RESEARCH ARTICLE

IJVAR *International Journal of Veterinary and Animal Research*
E-ISSN: 2651-3609 6(3): 91-95, 2023
DOI: 10.5281/zenodo.10442793

Preparation of Quail (*Coturnix coturnix*) Skeleton to Promote the Teaching Facilities of Avian Anatomy Laboratory

Swarup Kumar Kundu[1, a,*], Zahid Hasan Rocky [2,b], Md. Amim Al Maruf [2,c], Ahanaf Tahmid Chowdhory [2,d], Abu Sayeed [2,e]

[1]Khulna Agricultural University, Faculty of Veterinary, Animal and Biomedical Sciences, Department of Anatomy and Histology, Khulna, Bangladesh
[2] Khulna Agricultural University, Faculty of Veterinary, Animal and Biomedical Sciences, Khulna, Bangladesh

[a]ORCID: 0000-0003-2951-2010; [b]ORCID: 0009-0008-4075-5041; [c]ORCID: 0009-0002-3814-7967;
[d]ORCID: 0009-0000-4082-3296; [e]ORCID: 0009-0001-4794-5488

*Corresponding Author
E-mail: swarupkundu95@gmail.com

Received: July 30, 2023
Accepted: September 18, 2023

Abstract

The stiff structure of the body, or skeleton, provides the body with its overall form, permits movement, generates blood cells, and protects delicate organs. This research was done to prepare the quail (*Coturnix coturnix*) skeleton for the avian anatomy museum and educational facilities. A total of five matured Quails (at the age of 6 months) were collected from a commercial quail farm, in Khulna, Bangladesh. The carotid artery and jugular vein were carefully dissected before skinning each quail with feathers, removing all viscera, combs, and wattles. To adequately disintegrate the muscles, ligaments, and tendons, different body sections of the bones were separated, wrapped in markin cloth, and cooked in a 3% solution of soda water for 1.5 hours. The body parts were then maintained in separate solutions for 5 days. After five days, the bones were thoroughly cleaned by soaking them in a 5% hydrogen peroxide solution for 30 minutes, and rinse them under running water. To maintain the order of the vertebrae in the various segments, a steel wire was inserted into the vertebral foramen. After proper sun drying for 25 days, a set of bony components from different parts (axial and appendicular) of the body was finally found and articulated to rise into a whole skeletal frame. Therefore, the present work denotes time-consuming and easy preparation of the avian skeleton as well as the skeletal framework will be helpful for veterinary students in the avian anatomy laboratory as well as to enhance the elegance of the anatomy museum.

Keywords: Avian morphology, framework, knowledge, quail, veterinary students.

INTRODUCTION

In both veterinary and human medical education, skeletons are the most important teaching tools for anatomy lessons (Kempa et al., 2016). Academicians and students need to comprehend what the bones, cartilage, and then a skeleton are in order to have a better comprehension of the human or animal body's structure (Atabo et al., 2019). Anatomical understanding helps a surgeon or clinical practitioner to identify a condition, develop their capacity to think about the pathophysiological mechanisms behind a certain bodily system, etc. (Turney, 2007). For veterinary anatomists, researchers, and practitioners to correctly draw up a skeletal framework of avian species, they must have a basic understanding of the avian skeleton (Baker et al., 2003). Skeletons are also utilized in forensic applications, such as the identification of carcasses or, in rare instances, bones that have been taken as evidence in other crimes, to identify fossils and for a variety of other purposes (Olson, 2003). The hollow-structured, strong bones that make up the avian skeletal system give the body a lightweight appearance (Jacob, 2023). The development of a robust skeletal system has also been intimately linked to egg production. Worldwide, the production of eggs in avian species is hampered by soft and fragile bones (Linden, 2014). However, the quail's skeleton is unique compared to other animals' and developed as powered flight progressed. A skeleton that provides a strong base and rigidity for the attachment of flight muscles has resulted from a reduction in the total number of bones and the combination of numerous joints (Aspinall and Cappello, 2019). A skeleton can be prepared using a variety of techniques, including enzymatic maceration, burial maceration, cold water maceration, and more (Gofur and Khan, 2010). The processing of the skeletons of large and small animals requires different safety measures. Larger boiling times are required for large animal bones, particularly long bones, than for avian bones. Because excessive boiling causes a bone to become fragile and disintegrate (Hussain et al., 2007). The majority of anatomists and researchers prepare the skeleton using conventional procedures, placing special emphasis on the necessary timing. However, the authors of the present study emphasized more than just the expedient and economic aspect and they tried to prepare a quail skeleton that would last for a long time, helping educators and students in their basic anatomy education. As a result, this research will contribute to a greater knowledge of the avian skeleton and how it functions in relation to the skeletons of other birds. The information collected from this experiment might also be applied to teaching, improving student comprehension of comparative knowledge between large and avian anatomy by comparing various characteristics of the avian skeleton to that of other species.

