



Some aspects of the craniometry of adult Nigerian indigenous pigs (*Sus scrofa*) and its application in regional anaesthesia

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Abstract

Regional anatomy is an important component of surgical and clinical practice because it helps clinicians envisage the specifics of the structures relevant to the case at hand. This study was designed to evaluate some clinically important indices which could aid regional anaesthesia of the head in the Nigerian indigenous pig (NIP). Twenty-four (10 males and 14 females) skulls of adult NIP were examined to record 10 parameters. Data obtained were statistically analysed using the Student's t-test and Pearson Correlation, with significance set at $p < 0.05$. The study revealed that 50% of the indices were higher in female skulls but were not statistically significant. The mandibular length was, however, significantly longer in male skulls (19.0 ± 0.41), compared to females (18.0 ± 0.26). The distance from the facial crest to the infraorbital foramen was 1.3 ± 0.10 cm and 1.5 ± 0.08 cm, while that from the supraorbital foramen to the nasal bone was 2.1 ± 0.06 cm and 1.9 ± 0.06 cm, in male and female skulls, respectively. Pearson correlation analysis revealed a positive relationship between the distance from the facial crest to infraorbital foramen and that from infraorbital foramen to medial canthus of the orbit ($r = 0.669$). An accessory supraorbital foramen was seen in 12 (50%) of all the 24 skulls, just as several lateral mental foramina were observed on the rostro-lateral surface of the mandibular rami. Data generated provide clinically important information on the skull of adult Nigerian indigenous pigs which can be used as landmarks for tracking and desensitizing the branches of the frontal nerve (supraorbital), the maxillary nerve (Infraorbital) and the mandibular nerve, during the regional anaesthesia of the head, for tooth extraction procedures and the treatment of injuries and fractures. These results may also be useful for comparative anatomical, developmental, forensic, and clinical studies.

Keywords: Applied anatomy, Craniometry, Infraorbital nerve, Nigeria local pigs; Regional anaesthesia

Introduction

The Pig, *Sus scrofa*, belongs to the super-order *Ungulata*, the order *Artiodactyla* and Family *Suidae* (Myers *et al.*, 2022), and has around 500 species, with varied shape, size, colour and reproductive potentials (Rothschild, 2004; Wiener & Wilkinson, 2011;

Wilkinson *et al.*, 2013; Osei-Amponsah *et al.*, 2017). The several similarities in the morpho-physiology of tissues between humans and pigs have made them suitable models for biomedical training and research (Okandeji *et al.*, 2021; Okandeji *et al.*, 2023). The

similarities include dental characteristics, renal morphology and physiology, skin morphology and physiology, cardiovascular anatomy and physiology, and digestive anatomy and physiology (Nafikov & Beitz, 2007).

The Nigerian indigenous pig (NIP), also called the Nigerian local pig, is a predominantly black-coloured, moderately-sized pig breed having a short forehead, an elongated snout, and medium-sized ears. NIPs are narrow-bodied with relatively long legs, slightly elevated rumps and tails that end in tassels. (Okandeji *et al.*, 2022). They live with humans and are raised under semi-intensive management. They have reduced growth rate and poor carcass characteristics but possess the capacity to endure periods of high temperatures and insufficient food. They are reportedly resistant to several parasitic and infectious diseases (Abenga & Lawal, 2005; Adeola *et al.*, 2013). The head is an important part of wild and domestic animals as it houses and gives protection to important organs including the brain, eyes, nose, mouth, and their associated structures. An animal's health can thus be determined by the physiological status of these structures (Choudhary *et al.*, 2019; Din *et al.*, 2020). Regional anatomy deals with the structural and functional relationships of several anatomical structures available in a specific area. It is considered to be important in surgical and clinical practices because it helps the clinician to envisage the specifics of the structures which are important to the case being handled (Sarma, 2006); Keneisenuo *et al.*, 2021). An understanding of the regional anatomy of the head is important because the head coordinates the body, deglutition, olfaction, and defence (Dalga & Aslan, 2021). The different foramina on the skull are also clinically important when performing regional anaesthesia for surgical interventions on the head (Hall *et al.*, 2000, Olopade & Okandeji, 2010; Keneisenuo *et al.*, 2021).

