

Dimensions of the cranium and of the cranial cavity and intracranial volume in goats (*Capra hircus* LINNAEUS, 1758)

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Abstract

The aim of this project is to determine the dimensions of the cranium and the cranial cavity and the intracranial volume in goats, using 64 adults. The dimensions of the cranium and cranial cavity were measured through metric tape and paquimeter, considering the intervals of the largest distances. To determine the intracranial volume, balloons of latex were introduced in the cranial cavity, through the magnum foramen, later on, filled with water that was transferred for graduate test tube. The average and the standard deviation of length, width and height of the cranium, in millimeters, were respectively: 218.01 ± 6.96 , 120.17 ± 10.01 and 108.14 ± 4.46 . The average and the standard deviation of length, width, height, in millimeters, and of the volume of the cranial cavity, in cubic centimeters, were respectively: 109.31 ± 7.25 , 61.36 ± 4.51 , 63.85 ± 2.88 and 119.31 ± 12.21 . It was observed that, the width of the cranium possesses positive significant correlations with the length ($r = 0.6865$), with the height ($r = 0.5644$) and with the intracranial volume ($r = 0.5436$). They were still established, positive significant correlations among the height of the cranial cavity, with the length ($r = 0.5682$) and with the intracranial volume ($r = 0.5473$). Differences were evidenced between males and females, in relation to the dimensions of the cranium and cranial cavity. There wasn't difference of the intracranial volume in function of the sex of the goats.

Keywords: cranial dimensions, intracranial volume, cranial cavity, goats.

1 Introduction

The goat production is an activity that has been developing a lot in the last years. About 90% of the goats of the world are found in areas in development evidencing the capacity of the goat in adapting to the adverse conditions, justifying its reputation of rustic animal.

The goat was the first domesticated animal capable to produce food for the human being about ten thousand years ago. That animal always accompanied the humanity's history, as they attest the several historical, mythological reports and even biblical, that mentions the goats. In spite of that, it hardly ever had their value properly recognized.

In Brazil, most of the goat flocks is located in the Northeast region, where the majority of the animals is created in precarious conditions, being only explored the meat and the skin. On the other hand, it exists in the Center-South and in the own Northeast, a creation of the goats directed to the production of milk, where the high productivity is the main aim.

There are a great variety which comes from the goat: milk, meat, skin, hair and feces, besides being useful in the work of the field as animal traction; in certain areas, someone's power is measured by the number of goats somebody possesses, being the goat used as the gift that accompanies the bride in some countries of Africa. Still today, the goat has a very important role as supplier of food, particularly in countries or areas in development.

1.1 The goat

The Goat is mammal, herbivore, ruminant, that belongs to the family of the bovidae, subfamily of the caprinae. The goats has the same origin that the bovine ones, with the ancestral trunk of the antelopes and the differentiation happening in the Pliocene period. The breed probably descend of the *Capra aegagrus*, from Persia and Asia, *Capra falconeri*, from Himalaya, and *Capraprisca*, from the basin of Mediterranean. They are animals which generally have a robust constitution and they are enough flexible in their feeding, they could consume all the types of vegetable.

1.1.1 Zoological classification taxonomic

Kingdom: ANIMALIA;

Phylum: Chordata;

Class: Mammalia;

Order: Artiodactyla;

Family: Bovidae;

Subfamily: Caprinae;

Genus: *Capra*;

Species: *hircus*;

Race: without defined race.

1.2 Cranium, cranial cavity and intracranial volume

The cranium constitutes on a way of protection for the encephalon and the organs of the special senses (vision, sense of smell, audition, balance and gustation). Most of the bones of the cranium are plane, developed in membranes. On the other hand, bones of the cranial base can be classified as irregular and developed in cartilage. The immobile articulations located among most of the cranial bones are called sutures (GETTY, 1986). It consists on a mosaic of many bones, being most of the time equal, existing some medium and odd, that are fitted perfectly together to form an only rigid structure (DYCE, SACK and WENSING, 2004).