Cite this article as: Kundu SK., Rocky SH, Al Maruf MdA., Chowdhory AD., Sayeed A. 2023. Preparation of Quail (*Coturnix coturnix*) Skeleton to Promote the Teaching Facilities of Avian Anatomy Laboratory. International Journal of Veterinary and Animal Research, 6(3): 91-95. *DOI: 10.5281/zenodo.10442793*

MATERIALS AND METHODS

Sampling and equipment preparation

Five adult quails were taken from a commercial quail farm in Khulna, Bangladesh when they were around six months old. Prior to considering the utilization of the acquired quail for skeleton preparation, each quail's overall health, exterior appearance, eye mucous membrane, and all other body parts were meticulously inspected. Masks and rubber gloves were used as a safety precaution in accordance with the recommendations of Baker et al., (2003). The following supplies were utilized to create the desired skeleton: steel wire, 3% soda water solution, 5% hydrogen peroxide, a hardwood platform, adhesion agents (Fevicol), and varnish.

Animal Preparation and ethical guidelines

To drain all the blood from the body, captured quails were slaughtered by severing the carotid artery and jugular vein. A Littman stethoscope was then used to assess the sacrificial quail's heart rate in order to certify its demise. All the methods and procedures for killing the quails were approved by the Ethical Committee of Bangladesh Agricultural University (approval no. AWEEC/BAU/ 2023(34)).

Removal of skin and flesh

A scalpel, scissors, and forceps were used to trim the skin and muscles, which also helped to widen the abdominal cavity. Then, every organ of the digestive, respiratory, and reproductive systems was painstakingly removed, leaving only the visible, undamaged bones of the quail's structure. Finally, each segment of the body parts: the skull, thorax, forelimb, and hindlimb was cut away from the surrounding joint area and wrapped individually in clothing mainly because it minimizes the loss of tiny bones and helps to preserve the bones during boiling. In order to keep the spinal column aligned (from cervical to caudal), steel wires were specifically implanted.

Boiling and decomposing

The entire body segments coated with markin clothing were boiled for 1.5 hours in a metal container with soda water (sodium carbonate, NA2CO3) in a 3% solution. The appropriate digestion of each segment's fleshy portions is aided by the use of soda water as a macerating agent (Van Cleave, 2010; Simriti et al., 2019). The container was boiled and then left alone for five days. The bony segments' residual muscles correctly disintegrated throughout this period. The remainder of the muscles, ligaments, and other tissues were then completely removed with the use of a knife and forceps once the garments had been removed.

Cleaning and bleaching

After being collected, the skeletal pieces were immersed for 30 minutes in a 5% hydrogen peroxide (H_2O_2) bleaching solution to prevent further microbial deterioration, provide stability, and enhance the whitening look of the bones. In order to clean the bones, each bone fragment was lastly washed under running water.

Drying

For 25 days, the bones were correctly dried in the sun for 10 to 12 hours each day. After that, a cautious 50 ml varnish spray was applied to all the bony areas. Bones are given durability and protection from various microbial attacks by proper sun drying and varnishing.