Applied anatomy of the head, as it relates to regional anaesthesia has been reported in wild and domestic animals, including the antelope (Choudhary & Singh, 2015; Din *et al.*, 2020), deer (Keneisenuo *et al.*, 2021), sun bear (Kalita *et al.*, 2019), camel (Yahaya *et al.*, 2011; Monfared, 2013c; Choudhary *et al.*, 2016), cattle (Monfared, 2013b; Choudhary *et al.*, 2020), dog (Monfared, 2013d), goat (Olopade & Onwuka, 2007; Samuel *et al.*, 2013; Dalga, 2020; Dalga & Aslan, 2021), horse (Monfared, 2013a), sheep (Jashari *et al.*, 2022) and pig (Dyce *et al.*, 2002; Olopade & Okandeji, 2010; Choudhary *et al.*, 2017, 2019). There is, however, no information on the craniometric indices that relate to the applied anatomy of the skulls of

adult Nigerian indigenous pigs. This study was therefore designed to identify and evaluate some clinically important indices and landmarks which could be important in aiding the regional anaesthesia of the head of the Nigerian indigenous pig.

Materials and Methods

Study animals

For this study, 24 (10 males and 14 females) skulls of adult NIP were examined. The skulls were obtained from live pigs used for another study. Ethical Approval for the study was obtained from the University of Ibadan Animal Care and Use Research Ethics Committee (UI-ACUREC/20/009). The animals were selected on the basis of being apparently healthy and without any head deformity. The skulls were aged based on birth records made available, and varied between 24-51 months.

Methods

The animals, after adequate restraints, were slaughtered by decapitating them rapidly, at the atlanto-occipital joint. These heads were thereafter processed by using a modification of the hot water maceration technique reported by Okandeji (2012).

Brief description of the technique

After flaying the skin and the removal of a large chunk of muscles and other soft tissues (with sharp knives scalpel blade on a holder and probe), the heads were placed in a metallic pot containing water, detergent powder and chips of bar soap and heated to over 100°C for 45 minutes to 120 minutes. After boiling, the heads were removed placed under running water to remove muscle, ligaments or soft tissue remnants, using sharp knives, scalpel blades and a pair of forceps. Thereafter, the skulls were soaked in water, containing detergent powder, for about 24 hours to aid further removal of ligaments and muscles, if any. The skulls were bleached in a water solution containing 0.3-0.5% Sodium Hypochlorite (bleach) and hydrogen peroxide for 12 to 24 hours. Care was taken not to over-bleach the bones of the skull. Thereafter, the skulls were rinsed under running water and left in the sunlight to dry.

Pictures of the skulls were taken with a Nikon COOLPIX L320® (16.1 Megapixels) digital camera. Ten rostrorfacial and mandibular dimensions were measured in centimetres as adopted from Choudhary *et al.* (2019) and Okandeji (2012). The dimensions were measured with pair of dividers, digital vernier caliper and a ruler.

All the measured distances are as described below:

Infraorbital foramen to Canine alveolus (IFC): Distance between the most lateral prominences of the canine tooth alveolus to the rostral margin of the infraorbital foramen.

Infraorbital foramen to Premolar alveolus (IFP): Vertical distance between the ventral limit of the infraorbital foramen and the dorsal border of the maxillary fourth premolar alveolus.

Diameter of Infraorbital foramen (DIOF): Distance between the rostral and caudal limits of infraorbital foramen.

Facial Crest to Infraorbital foramen (FCIF): Maximum distance between the rostral tip of the facial crest and the caudal limit of the Infraorbital foramen

Infraorbital foramen to medial canthus (IFMO): Distance between the medial canthus of the orbit and the caudal rim of the infraorbital foramen.

