

ORIGIN AND DISTRIBUTION OF THE CELIAC ARTERY IN OSTRICH (*Struthio camelus*)

BRUNO GOMES VASCONCELOS¹, FREDERICO OZANAM CARNEIRO E SILVA², RENATA LIMA DE
MIRANDA³, CHESTON CESAR HONORATO PEREIRA⁴, AMILTON CESAR DOS SANTOS¹, MARIA ANGELICA
MIGLINO⁵

¹ Graduate Student at the Faculty of Veterinary Medicina and Animal Science of Universidade de São Paulo, São Paulo, SP, Brazil. -
brunog_vet@hotmail.com

² Professor, PhD, at Universidade Federal de Uberlândia, Uberlândia, MG, Brazil

³ Graduate Student at Universidade Federal de Uberlândia, Uberlândia, MG, Brazil

⁴ Professor, MSc, at Universidade de Rio Verde, Rio Verde, GO, Brazil

⁵ Professor, PhD, at Universidade de São Paulo, SP, Brazil.

ABSTRACT

The exploration of ostriches aims at trade in meat, feathers, leather and grease. The digestive system is intimately related to productivity, and the celiac artery is amongst the major vessels responsible for its nutrition. The artery's origin and distribution were studied here. In 30 specimens, the left ischiatic artery was cannulated for the injection of a blood vessels marker solution and then

fixed in formalin solution 10% via deep intramuscular, subcutaneous and intracavitary applications. We concluded that this artery originated from the descending aorta, its first branch is ventral and it headed for the right side sending branches to: esophagus, proventriculus, ventriculus, spleen, liver, gallbladder, pancreas, duodenum, ileum, left and right cecum.

KEYWORDS: birds; digestive system; irrigation.

ORIGEM E DISTRIBUIÇÃO DA ARTÉRIA CELÍACA DE AVESTRUZES (*Struthio camelus*)

RESUMO

A exploração de avestruzes visa à comercialização das carnes, penas, couro e gordura. Intimamente relacionado à produtividade está o sistema digestório e, dentre os importantes vasos responsáveis pela sua nutrição, está a artéria celíaca, cuja origem e distribuição foram aqui estudadas. Em 30 exemplares, a artéria isquiática esquerda foi canulada para injeção de solução marcadora de vasos sanguíneos, em seguida, fixada em solução aquosa de

formol 10%, mediante aplicações intramuscular profunda, subcutânea e intracavitária. Concluímos que ela originou-se da aorta descendente, sendo o seu primeiro ramo ventral e dirigindo-se para o antímero direito em seu trajeto enviou vasos para: esôfago, proventrículo, ventrículo, baço, fígado, vesícula biliar, pâncreas, duodeno, íleo, cecos esquerdo e direito.

PALAVRAS-CHAVE: aves; irrigação; sistema digestório.

INTRODUCTION

The ratites are running birds which have anatomical and physiological characteristics that distinguish them from carinate birds (flying birds); in other words, ratites are flightless birds, which do not have chest muscles for flying and no keel on the sternum (SICK, 1997). Among them, the more commercially exploited species are ostriches, emus and rheas (GIANNONI, 1998).

The ostrich is the largest running bird in the world, with wide and robust legs, and feet with only two fingers. Its name derives from the Latin *Struthio camelus*, meaning camel bird (CARBÓ, 2003).

Regarding livestock, ostrich's meat, the main product generated, presents characteristic dark color and is gaining popularity in many parts of the world. The ostrich's second product, the skin, found a limited but expansive market and, finally, the feathers, considered as a marginal product, are widely sold at carnival (CARBÓ, 2003).

The digestive system, where food processing occurs, is closely related to the productivity of the ostriches. The recognition of their structures and physiology is essential to establish a more adequate nutrition, based on the particular digestive characteristics, aiming at obtaining a highly digestible feed in order to guarantee its better utilization by the animal, providing better feed conversion and thereby increasing production (MIRANDA et al., 2009).