Sequential arrangement of bones and construction of the skeletal frame

During the preparation of boiling and cleaning, different structures were disorganized. So, after completing sundry, different segments of the bony parts were articulated by using fevicol. Firstly, the axial part was taken into consideration for articulation. The nasal process of the premaxilla and hyoid bone were precisely organized in the correct position and the mandible was attached to the quadrate region by the fevicol. All the vertebrae of the column from cervical to caudal (although the lumbar and sacrum fuse together to form the synsacrum) were numbered and fixed to each other by adhesives. Firstly, a piece of heavy wire was pushed as far as possible inside the neural canal of the fused vertebra of the back. Then the first thoracic vertebrae were put in place, and then the cervical vertebrae were put on the wire and pushed into their normal positions. After the cervical vertebrae were in place and glued, it was then bent in an "S" shape curve to match the natural curve of the neck of the bird. The wire was cut and inserted into the skull. It was attached to the vertebral column with the support of wire and glue. Anteriorly (in the wing region), the scapula, coracoid, clavicle, humerus, radius-ulna, and carpometacarpus were articulated in sequence as well as the pairs of ribs were arranged in ascending order and attached to each thoracic vertebrae by fevicle. The Sternum was attached with the true rib pairs and coracoids on both sides by fevicle. Next, the hindlimb (leg) bones called the hip bones (ilium, ischium, and pubis), femur, tibia-fibula, and foot bones (metatarsals and digits) were articulated chronologically with fevicle glue. Finally, the skeletal structure was positioned on a wooden platform of the required dimensions according to the size of the animal for display in the avian anatomy museum and gross anatomical study in the academic lecture.

RESULTS

Compared to mammals, the avian skeletal system is light weighted. Mainly the bones are hollow structured which makes the weight light. Numerous bones fused together and make the bird's skeleton rigid. Table 1 shows the steps which were maintained with a specified time schedule.

In the present study of the quail skeleton, it has been designated into two parts: axial and appendicular parts. In the axial region: the skull; vertebrae: cervical; thoracic, lumbar, and sacral fused to form synsacrum and coccygeal vertebrae or caudal vertebrae (fused caudal vertebrae are called pygostyle); ribs, and breast bone or keel bone (Figure 1). On the other hand, in the appendicular skeleton: the forelimb or wing bone possesses scapula, coracoid, and clavicle (fusion of two clavicles form furcula or wishbone), humerus, radius-ulna, and carpometacarpus, phalanges (Figure 2). On the contrary, the hind limb or leg bone was formed by of pelvic girdle (ilium, ischium, and pubis), femur, tibia-fibula, and feet bone (tibiotarsus, tarsometatarsus, and phalanges) (Figure 3).

Table 1. Steps involved in time required for preparation of quail skeleton.

SI No.	Sequence maintained in the skeleton preparation	Required time
1.	Animal preparation	30 minutes
2.	Removal of skin and flesh	2 hours
3.	Boiling and decomposing	Boiling: 1.5 hours Decomposing: 5 days
4.	Cleaning and bleaching	Bleaching: 30 minutes Cleaning: 2 hours
5.	Drying	25 days
6.	Articulation and rising of the skeleton	1.5 hours

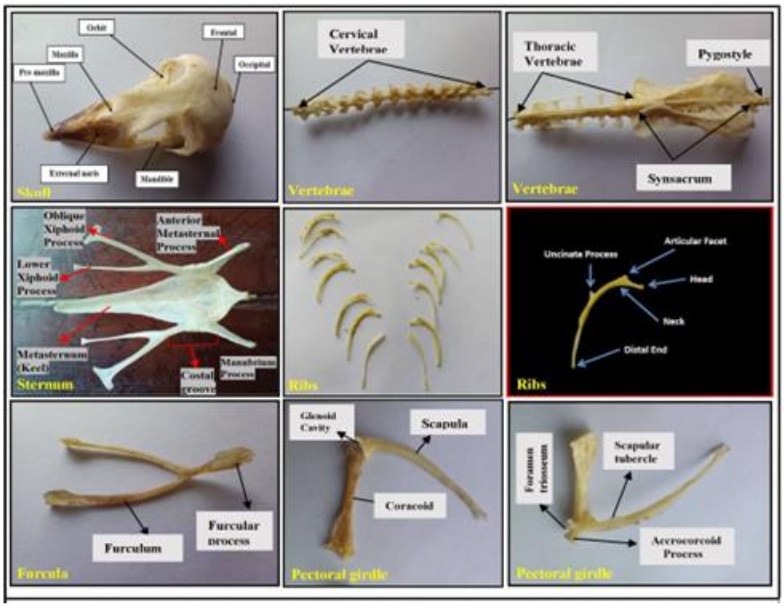

Figure. 1: Representative photographs depict the different bones (Skull, Vertebrae, Sternum, Ribs, Furculum, and Pectoral girdle) of the quail's skeleton. Identified structures (different colour arrows) of different bones illustrate the morphological characteristics of a quail's skeleton.