Distance between supraorbital foramina (DSOF): Distance between the medial rims of the supraorbital foramina.

Supraorbital foramen to nasal bone (SFNB): Horizontal distance between the rostral margin of the supraorbital foramen and the caudal margin of the nasal bone (fronto-nasal suture).

Mandibular Length (MDL): Maximum length of the mandible between the caudal border of the condyle and its rostral tip.

Mandibular Foramen to Mandibular Base (MFMB): Distance between base of the mandible and the ventral limit of the mandibular foramen, along a vertical line.

Mandibular Foramen to Caudal Border (MFCB): Distance between the caudal border of the mandible and the ventral rim of the mandibular foramen, along a horizontal line.

Data analysis

Data obtained were expressed as mean ± standard error of mean. Statistical analysis was done using the Student’s t-test and Pearson Correlation, with significance set at $p < 0.05$. The GraphPad Prism (version 7.0) software was used for the analysis.

Results

This study details 10 craniometric parameters of adult skulls of Nigerian indigenous pigs (Plates I-III), that relates to the regional anatomy of the head, with 50% (n=5) being higher in female skulls, compared to males. The higher values were however not statistically significant. The mandibular length was, however, significantly longer in male skulls ($p < 0.05$). The mean values and standard deviations of the skull measurements are as stated in Table 1.

An accessory supraorbital foramen was seen in 12 (50%) of all the 24 skulls (5 males, 7 female). Four female and two male skulls had it close to the left supraorbital foramen while three female and five male skulls had it close to the right supraorbital foramen (Plate IV). Several lateral mental foramina were also observed on the rostro-lateral surface of the mandibular rami (Plate I).

Pearson correlation analysis (Table 2) revealed a positive relationship between FCIF and IFMO ($r=0.669$), IFC and IFMO ($r=0.610$), IFC and MFCB ($r=0.723$), as well as between MDL and MFCB ($r=0.602$). These observations were however, not statistically significant.

Table 1: Craniometric measurements of the skull of the Nigerian indigenous pig

Parameters (cm)	Male (n=10)	Female (n=14)
IFC	4.1 ± 0.15	4.5 ± 0.14
IFP	1.5 ± 0.09	1.4 ± 0.06
DIOF	1.0 ± 0.07	1.1 ± 0.07
FCIF	1.3 ± 0.10	1.5 ± 0.08
IFMO	4.8 ± 0.07	4.9 ± 0.08
DSOF	2.3 ± 0.14	2.3 ± 0.08
SFNB	2.1 ± 0.06	1.9 ± 0.06
MDL	19.0 ± 0.41*	18.0 ± 0.26
MFMB	3.4 ± 0.16	3.7 ± 0.11
MFCB	3.6 ± 0.17	3.4 ± 0.09

*Significant ($p < 0.05$)

Table 2: Pearson's correlation coefficient of craniometric measurements of the skulls of Nigerian indigenous pigs

	IFMO	IFP	FCIF	MFMB	MFCB
FCIF	0.080	0.862	1.000	0.347	0.198
IFC	0.610	0.128	0.388	0.375	0.723*
DSOF	0.145	0.158	0.341	-0.120	-0.538
SFNB	0.662	-0.059	0.450	-0.176	-0.150
MDL	0.875	0.301	0.577	0.288	0.694

* Significant ($p < 0.05$)

Discussion

The results from this present study showed that female NIPs had slightly higher craniometric measurements than males. The values obtained for FCIF, IFMO and IFP from this study were higher than what was reported by Olopade & Okandeji (2010) in mongrel pigs, but lower than the values reported in Zovawk pig by Choudhary *et al.* (2019). The infraorbital foramen was observed to be positioned dorsal to the fourth maxillary premolar tooth. It has been reported to be located dorsal to first maxillary premolar tooth in the cattle, dorsal to the second maxillary premolar tooth alveolus in camels, and dorsal to the third maxillary premolar tooth alveolus in dogs and horses (Monfared, 2013a, b, c, d).