Therefore, the growth of the ostrich production in Brazil and the scarcity of studies on the vascularization of the digestive organs of this species have guided this study, whose objective is to determine the origin and distribution of the celiac artery in ostriches.

MATERIAL AND METHODS

We used 30 specimens of ostriches (*S. camelus*) from farms in the municipality of Uberlândia-MG, obtained from natural deaths at one week of age.

After the natural death of the birds, the left ischiatic artery was cannulated for injection of a 50% aqueous neoprene latex "450" (Du pont do Brasil. Indústrias Químicas. São Paulo – SP), and stained with specific red pigment (Globo S/A Tintas e Pigmentos). Then, the birds were fixed in formalin 10% by deep intramuscular, subcutaneous and intracavitary applications, and subsequently maintained submerged in the same solution, with the minimum of 48 hours interval for dissection.

For dissection of the celiac artery, we used the appropriate surgical instruments, aided when necessary by the visual field of a Wild-type monocular (10X).

After the dissection, schemes of each specimen were performed, recording the origin, and the number and distribution of the artery studied. Besides, photographs (Figure 1) and a schematic drawing (Figure 2) were made for better illustration of the results.

Simple percentage descriptive analyses of the data were used to determine statistical differences between them.

The nomenclature used for describing the results was the *Nomina Anatomica Avium* (BAUMEL, 1993).

The study was approved by the Ethics Committee on Use of Animals, Universidade Federal de Uberlândia, under protocol number 079/10.

RESULTS

The celiac artery arises from the descending aorta, being its first ventral branch directed to the right antimer. Along the artery's path it gives off branches to esophagus, proventriculus, gizzard, spleen, liver, gallbladder, pancreas, duodenum, ileum and left and right cecum.

After the origin, it gives off the dorsal and splenic proventricular arteries, in all specimens studied, and the first one irrigated the esophagus in 10% and the spleen in 3.3%. Then, the celiac artery was divided into right and left branches (Figure 1).