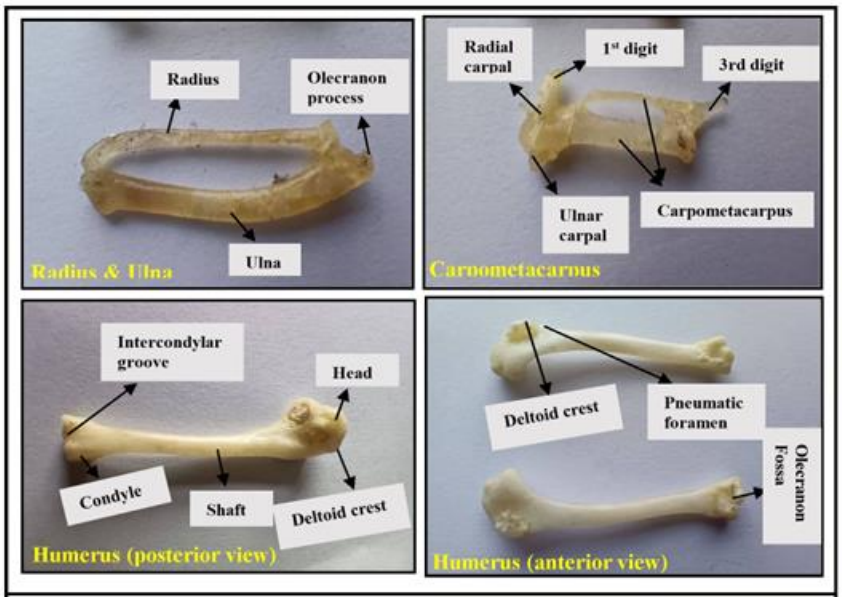

Figure. 2: Representative photographs depict the different bones (Radius-ulna, Carpometacarpus, and Humerus) of the quail's skeleton. Identified structures (black arrow) of different bones illustrate the morphological characteristics of a quail's skeleton.