The infraorbital nerve block is utilized in the desensitization of the skin of the lip, nostril and face, for clinical examination or dental procedures on the upper jaw (Choudhary *et al.*, 2019). In equine species, the desensitization also affects the incisors and first two molars, while in the pig, it affects the incisor teeth, the canine, and the corresponding portion of the gum by desensitizing the rostral alveolar branch of the nerve (Olopade & Okandeji, 2010). The knowledge of the values of FCIF, IFMO, IFC and IFP

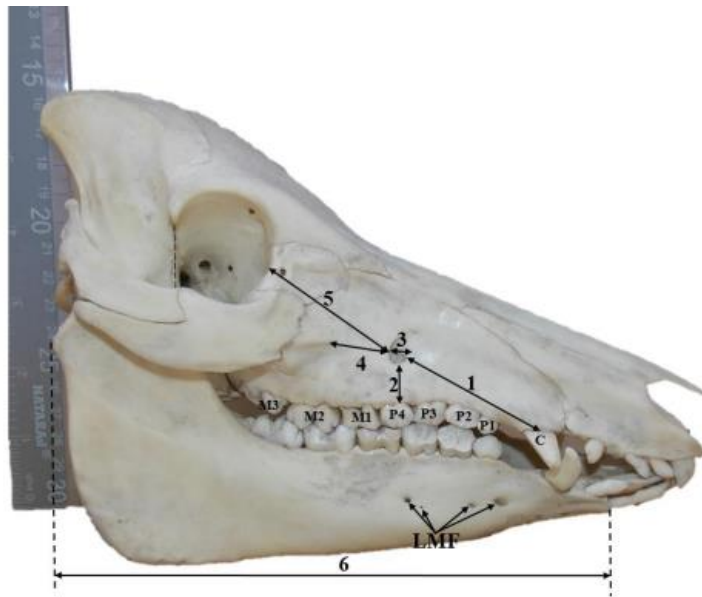


Plate I: Lateral view of the whole skull of adult Nigerian indigenous pig. **1:** Infraorbital foramen to Canine alveolus, **2:** Infraorbital foramen to Premolar alveolus, **3:** Diameter of Infraorbital foramen, **4:** Facial Crest to Infraorbital foramen, **5:** Infraorbital foramen to medial canthus, **6:** Mandibular Length. **LMF:** Lateral mental foramina



Plate II: Dorsal view of the skull of adult Nigerian indigenous pig. **7:** Distance between supraorbital foramina, **8:** Supraorbital foramen to nasal bone



Plate III: Caudal view of the mandible of adult Nigerian indigenous pig **9:** Mandibular foramen to mandibular base **10:** Mandibular foramen to caudal border

can be used as landmarks to locate the infraorbital foramen and track the corresponding nerve, in pigs, as the facial crest is not as conspicuous as seen in horse.

The mean values of DSOF and SFNB obtained from this study were observed to be lower than the reports of Okandeji (2012) in mongrel pigs, Choudhary *et al.* (2017) in Indian wild pigs, and Choudhary *et al.* (2019) in Zovawk pigs. This observation may be attributed to the influence of genetics on the aforementioned breeds. The supraorbital nerve is a branch of the frontal nerve that traverses through the supraorbital foramen to innervate the skin of forehead and the upper eyelid. It also forms a plexus with the auriculo-palpebral nerve (Getty, 1975). DSOF and SFNB can thus be used to track and locate the supraorbital foramina during clinical examination of the forehead and upper eyelids. The observation of accessory supraorbital foramina in this study was similar to the reports of Sarma (2006), in the skull of Assam goat, and Okandeji (2012), in the skulls of mongrel pigs.