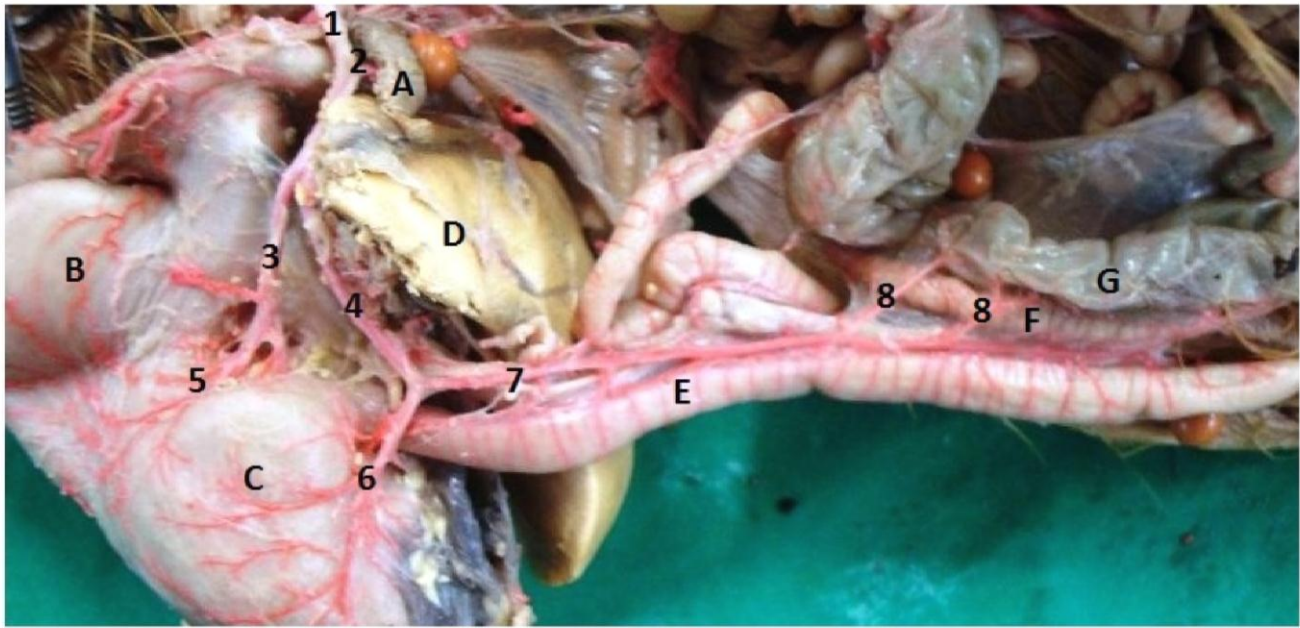


Figure1. Macrophotography of the left coelomic cavity of ostriches (*S. camelus*), with the organs: A - spleen, B - proventriculus; C - ventriculus; D - liver; E - duodenum; F - ileum and G - left cecum; and the branchings of celiac artery (1): lineal artery (2), left (3) and right (4) branches, left gastric artery (5), dorsal gastric artery (6), pancreaticoduodenal artery (7) and ileocecal arteries (8).

The left branch gives off the following arteries: ventral proventricular (90%), left and ventral gastric (100%) (Figure 1) and esophageal branches (33.3%). The liver receives arterial supply directly from the left branch through the left hepatic artery (13.3%) and indirectly from the esophageal branch (3.3%) distributed by the left branch.

The right branch of the celiac artery is divided into right hepatic artery, gall bladder and right and dorsal gastric (Figure 1), in all birds. Near the gastroduodenal transition, the right branch gives

off esophageal (3.3%), duodenal (13.3%) and pancreatic (46.6%) branches and continues as pancreaticoduodenal artery (Figure 1), which passes between the duodenal loop, vascularizes duodenum and pancreas and ends giving off ileocecal arteries (Figure 1) that irrigate the ileum (86.6%) and the left (100%) and right (96.6%) cecum.

In order to facilitate the understanding of the distribution of the celiac artery, we made a schematic drawing (Figure 2).