It is still observed that the cranium is divided in two different portions, the tail part involving the encephalon, and the rostral part sustaining the face. The orbits, the fossas that accommodate the ocular globes, are part of the face, although they are placed in the limit of themselves. In most of the domestic animals, the facial part of the cranium is larger than the neural part (DYCE, SACK and WENSING, 2004).

The cranial cavity is placed later on to the nasal cavities. Its form and extension are not easily previsible to the external inspection, since the paranasal sinuses, the horns, the muscular saliciencies and other cranial projections, as well as the temporalis muscle, contribute significantly to conformation of this part of the cranium (DYCE, SACK and WENSING, 2004).

The bones that form the cranial cavity are: the occipital, the interparietal, the basiesfenoide, the presphenoid, the pterygoid, the temporal, the parietal bone, the frontal, the ethmoid and the vomer (GETTY, 1986).

The interior of the cranial cavity presents a correspondence reasonably larger with the contours of the encephalon, in spite of being necessary a significant one intracranial space, for the meninges and the intermeningeal spaces that surround the encephalon (DYCE, SACK and WENSING, 2004).

The intracranial volume corresponds to the portion filled by the meninges, the encephalon and the Liquor cerebrospinalis in the cranial cavity.

This project had as objective, to determine the dimensions (height, width and length) of the cranium and the dimensions and volume of the cranial cavity in goats without defined race, establishing correlations among these measurements, and also, with the sex of the animals, in Petrolina City, State of Pernambuco, (Latitude: 09° 23' 55" / Longitude: 40° 30' 03" / Altitude: 376 m) and region.

Due to the wide growth of the creation of the goats in Brazil, their great socioeconomic importance, mainly in the region of semi-arid climate of the Brazilian Northeast, and to the reduced number of studies in relation to the anatomy of the goats in this ambient, it becomes indispensable the detailed report of the species, obtaining larger knowledge and, with that, guaranteeing scientific support, collaborating with the researches and the professionals of the area of Animal Anatomy studies, Biology and Veterinary Medicine, assuring the continuous ascension of the creation of the goats.

2 Material and methods

To make the present work, it was approved previously by the Commission of Bioethics of the Faculty of Veterinary Medicine and Animal Science of the University of São Paulo, registered with the number: 1059/2007, being in conformity with its guidelines.

64 adult animals of the species *Capra hircus* LINNAEUS, 1758, were used (32 males and 32 females), being the females with corporal mass average of 29.2 ± 1.6 kg and the males with 29.9 ± 1.5 kg coming from frigorific of the Petrolina City, State of Pernambuco. Initially, before the slaughter, the animals had their corporal mass obtained through a digital analytic balance (FILIZOLA^{®1}).

The slaughter was accomplished through the cervical displacement. Soon after, the goats were decapitated, and their heads, driven to the Laboratory of Animal Anatomy of the Federal University of the Vale of São Francisco (UNIVASF), where the musculature was removed, using for this, appropriate surgical material, cable (ABC^{®2}) and sheet (LÂMINA SOLIDOR^{®3}) for bistoury and anatomical tongs (ABC^{®2}). After that, the craniums were immersed in the water for 3 days so that for they are macerated.

When the maceration is finished, the dimensions of the cranium were measured with the use of a metric tape (CORRENTE^{®4}) and of a paquimeter of approach millimeter (VONDER^{®5}), always considering the intervals of the largest distances. The length was measured for the alveolar margin of the incisive bone to the nuchal crest. The width was measured from the interval among the zygomatic arches. At last, the height of the cranium that was measured from the basiesfenoide bone to base of the cornual process.

The dimensions of the cranial cavity were also measured with the aid of a caliper of approach millimeter, also, considering the intervals of the largest distances. The length was measured from the cribrosa lamina of the etmoidal bone to the magnum foramen. The width was obtained measuring the space between the scaly parts of the temporal bones. The height was established through the distance of the pituitary fossa to the interparietal bone.

To determine the intracranial volume, volumetric balloons of latex (SÃO ROQUE^{®6}) were introduced emptied through the magnum foramen in the cranial cavity, being later on, filled with water, that then, it was transferred for a graduate test tube (NALGON^{®7}), obtaining the volume in cubic centimeters (cm³).