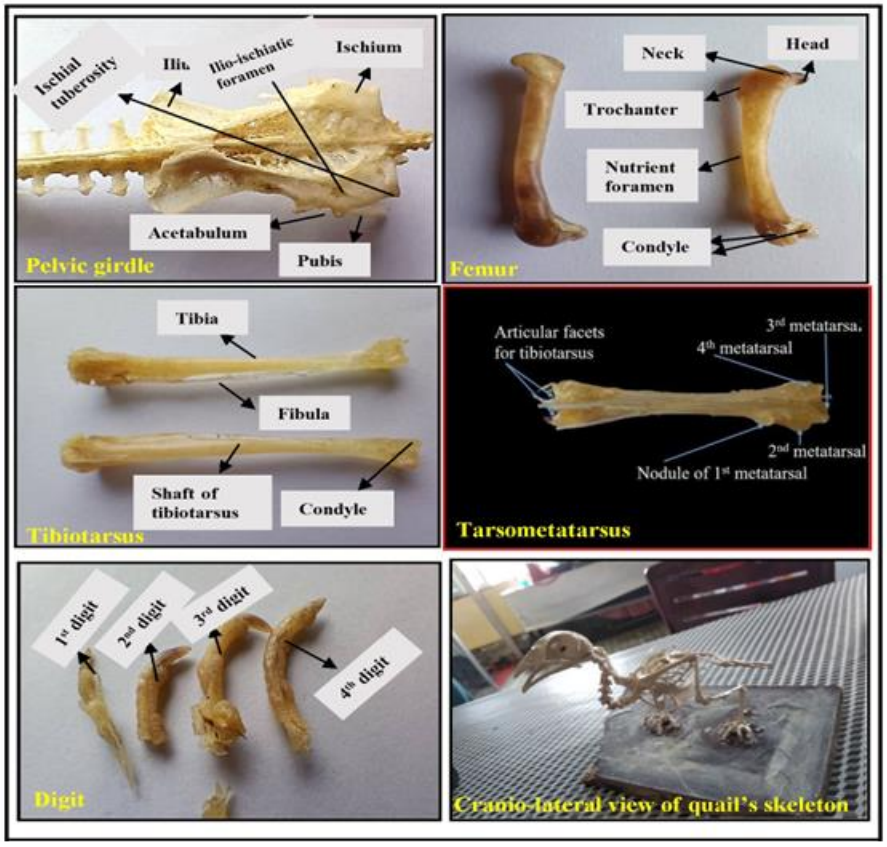

Figure. 3: Representative photographs depict the different bones (Pelvic girdle, Femur, Tibiotarsus, Tarsometatarsus, Digits and Cranio-lateral view of quail's skeleton) of the quail's skeleton. Identified structures (black arrow) of different bones illustrate the morphological characteristics of a quail's skeleton. Cranio-lateral view of a structured quail's skeletal frame is also presented.

DISCUSSION AND CONCLUSION

All vertebrates have skeletons because they need them for support and to protect internal organs and tissues. The skeletal structure of a bird is similar to that of other animals, but it is too light, which is what they need to fly while yet having the essential bodily support. Most aspects of the avian skeleton emphasize lightness and strength (Getty, 1975). Every stage of the quail skeleton preparation in the current investigation has been carried out with exceptional efficiency. Using the skeleton in the anatomy lab for a longer period of time was the primary goal of this preparation. The quail's fragile bones need extra care during the skinning and removal of the muscle before boiling. Gofur and Khan, (2010) likewise maintained this precaution. They also removed flesh by avoiding any damage to the bones. The boiling time was strictly maintained in the current bony management. As the excess boiling may cause any rupture or shrinking of the soft bones. The statement was fully agreed upon by Van Cleave, (2010). A 3% solution of soda water was used during boiling for the easy removal of the rest portion of the muscle as well as to properly decompose (Baker et al., 2003; Gofur and Khan, 2010) also in agreement with the procedure. They stated that using any other biological compounds may have corrosive actions on bones. After boiling, the decomposing period (Table 1) was taken into special consideration because, without proper decomposing of muscle, microorganisms may attack at any time in the bone which causes fragility or reduction of longevity. Leon et al., (2004) also completed these steps with special care. Bones were then bleached into a 5% hydrogen peroxide (H_2O_2) solution for 30 minutes to enhance the whitening of the bone's surface according to the study of (Faruk and Das, 2023). Bones' impact strength, compressive strength, and shear strength also remained unaffected by the use of hydrogen peroxide (H_2O_2) solution which was revealed by De Paula, (2005). Curran et al., (2004) also suggested that, besides the hydrogen peroxide (H_2O_2) solution, different treatment methods may be applied to clean or disinfect the bones using ethanol, gamma radiation, acid washing, antibiotic solutions, etc. which have baleful effects on biochemistry and biomechanical integrity of the allograft tissues. The prepared bones were dried completely by sun rays. Then, the bones of different segments were articulated sequentially to form a skeletal structure and positioned on a wooden stage with the aid of a metal wire according to the direction of (Musa et al., 2015). According to the description of (Bairbre, 2008) as a fellow veterinary student or educator, or wildlife researcher, knowledge of avian anatomy helps them when providing avian care in a wildlife hospital. No one can develop a basic knowledge of comparative anatomy without learning avian anatomy. In conclusion, the morphology of different bird species and other big animals differs significantly. The importance of avian anatomy in the veterinary study is easily demonstrated by the importance of birds, thermoregulation mechanism, metabolism, behavioral pattern, flight

mechanism, the fusion of the bones of the different regions (furculum, pygostyle, synscarum, etc.), cardiac output, large volume of oxygen capturing capacity, and unique digestive procedure data. The veterinarian can better care for avian species by having an understanding of their anatomical structures, especially when it comes to medicine administration. Various organs and bone's morphological makeup also aids in identifying species. The quail's skeleton will therefore make a significant contribution to academics and students' understanding of anatomy, as well as improve the aesthetics of the avian anatomy museum.

Acknowledgment
The authors are sincerely thankful to the Department of Anatomy and Histology, Faculty of Veterinary, Animal and Biomedical Sciences, Khulna Agricultural University, for the generous technical support to continue their research and improve the understanding of avian anatomy.

Conflict of Interest
The authors declared that there is no conflict of interest.