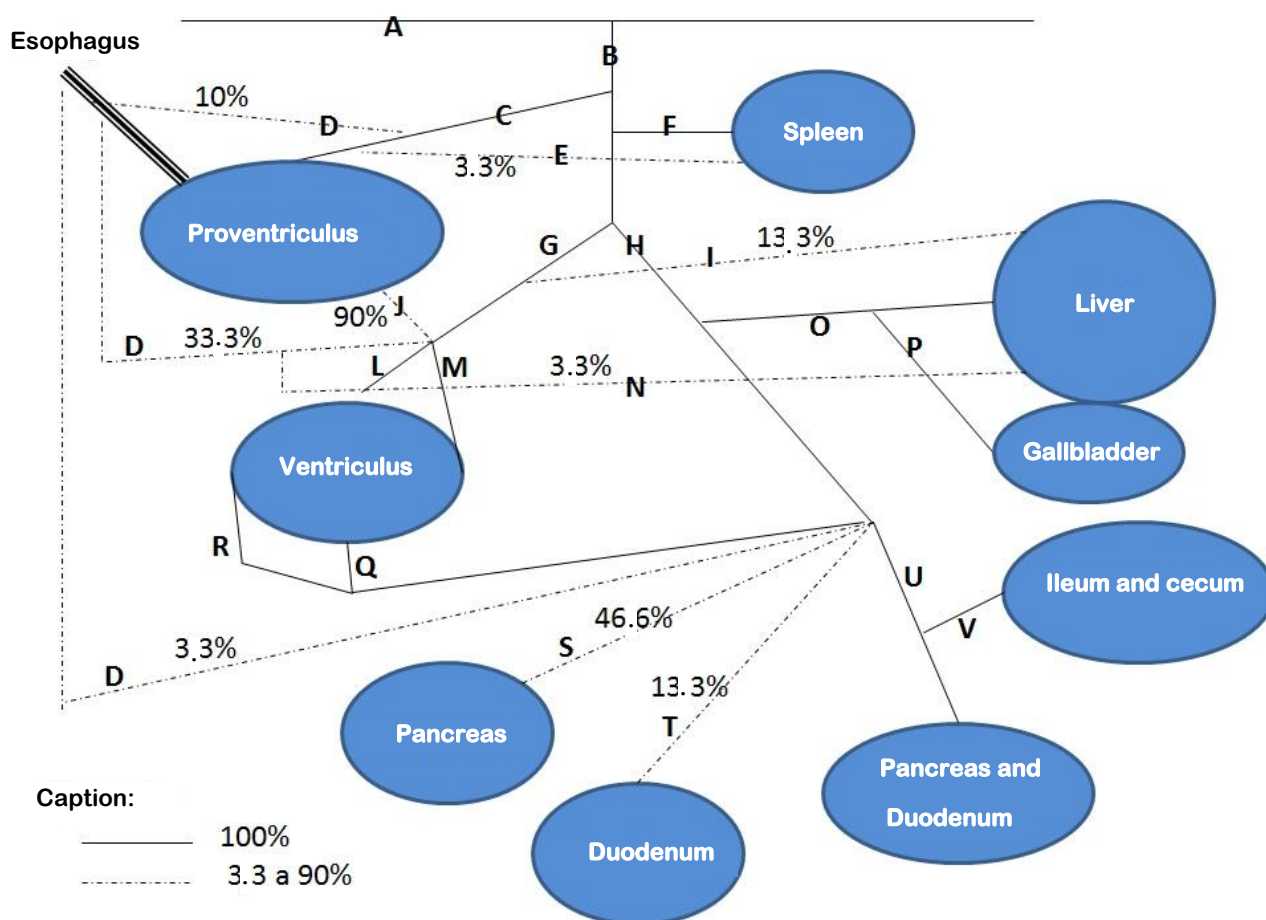


Figure 2. Scheme of the origin and distribution of the celiac artery in ostriches, as follows: A – descending aorta; B – celiac artery; C - proventricular dorsal artery; D - oesophageal branch; E - lineal branch; F – lineal artery; G - left branch; H - right branch; I - left hepatic artery; J - ventral proventricular artery; L - ventral gastric artery; M - left gastric artery; N - hepatic branch; O - right hepatic artery; P – gallbladder artery; Q - dorsal gastric artery; R - right gastric artery; S – pancreatic branch; T – duodenal branch; U – pancreaticoduodenal artery and V – ileocecal artery.

The lineal arteries varied from one to two vessels, and one vessel corresponds to 80% and two to 20%. The number of branches to the proventriculus arisen from the dorsal proventricular artery varied from two to 18 vessels, being two, five, 13, 16 and 18 equivalent to 3.3%; four, seven and 17 to 6.6%; six and eight to 10%; ten and 14 to 13.3%; and 12 to 16.6%; dorsal proventricular artery distributed collateral vessels to the esophagus (10%) and spleen (3.3%), giving off one and two branches, respectively. In addition, the proventriculus is irrigated by the ventral proventricular artery arisen from the left branch of the celiac artery in 90% of the birds, ranging from one to nine, being seven and nine equivalent to 3.7%, three and eight to 7.4%, one to 11.1%, five and six to 14.8% and two and four to

18.5%.

Subsequently, the left branch divides into the left and the ventral gastric arteries (100%) and esophageal branches (33.3%). The left gastric artery gives off from two to five collateral vessels (five corresponding to 13.3%, four to 16.6%, three to 26.6%, and two to 43.3%), and the gastric ventral artery gives off from three to 15 (three, four, 14 and 15 corresponding to 3.3%, six and ten to 6.6%, nine and 12 to 10%, five to 13.3% and seven and eight to 20% and the esophageal branch gives off one.

The liver receives arterial supply directly from the left branch through the left hepatic artery (13.3%), obtaining from one to two vessels, and 50% have one and two; and, indirectly, from an

esophageal branch (3.3%) given off by the left branch.

In all the animals, the right branch gives off the right hepatic artery ranging from one to two collateral vessels (90% and 10%, respectively). Before the branching of the right hepatic artery in the hepatic parenchyma, it gives off the gallbladder artery which received one branch in all cases.

