. These findings were in agreement with previous reports on the stomach of fowl by Suganuma *et al.,* (1981), Bailey *et al.,* (1997), Bacha and Bacha (2000) and Dyce *et al.,* (2002).

In this present result, the small intestine of common barn owl (*Tyto alba)* is differentiated into duodenum, jejunum and ileum. These results agree with Taylor (2000) and Vukicevic (2004). The jejunum of the common barn owl is arranged in coils (jejunal loops) and was the longest segment of the small intestine and was suspended by mesentery to the dorsal part of abdominal cavity. It takes its origin from the caudal end of the duodenum where the bile and the pancreatic ducts are located and ends at the ileocaeco-colic junction (the junction where the small intestine, the two caeca and the colon meets). Similar findings have been reported by Mostafa *et al.,* (2012) in common quail (*Coturnix coturnix)*. Ventrally, jejunum was in contact with duodenum and ventriculus. Hamida *et al.,* (2013) reported absence of jejunum in black- winged kite *(Elanus caeruleus)*. In this study, the vitelline diverticulum marks the end of the jejunum and the beginning of the ileum in all the three age group of barn owl studied. This vitelline diverticulum has been reported absent in black- winged kite (2013) but present in common quail (Mostafa *et al.,* 2012). The result on location and relationship of small intestines to other organs is similar to the previous works of Ahmad *et al.,* (2012) on small intestine of quail.

The present study revealed that, the rectum and colon of cannot be differentiated from each other and hence called colorectum, which is the terminal segment of the intestine. It begins at the ileocaecocolic junction and ends with the cloaca. Similar to the report of Strobel *et al.,* (2015) on common pipistrelle bat (*Pipistrellus pipistrellus*), barn owl is both carnivorous and omnivorous hence has a pair of well developed caeca. This agrees with Chen *et al.,* (2002) in geese. The two caeca were blind pouches and extend along the line of the small intestine towards the liver having proximal and distal part, and were closely attached to the small intestine along their length by mesentery. These results are similar to earlier reports of Hassouna (2001) and Nasrin *et al.,* (2012) in chickens.

Morphometrics

The mean live body weight the birds increased with age with a significant difference (P<0.05). Similar findings have been reported by Usende *et al.,* (2013) on live body weight of two hybrids of broiler birds.

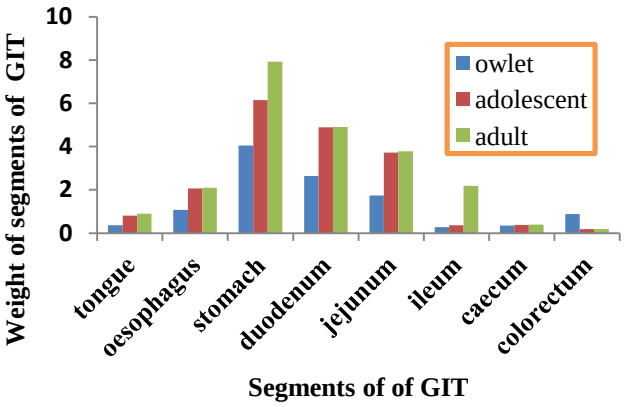

Chart 1: Comparison of the mean weights (g) of oesophagus, tongue, stomach duodenum, jejunum, ileum, caecum and colorectum in owlet, adolescent and adult Common Barn Owl(*Tyto alba*).

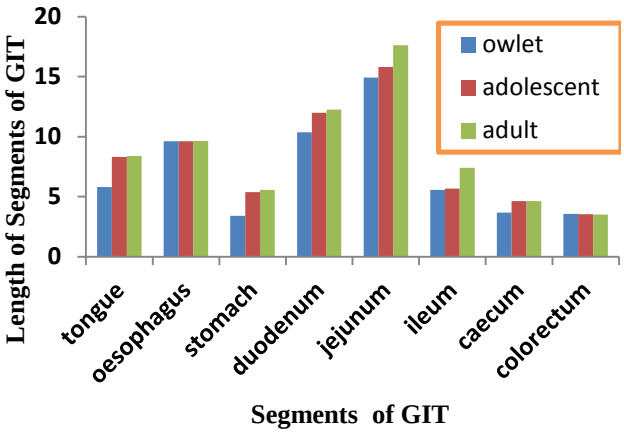

Chart 2: Comparison of the mean length (cm) of oesophagus, tongue, stomach duodenum, jejunum, ileum, caecum and colorectum in owlet, adolescent and adult of Common Barn Owl (*Tyto alba*).

On the tongue, there was no significant difference (P>0.05) between the weight and length of the adolescent and adult. However, a difference (P<0.05) was observed when the owlet was compared to the adolescent on same parameter. The same pattern was observed with the oesophagus. However, the weight and length of the oesophagus of adult barn owl reported here is significantly lower (P<0.05) than that reported for same organ in three different Nigeria indigenous genotypes of chicken (Mahmud *et al.,* 2015). The difference could be attributed to the different breeds of avian species used.

The weight of stomach of owlet was significantly lower than the adolescent and adult. The adolescent and adult showed no difference (P>0.05) when statistically compared. The same pattern was observed with the weight and length of the duodenum. The jejunal weight showed no significant difference (P>0.05) between the adolescent and the adult barn owls. However, a difference (P<0.05) was observed when the jejunal weight of the owlet was compared with the other two age groups.

For the length of the jejunum, an opposite result was seen; no significant difference (P>0.05) was noticed between owlet and adolescent. However, when the adult owl was compared with the other groups, there was a significant difference (P<0.05) observed. On the morphometrics of the ileum, caecum and colorectum of the three age groups studied, only the weight of the ileum of adult showed a significant difference. The caecum and colorectum of all the three age groups showed no significant difference (P>0.05) statistically. The increase in length and weight of the intestinal segments observed with increase in age could be attributed to such factors as; change in diet, high feed intake, and increased digestion and absorption. These were similar to the reports of Usende *et al.,* (2013). The length and weight of all the segments of the gastrointestinal tract of adult barn owl measured were significantly lower (P>0.05) than reports on the same segments in three Nigeria indigenous genotype of chicken (Mahmud *et al.,* 2015). The possible reason could be difference in breeds, nutrition and age.

Conclusion

The report on this study showed that the common barn owl found in North central Nigeria has no crop and this was contrary to the reports on other birds. The stomach is cone shaped and it is not distinctly separated into proventriculus and ventriculus externally but distinct internally. A unique microphone or match stick shape was characteristic of the caecum. This shape of the caecum has not been described in literature, we venture therefore, to call it microphone shaped caecum (of Abiyere). The small intestine was found to have the highest weight, followed by stomach, oesophagus, tongue and large intestine. There was a level of significant difference in weight; between other segments of the GIT except the colorectum in the three age groups. The mean length of the stomach, small and large intestines of the three age groups studied were not statistically significant. In summary, the decreasing order in length of these different segments of the GIT was found to be: jejenum>duodenum>oesophagus>tongue> ileum>stomach> caecum> colorectum.

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