Authorship Contributions
Concept: S.K.K., Design: S.K.K., Data Collection or Processing: S.K.K., Z.H.R., M.A.A.M., A.T.C., Analysis or Interpretation: S.K.K., A.S., Literature Search: S.K.K., A.S., Writing: S.K.K. Critical Review: S.K.K., Z.H.R., M.A.A.M., A.T.C., A.S.

Financial Disclosure: This research received no grant from any funding agency/sector.

REFERENCES

Aspinall V, Cappello M. 2019. Introduction to Animal and Veterinary Anatomy and Physiology, fourth ed. CABI Digital Library, pp. 31-45.

Atabo SM, Hena SA, Jaji AZ, Bodinga AH. 2019. Bovine skeleton preparation using hot water technique for anatomical studies. Asian Journal of Research in Animal and Veterinary Sciences, 4(3): 1-7.

O'Malley B. 2008. Clinical anatomy and physiology of avian species-from bird brains to pigeon toes. World Small Animal Veterinary Association. World Congress Proceedings. Dublin, Ireland.

Baker P, Davis S, Payne S, Revill M. 2003. On preparing animal skeletons: a simple and effective method. International Council for Archaeozoology, 4(1): 4-15.

Curran AR, Adams DJ, Gill JL, Steiner ME, Scheller AD. 2004. The biomechanical effects of low-dose irradiation on bone-patellar tendon-bone allografts. The American Journal of Sports Medicine, 32(5): 1131-1135.

DePaula CA, Truncale KG, Gertzman AA, Sunwoo MH, Dunn MG. 2005. Effects of hydrogen peroxide cleaning procedures on bone graft osteoinductivity and mechanical properties. Cell Tissue Bank. 6: 287-298.

Faruk AZ, Das SK. 2023. Detergent Maceration: A convenient skeleton preparation technique for teaching and demonstration of veterinary anatomy. Journal of Applied Veterinary Sciences, 8(1): 11-17.

Getty R. 1975. Sisson and Grossman's, the anatomy of the domestic animals. 5th ed. Philadelphia: W. B. Saunders Company; pp. 1790.

Gofur MR, Khan MS.2010. Development of a quick, economic and efficient method for preparation of skeleton of small animals and birds. International Journal of BioResearch, 2(7): 13-17.

Hussain M, Hussain N, Zainab H and Qaiser S. 2007. Skeletal preservation techniques to enhance veterinary anatomy teaching. International Journal for Agro Veterinary and Medical Sciences, 1: 21-23.

Jacob J. Accessed 2023. Small and backward poultry, avian skeletal system. The University of Kentucky. Available at: https: // poultry. extension.org / articles / poultry-anatomy/avian-skeletal-system.

Kempa K, Kulawik M, Bartyzel BJ, Jakubowski M, Skubis J, Koczon P. 2016. Characterization of selected techniques of maceration bones of Gallus gallus domesticus. Folia Pomeranae Universitatis Technologiae Stetinensis. Agricultura, Alimentaria, Piscaria et Zootechnica, 39(3(328)): 109-116.

Leon TH, Justin K. 2004. Carcass Disposal: A Comprehensive Review. National Agricultural Biosecurity Center, Kansas State University, USA. Chapter 6.

Linden J. 2014. Understanding the role of the skeleton in e.gg production. The poultry site. Available at: https://www.thepoultrysite.com/articles/understanding-the-role-of-the-skeleton-in-egg-production.

Mussa MT, Kamal MM, Mahmud MA, Sarker BK, Jalil MA, Das SK. 2015. Evaluation of a rapid and efficient method for preparation of skeletons of rabbit and goose. Bangladesh Journal of Veterinary Medicine, 13(2): 27-31.

Olson SL. 2003. Development and uses of avian skeleton collections. Bulletin of the British Ornithologists' Club.

Simriti, Gupta S, Jamwal NS and Raina S. 2019. Use of sodium carbonate as bone preparation agent. International Journal of Applied Research, 5(5): 66-67.

Turney BW. 2007. Anatomy in a modern medical curriculum. The Annals of The Royal College of Surgeons of England, 89(2): 104-107.

Van Cleave J. 2010. Available at: http://scienceprojectideasforkids.com/2010/how-to-prepare-a-chicken-skeleton.