Then, the right branch distributed vessels in the ventriculus through the right and the dorsal gastric arteries. The right gastric artery varied from two to six collateral vessels, in the following proportions: four and six, 10%; five, 20%; three, 26.6%; and two, 43.3%. The dorsal gastric artery varied from two to 14, with two, four and 14 equivalent to 3.3%, 12 to 6.6%, five and nine to 10%; seven and 10 to 13.3%, six to 16.6%, and eight to 20%. In one specimen (3.3%), the right branch ended by giving off an esophageal branch.

Near the gastroduodenal transition, the right branch gives off esophageal branch (3.3%) through a collateral vessel; the duodenal branch (13.3%) presents from one to two, being 50% with two, and the pancreatic branch (46.6%) ranges from one to five branches, in the proportion of 7.1% one to five, 14.2% two, 28.5% four and 42.8% three.

The right branch of the celiac artery continues as pancreaticoduodenal artery that irrigates the pancreas and the duodenum, giving off from nine to 18 branches to the pancreas (3.3% with 11, 6.6% with nine, 10% with 12, 14 and 17, 13.3% with ten and 13, and 16.6% with 15 and 19). It gives off from 15 to 59 vessels to the duodenum (3.33% with 15, 18, 21, 24, 31, 32, 41 and 59; 6.6% with 19, 20, 34 and 38; 10% with 25 and 27; 13.3% with 26 and 28).

The ileocecal arteries arise from the pancreaticoduodenal artery and are found in number of one (90%) or two (10%). They are distributed into the ileum (86.6%), left cecum (100%) and right cecum (96.6%). In the ileum, the vessels varied from one to ten, being 3.8% with ten, 7.6% with six and seven, 11.5% with four, 15.3% with one and five, 19.2% with two and three. In the left cecum, they vary from two to ten, being 3.3% with two, three, five and ten, 10% with four, 16.6% with eight, 20% with six and 40% with seven. In the right cecum they range from two to nine, being 3.4% with three and nine, 6.8% with four and seven, 10.3% with two,

20.6% with five and eight and 27.5% with six.

DISCUSSION

According to SISSON & GROSSMAN (1975), in the domestic chicken (*Gallus gallus*) the celiac artery is an odd vessel of the aorta, EDE (1965) described its origin in the extreme anterior of peritoneal cavity, NICKEL et al. (1977) considered it as the first major ventral branch of the aorta and BAUMEL (1993) referred to it as a vessel arisen from the descending aorta. We agree with SCHWARZE & SCHRODER (1972), GETTY (1981) and SILVA et al. (1996) who reported that in *G. gallus* and in Hubbard lineage, respectively, the celiac artery comes from the ventral side of the descending aorta. We also add that in the case of the ostrich, it goes to the right antimere.

The esophageal branch, which arises from the celiac artery right after its origin, was mentioned by BHADURI et al. (1957), SCHWARZE & SCHRODER (1972) and NICKEL et al. (1977), in *G. gallus*; DRUMMOND et al. (2000) in *G. gallus domesticus* and SILVA et al. (2001) in Avian Farms lineage. MIRANDA et al. (2005), in Redbro Plumé, added that it was found in 80% of specimens. However, we agree with BAUMEL (1993), who mentioned that, in *G. gallus*, these branches arise from the dorsal proventricular artery, and was present in 10% of the birds, but we also found irrigation through the left and right branches of the celiac artery in 33.3% and 3.3% of the cases, respectively.

The branches to the proventriculus, reported by BHADURI et al. (1957), SCHWARZE & SCHRODER (1972), SISSON & GROSSMAN (1975), GETTY (1981) and BAUMEL (1993) in *G. gallus*; DRUMMOND et al. (2000) in *G. gallus domesticus* and SILVA et al. (2001) in Avian Farms were found in 100% of the birds. MIRANDA et al. (2005) add that, in Redbro Plumé, these vessels were distributed by the dorsal proventricular artery and the left branch of the celiac artery through the ventral proventricular artery, as observed in birds of this work.