The statistical analysis was accomplished through the program Statistic Analysis System (2006), being, used the correlation of Pearson to find the correlation head office among the variables. They were just considered the largest correlations than (0.5). To do the variance analysis, and to verify the correlation differences among the sexes, in relation to the studied variables. Procedure CORR and Procedure GLM were used, respectively.

3 Results

Accomplished the statistical analyses, the animals were distributed graphically according to the established correlations among the analyzed variables (height, width and length of the cranium and the dimensions and volume of the cranial cavity), as it is shown in Figures 1, 2 and 3, respectively,

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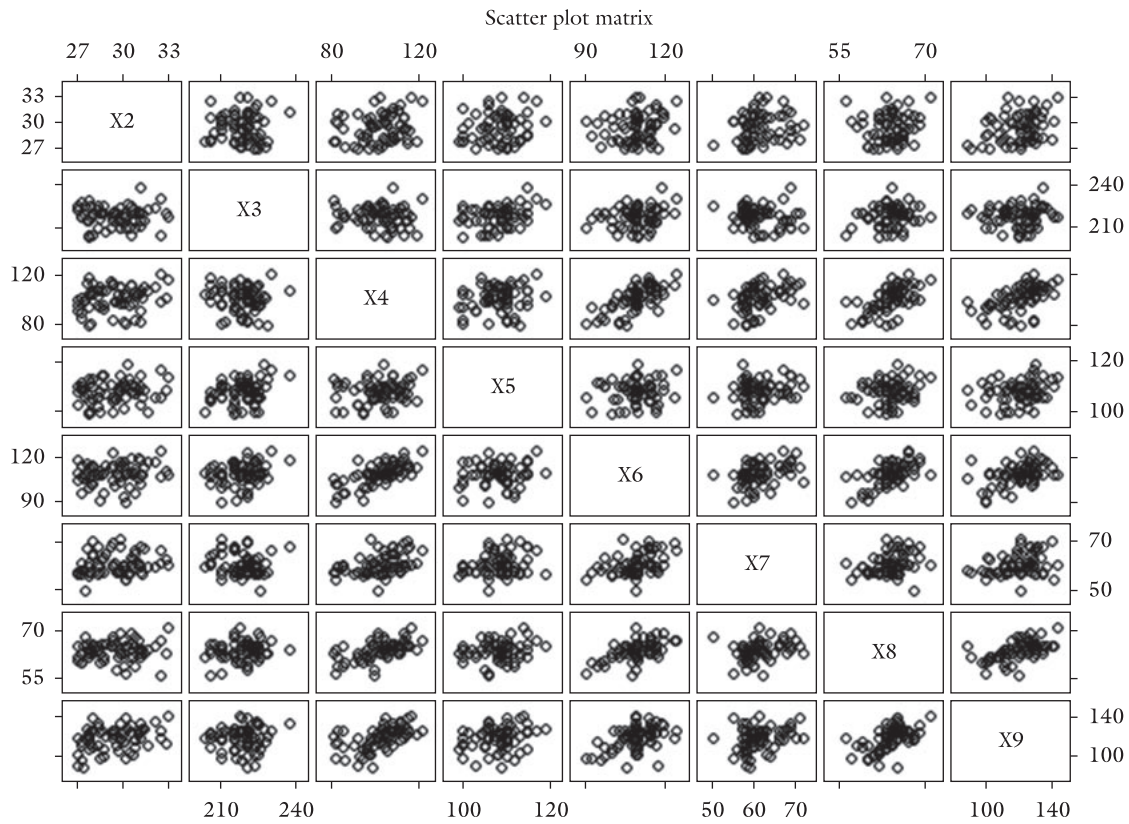


Figure 1. Graphic distribution of the male and female animals (N = 64) in function of the established correlations among the variables of the cranium and of the cranial cavity in goats – Petrolina, 2009.