The mean value for MFMB in this study was higher in the female skulls compared to the males, but the reverse was the case for MFCB, being higher in the males when compared to the female skulls. These observations were similar to the report of Olopade & Okandeji (2010) in mongrel pigs, although female skulls had higher values for both indices. The values obtained for MFMB were reported to be higher in Indian wild pigs and Zovawk pigs (Choudhary *et al.*,

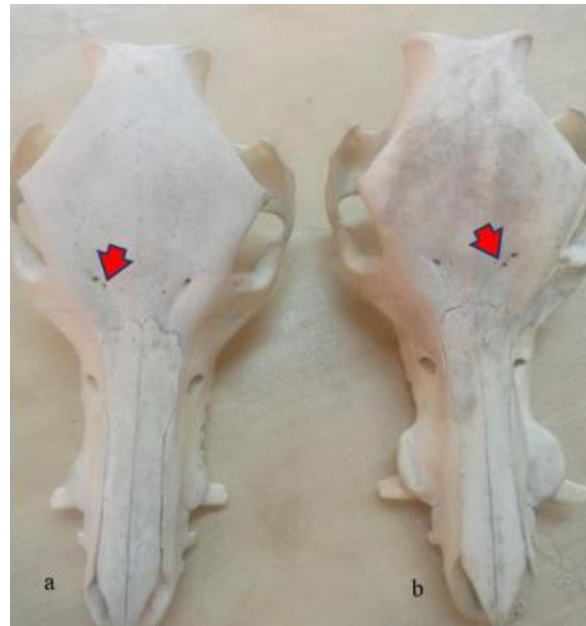


Plate IV: The skulls of the Nigerian indigenous pigs showing (arrow) accessory supraorbital foramen in the female (a) and male (b)

2017; Choudhary *et al.*, 2019), when compared to the values obtained from this present study. The mandibular nerve block is essential for desensitizing structures associated with the mandible, including teeth and muscles (Olopade & Okandeji, 2010), therefore MFMB and MFCB are clinically important landmarks for the local anaesthesia of the mandible which ultimately desensitizes the mandibular nerve. (Hall *et al.*, 2000).

The mental nerve provides nervous stimulation to the chin and the lower lip, therefore, administering anaesthetic injections into the mental foramen desensitizes the mental branch of the mandibular nerve leading to the absence of nervous stimuli to lower lip and the mandibular incisor and premolar teeth (Hall *et al.*, 2000). In pigs, several branches of the mental nerve exit through several foramina (Dyce *et al.*, 2002) and these foramina were observed, in our study, on the rostro-lateral parts of the mandibular rami. The presence of accessory mental nerves, navigating through these foramina, should be considered as a possibility and may thus pose a challenge when attempting to achieve mental nerve anaesthesia for surgical interventions involving the mandible (Olopade & Okandeji, 2010).

On conclusion, the craniometric measurements of the skull and applied anatomy of the head region of adult Nigerian indigenous pig provide important baseline data for further research in this field. Data generated provide clinically important information on the skull

of adult Nigerian indigenous pigs which can be used as landmarks for tracking and desensitizing the branches of the frontal nerve (supraorbital), the maxillary nerve (Infraorbital) and the mandibular nerve, during the regional anaesthesia of the head, for tooth extraction procedures and the treatment of injuries and fractures. These results may also be useful for comparative anatomical, developmental, forensic, and clinical studies.

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Conflict of Interest

The authors declare that there is no conflict of interest.