SILVA et al. (2001) described branches of the celiac artery to the heart in Avian Farms lineage, which was not observed in this study.

The division of the celiac artery into two branches, left and right, was described by BHADURI et al. (1957), SCHWARZE & SCHRODER (1972), GETTY (1981) and BAUMEL (1993) in *G. gallus*; SILVA et al. (1996) in Hubbard lineage; SILVA et al. (2001) in Avian Farms and MIRANDA et al. (2005) in Redbro Plumé, as observed in all specimens of this research.

GETTY (1981) mentioned that, in *G. gallus*, the left branch irrigated the liver via the left hepatic artery, and the right branch gave off the wide right hepatic artery, which vascularized the liver and the gallbladder, as verified in the ostriches.

The vascularization of the ventriculus in domestic chicken arose from the left branch of the celiac artery, called the ventral gastric artery by BAUMEL (1993), besides an artery to the left side of the ventriculus (EDE, 1965), which was named by BHADURI et al. (1957) as the left gastric artery, and we agree with it. MIRANDA et al. (2005) reported that the left and right ventral and dorsal gastric arteries, in Redbro Plumé lineage, vascularized the ventriculus, ranging from six to 12 collateral vessels. Similar variation occurred in this work, but from two of the vessels 15.

The spleen of *G. gallus*, according to BHADURI et al. (1957), received only a thin splenic artery, while NICKEL et al. (1977) cited a number of small vessels, SCHWARZE & SCHRODER (1972) reported from two to three arteries and GETTY (1981) described that the vascularization in the spleen is made by the wide cranial and caudal splenic arteries, but he did not number them. MIRANDA et al. (2005) found that, in the Redbro Plumé lineage, the right branch vascularized the spleen ranging from two to five vessels, which did not occur in ostriches, in which those arteries arose from the celiac artery in 100% of cases, ranging from one to two, and in 3.3% there was the contribution of the splenic branch through the dorsal proventricular artery.

Regarding the pancreaticoduodenal artery, GETTY (1981) in *G. gallus*; SILVA et al. (1996) in Hubbard lineage; SILVA et al. (1997) in Ross lineage; DRUMMOND et al. (2000) in *G. gallus domesticus*; SILVA et al. (2001) in Avian Farms and MIRANDA et al. (2005) in Redbro Plumé lineage, agreed that it is the final segment of the right branch

of the celiac artery and that it gave off vessels to the pancreas and duodenum. We observed that, in the ostrich, these organs were directly vascularized by the right branch, near the gastroduodenal transition, the pancreas in 46.6% of birds, ranging from one to five, and the duodenum in 13.3%, varying from one to two.

In the domestic chicken, ileocecal arteries originated from the pancreaticoduodenal artery, as mentioned by EDE (1965), as secondary branches; SCHWARZE & SCHRODER (1972) reported the distribution of an ileocecal artery after giving off the splenic arteries, before giving off the pancreaticoduodenal artery; GETTY (1981) referred to the ileocecal arteries, and we not only agree but also add that they may be presented in a number of one (90%) or two (10%) and that their contribution to the ileum was from one to ten branches, from two to ten to the left cecum, and from two to nine to the right cecum.

CONCLUSIONS

The celiac artery arises from the descending aorta, being its first ventral branch is directed to the right antimere. Along the artery's path it gives off branches to esophagus, proventriculus, ventriculus, spleen, liver, gallbladder, pancreas, duodenum, ileum and left and right cecum.