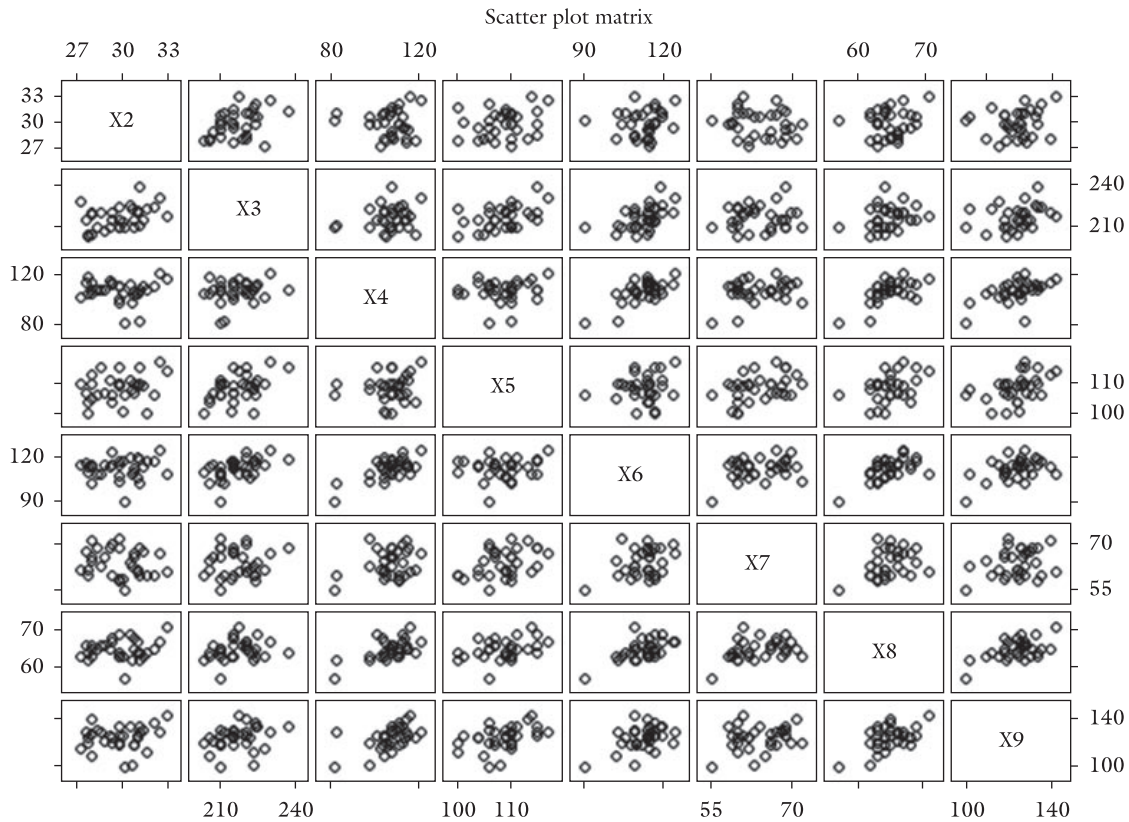


Figure 2. Graphic distribution of the male animals (N = 32) in function of the established correlations among the variables of the cranium and of the cranial cavity in goats – Petrolina, 2009.