References

- Abenga JN & Lawal IA (2005): Implicating roles of animal reservoir hosts in the resurgence of Gambian trypanosomiasis (sleeping sickness). *African Journal of Biotechnology*, **4**(2): 134–137.
- Adeola AC, Oseni SO & Omitogun OG (2013). Morphological characterization of indigenous and crossbred pigs in rural and peri-urban areas of southwestern Nigeria. *Open Journal of Animal Sciences*, **3**(3): 230–235.
- Choudhary OP & Singh I (2015). Applied anatomy of the maxillofacial and mandibular regions of the Indian blackbuck (*Antelope cervicapra*). *Journal of Animal Research*, **5**(3): 497-500.
- Choudhary OP, Kalita PC, Kalita A & Doley PJ (2016). Applied anatomy of the maxillofacial and mandibular regions of the dromedary camel (*Camelus dromedarius*). *Journal of Camel Practice and Research*, **23**(1): 127-131.
- Choudhary OP, Kalita PC, Doley JP & Kalita A (2017). Applied anatomy of the head region of the Indian wild pig (*Sus scrofa*) and its clinical value during regional anaesthesia. *Journal of Animal Research*, **7**(2): 339-344.
- Choudhary OP, Kalita PC, Konwar B, Doley PJ, Kalita G & Kalita A (2019). Morphological and applied anatomical studies on the head region of local Mizo Pig (Zovawk) of Mizoram. *International Journal of Morphology*, **37**(1): 196-204.
- Choudhary OP, Kalita PC, Keneisenuo B, Konwar PJ, Doley A, Kalita A & Gundemir O (2020). Applied anatomy of the maxillofacial and mandibular regions of Indian Mithum (*Bos frontalis*) and its clinical significance in regional anaesthesia. *Indian Journal of Animal Research*, **55**(10): 1177-1183.
- Dalga S (2020). Topographic and morphometric study of the mental foramina of Abaza goats with its clinical implication for regional anesthesia. *Folia Morphologica*, **79**(3): 576-579.
- Dalga S & Aslan K (2021). Applied anatomy to the Gurcu goat's mandible in Kafkas and its clinical significance in regional anesthesia. *Turkish Journal of Veterinary Research*, **5**(2): 51-56.
- Din S, Masood S, Zaneb H, Rehman H, Ashraf S, Khan I, Shah M & Abdul Hadi S (2020). Gross and Clinical Anatomy of the Skull of Adult Chinkara (*Gazella bennettii*). *Pakistan Journal of Zoology*, **52**(5): 1723-1733.
- Dyce KM, Sack WO & Wensing CJG. (2002). *Textbook on Veterinary Anatomy*. Third edition. W. B. Saunders Company. Philadelphia, USA. Pp 761-771.
- Getty R. (1975). Sisson and Grossman's *The Anatomy of the Domestic Animals*, fifth edition. W.B. Saunders Company. Philadelphia, USA. Pp 1231-1252.
- Hall LW, Clarke KW & Trim CM (2000). *Wrights Veterinary Anaesthesia and Analgesia*, tenth edition). ELBS and Baillière Tindall, London. Pp 247-314.
- Jashari T, Duro S, Gündemir O, Szara T, Ilieski V, Mamuti D & Choudhary OP (2022). Morphology, morphometry and some aspects of clinical anatomy in the skull and mandible of Sharri sheep. *Biologia*, **77**(2): 423–433.
- Kalita PC, Singh TS, Choudhary PO, Debroy S, Kalita A & Doley OJ (2019). Morphological and applied anatomical studies on the head region of Malayan sun bear (*Helarctos malayanus*). *Journal of Animal Research*, **9**(5):753-758.
- Keneisenuo K, Choudhary OP, Priyanka P, Kalita PC, Kalita A, Doley PJ & Choudhary JK (2021). Applied anatomy and clinical significance of the maxillofacial and mandibular regions of the barking deer (*Muntiacus muntjak*) and sambar deer (*Rusa unicolor*). *Folia Morphologica*, **80**(1): 170–176.