REFERENCES

- BAUMEL, J. J. **Handbook of avian anatomy: Nomina anatómica avium**. 2 ed. Massachusetts: Cambridge, 1993. p.407-421.
- BHADURI, J. L.; BISWAS, B.; DAS, S. K. The arterial system of the domestic pigeon (*Columba líva gmelin*). **Anatomischer Anzeiger**, Deerfield Beach, v. 104, n. 14, p. 1-14, 1957.
- CARBÓ, C. B. **Producción del avestruz: aspectos claves**. Madrid: Mundi Pressa, 2003. p. 7-30.80.
- DRUMMOND, S. S.; CARDOSO, J. R.; SILVA, F. O. C.; SEVERINO, R. S.; MARTINS, A. K.; MOTA, F. C. D. Origem e distribuição da artéria celiaca em *Gallus gallus domesticus*. **Veterinária Notícias**, Uberlândia, v.6, n.1, p. 35-42, 2000.
- EDE, D. A. Las vísceras. In: _____. **Anatomia de las aves**. Zaragoza: Acribia, 1965. p.86-88.

- GETTY, R. **Sisson/ Grossman anatomia dos animais domésticos**. 5. ed. Rio de Janeiro: Interamericana, 1981. v. 2. p. 1862-1869.
- GIANNONI, M. L. **Viabilidade da exploração de ratitas em São Paulo**. São Paulo: Biológico, v. 1, n. 2, 1998. p. 91-96
- MIRANDA, R. L.; SILVA, F. O. C.; LIMA, J. C. S.; CASTRO, J. R.; QUIRINO, R. C.; SEVERINO, R. S.; DRUMMOND, S. S. Origem e distribuição da artéria celíaca em aves (*Gallus gallus*) de corte da linhagem Redbro Plumé. **Bioscience Journal**, Uberlândia, v. 21, n. 3, p. 77-83, Spt./Dec. 2005.
- MIRANDA, R. L.; SILVA, F. O. C.; SEVERINO, R. S.; DRUMMOND, S. S. SOLA, M. C.; MENDONÇA, E. P.; SILVA JÚNIOR, W. Origens e distribuições das artérias mesentéricas cranial e caudal em aves (*Gallus gallus*) da linhagem Bovans Goldline. **Bioscience Journal**, Uberlândia, v. 25, n. 1, p. 157-162, Jan./Feb. 2009.
- NICKEL, R.; SCHUMER, A.; SEIFERLE, E. Circulatory system. In: _____. **Anatomy of the domestic birds**. Berlin: Velag Paul Parey, 1977. p.85-107.
- SCHWARZE, E.; SHRODER, L. **Compêndio de anatomia veterinária**. Zaragoza: Acribia, 1972. v.5, p. 64-74.
- SICK, H. Ordem Rheiformes – emas: família Rheidae. In: SICK, H. **Ornitologia brasileira**. Rio de Janeiro: Nova Fronteira, 1997. p. 168-171.
- SILVA, F. O. C.; SEVERINO, R. S.; SANTOS, A. L. Q. ; DRUMMOND, S. S.; BOMBONATO, P. P.; SANTANA, M. I. S.; LOPES, D. Origem e distribuição da artéria celíaca em aves (*Gallus gallus domesticus*) da linhagem Avian Farms. **Veterinária Notícias**, Uberlândia, v. 7, n. 2, p. 27-36, 2001.
- SILVA, F. O. C.; SEVERINO, R. S.; SANTOS, A. L. Q.; DRUMMOND, S. S.; BOMBONATO, P. P.; SANTANA, M. I. S.; LOPES, D.; MARÇAL, A. V. Origem e distribuição da artéria celíaca em aves (*Gallus gallus domesticus* linhagem Ross). **Revista da Faculdade de Zootecnia, Veterinária e Agronomia**, Uruguaiana, v.4, n.1, p.35-41, 1997.
- SILVA, F. O. C.; SEVERINO, R. S.; SANTOS, A. Q.; DRUMMOND, S. S.; JÚNIOR, W. S.; BOMBONATO, P. P.; SANTANA, M. I. S.; CAMILO, V. Origem e distribuição da artéria celíaca em aves (matrizes de corte linhagem Hubbard). **Veterinária Notícias**, Uberlândia, v.2, n.1, p.17-24, 1996.
- SISSON, S.; GROSSMAN, J. D. **Anatomia de los animals domésticos**. 4.ed. Barcelona: Salvat, 1975. p.920-923.

Submitted on August, 30, 2011. Accepted on March, 1, 2012.