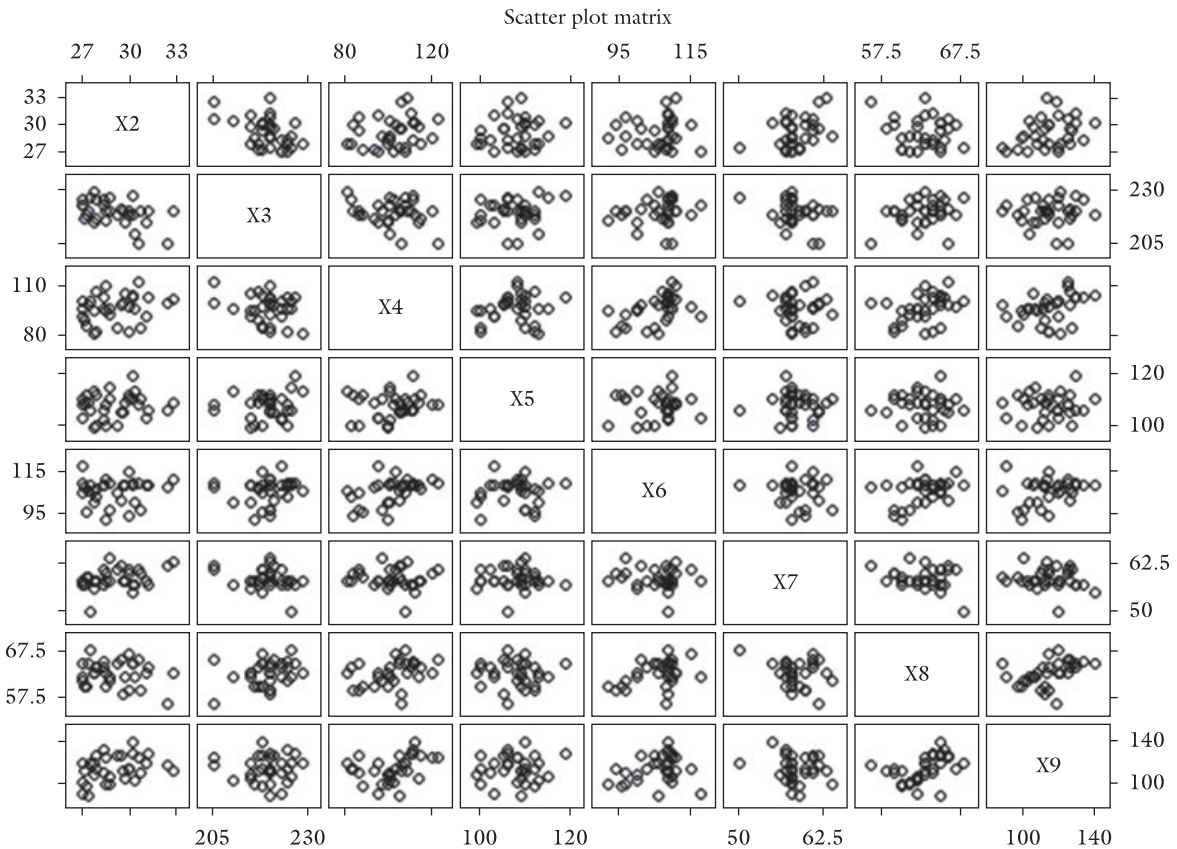


Figure 3. Graphic distribution of the females (N = 32) in function of the established correlations among the variables of the cranium and of the cranial cavity in goats – Petrolina, 2009.

being the variables: (X2) the corporal mass, (X3) the length of the cranium, (X4) the width of the cranium, (X5) the height of the cranium, (X6) the length of the cranial cavity, (X7) the width of the cranial cavity, (X8) the height of the cranial cavity and (X9) the intracranial volume.

Besides, it was obtained the average and the standard deviation of the length, of the width and of the height of the cranium and of the cranial cavity, as well as the intracranial volume, as the analyzed male and female animals together (N = 64) or separated according to the sex (N = 32), as they show the Tables 1, 2 and 3, respectively.

After the analyses with the total number of animals (N = 64), it was observed that, the width of the goats cranium possesses positive significant correlations with the length of the cranial cavity ($r = 0.6865$), with the height of the cranial cavity ($r = 0.5644$) and with the intracranial volume ($r = 0.5436$). They were still established, positive significant correlations among the height of the cranial cavity, with length of the cranial cavity ($r = 0.5682$) and also, with the intracranial volume ($r = 0.5473$).

Besides the mentioned analyses, they were still accomplished, correlation studies for sex (N = 32), where it was found significant differences ($p < 0.05$) between, the male and female animals, for the variables studied. The male animals obtained the positive significant correlations between: the length of the cranium with the length of the cranial cavity ($r = 0.5184$); the width of the cranium with the length of the cranial cavity ($r = 0.6780$), with the height

Table 1. Average and standard deviation of the variables studied in the cranium and in the cranial cavity of the animals males and females (N = 64) - Petrolina, 2009.