- Monfared AL (2013a). Some aspects of clinical anatomy of the head region of the Caspian miniature horse and its clinical value during regional anesthesia. *Global Veterinaria*, **10**(2): 214-218.
- Monfared AL (2013b). Gross anatomical measurements of the head region of the Iranian native cattle (*Bos taurus*) and their clinical value for regional anaesthesia. *Global Veterinaria*, **10**(2): 219-22.
- Monfared AL (2013c). Applied Anatomy of the Head Regions of the One-Humped Camel (*Camelus dromedarius*) and its Clinical Implications during Regional Anesthesia. *Global Veterinaria*, **10** (3): 322-326.
- Monfared AL (2013d). Anatomical study of the skull of the adult dogs and its clinical value during regional anesthesia. *Global Veterinaria*, **10**(4): 459-463.
- Myers P, Espinosa R, Parr CS, Jones T, Hammond GS & Dewey TA (2022). The Animal Diversity Web (online). <https://animaldiversity.org/accounts/Sus/cl> assification, retrieved 12-11-2022.
- Nafikov RA & Beitz DC (2007). Carbohydrate and lipid metabolism in farm animals. *The Journal of Nutrition*, **137**(3): 702-705
- Okandeji ME (2012). Cranio-morphometric indices of the skull of mongrel pigs (*Sus scrofa*) in Southwestern Nigeria. MSc Dissertation, Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Ibadan. Pp 1-94.
- Okandeji ME, Lijoka AD, Atiba FA & Olopade JO (2021). The eruption patterns of the teeth of Nigerian local pigs (*Sus scrofa*): profile of deciduous teeth. *Journal of Veterinary Anatomy*, **14**(2): 1-15.
- Okandeji ME, Femi-Akinlosotu OM, Omotosho OO & Olopade JO (2022). Dental pathologies in the Nigerian local pigs (*Sus scrofa*) *Archives of Anatomy and Physiology*, **7**(1): 1-8.
- Okandeji ME, Lijoka AD, Olude MA, Atiba FA & Olopade JO. (2023) Permanent tooth eruption patterns in Nigerian local pigs. *Journal of Veterinary Dentistry*, doi.10.1177/08987564231152390.
- Olopade JO & Okandeji ME (2010). A study of some rostrfacial indices related to regional anaesthesia of porcine: implications as an animal model for dental research. *Nigerian Journal of Physiological Sciences*, **25**(2): 159-164.
- Olopade JO & Onwuka SK (2007). Osteometric studies of the skull of Red Sokoto (Maradi) goats (*Capra hircus*): implications for regional anaesthesia of the head. *International Journal of Morphology*, **25**(2): 407-410.
- Onar V (1999). A morphometric study of the skull of the German Shepherd Dog (Alsatian). *Anatomy Histology Embryology*, **28**(4): 253-256.
- Osei-Amponsah R, Skinner BM, Adjei DO, Bauer J, Larson G, Affara NA & Sargent CA (2017). Origin and phylogenetic status of the local Ashanti Dwarf pig (ADP) of Ghana based on genetic analysis. *BMC Genomics*, **18**(1): 193. <https://doi.org/10.1186/s12864-017-3536>.
- Rothschild MF (2004). Porcine genomics delivers new tools and results: This title piggy did more than just go to market. *Genetical Research*, **83**(1): 1–6.
- Samuel OM, Olopade JO, Korzerzer MR, & Onwuka SK (2013). Craniometric evaluation of some cranial indices of clinical significance in goats (*Capra hircus*) from the middle-belt region of Nigeria case for population surveillance and eco-migration. *European Journal of Zoological Research*, **2**(4): 89-97.
- Sarma K (2006). Morphological and craniometrical studies on the skull of Kagani Goat (*Capra hircus*) of Jammu Region. *International Journal of Morphology*, **24**(3): 449-455.
- Wiener P & Wilkinson S (2011). Deciphering the genetic basis of animal domestication. *Proceedings of the Royal Society B: Biological Sciences*, doi.10.1098/rspb.2011.1376.
- Wilkinson S, Lu ZH, Megens HJ, Archibald AL, Haley C, Jackson IJ, Groenen, MAM, Crooijmans R, Ogden R & Wiener P (2013). Signatures of diversifying selection in European pig breeds. *PLoS Genetics*, doi.10.1371/journal.pgen.1003453.
- Yahaya A, Olopade JO & Kwari HD (2011). Clinical implication of craniometric indices of the one-humped camel (*Camelus dromedarius*) to oral health and clinical regional anaesthesia of the head. *Journal of Veterinary Anatomy*, **4**(1): 19-31.