Variable	Average	Standard deviation
Length of the cranium (mm)	218.01	6.96
Width of the cranium (mm)	120.17	10.01
Height of the Cranium (mm)	108.14	4.46
Length of the cranial cavity (mm)	109.31	7.25
Width of the cranial cavity (mm)	61.36	4.51
Height of the cranial cavity (mm)	63.85	2.88
Volume of the cranial cavity (cm ³)	119.31	12.21

Table 2. Average and standard deviation of the variables studied in the cranium and in the cranial cavity of the animals males (N = 32) - Petrolina, 2009.

Variable	Average	Standard deviation
Length of the cranium (mm)	216.66	7.97
Width of the cranium (mm)	107.56	8.67
Height of the Cranium (mm)	108.56	4.26
Length of the cranial cavity (mm)	112.62	6.91
Width of the cranial cavity (mm)	64.09	4.36
Height of the cranial cavity (mm)	64.87	2.67
Volume of the cranial cavity (cm ³)	123.94	9.84

Table 3. Average and standard deviation of the variables studied in the cranium and in the cranial cavity of the females (N = 32) - Petrolina, 2009.

Variable	Average	Standard deviation
Length of the cranium (mm)	219.37	5.59
Width of the cranium (mm)	96.78	8.28
Height of the Cranium (mm)	107.72	4.69
Length of the cranial cavity (mm)	106.00	6.04
Width of the cranial cavity (mm)	58.62	2.62
Height of the cranial cavity (mm)	62.83	2.74
Volume of the cranial cavity (cm ³)	114.69	12.72

of the cranial cavity ($r = 0.5920$) and with the intracranial volume ($r = 0.5394$); the height of the cranial cavity with the length of the cranial cavity ($r = 0.5983$) and also, with the intracranial volume ($r = 0.5579$). They were not established significant correlations ($r > 0.5$) among the variables studied in the cranium and in the cranial cavity of the females.

4 Discussion

The average for the dimensions of the cranium and the volume and the dimensions of the cranial cavity, obtained in the present researches are smaller than described for Kalita, Sarma, Shalini et al. (2004), that found 247.4 ± 2.1 mm length and 173.5 ± 2.4 mm of width of the cranium; and 117.10 ± 8 mm length and 135.38 ± 33 cm³ for the volume of the cranial cavity in goats. Sarma (2006) determined the length (247 ± 9.3 mm) and the width (104.0 ± 6.1 mm) of the goats cranium. Besides, it is also evidenced, the medium volume of the cranial cavity using mustard seeds (113.0 ± 0.84 cm³). Archana Sudhakar and Sharma (2000) established the following dimensions of the cranium and of the cranial cavity in yaks: 392.6 ± 34.8 mm of length of the cranium, 250.0 ± 11.9 mm of width of the cranium, 129.8 ± 4.7 mm of length of the cranial cavity and 465 ± 80.98 cm³ intracranial volume.

Kalita, Sarma, Shalini et al. (2004), differently of this research, didn't observe correlations among the width of the cranium, with the length and with the volume of the cranial cavity in goats. On the other hand, Sarma (2006) established a positive correlation among the intracranial volume with the width of the goats cranium. Garcia-Real, Kass and Sturges (2004), observed that there are significant correlations between absolute data of the volume of the cranial cavity and certain lineal measures of the cranium and of the cranial cavity in dogs. Brudnicki (2005) described that a correlation exists between the length of the neurocranium base and the intracranial volume in pings. Acer, Sahin and Ekinici (2006) showed that the intracranial volume, the measures (width, height and length) of the cranium and the area of surface of the magnum foramen, they were well correlated in humans' craniums.

Garcia-Real, Kass and Sturges (2004) found significant differences in absolute values of the volume of the cranial

cavity in relation to the sex of canine. However, in the present project, there was not difference of the intracranial volume in function of the sex of the goats.

5 Conclusion

The determination of the dimensions of the cranium and the cranial cavity and the intracranial volume in goats allowed to establish positive significant correlations among: the width of the cranium with the length of the cranial cavity, the height of the cranial cavity and with the intracranial volume; the height of the cranial cavity with length of the cranial cavity and with the intracranial volume. And, besides, significant differences were evidenced among, the male and female animals, in relation to the dimensions of the cranium and of the cranial cavity. Even so, there was not difference of the intracranial volume in function of the sex of the goats.

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