
Nutritional values of carcasses of *Gallus gallus domesticus* (Linnaeus, 1758). (Galliformes, Phasianidae) used for animal feed

Valores nutricionais de carcaças de *Gallus gallus domesticus* (Linnaeus, 1758). (Galliformes, Phasianidae) utilizadas na alimentação animal.

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RESUMO

A nutrição de carnívoros em cativeiro ainda é limitada pela escassez de dados sobre a composição bromatológica de presas inteiras. Neste contexto, o estudo objetivou caracterizar a composição nutricional de pintinhos de *Gallus gallus domesticus* com um dia de vida, avaliando seu potencial como recurso alimentar. Foram analisadas cinco amostras compostas (n = 5), constituídas por material integral homogeneizado, quanto aos teores de proteína bruta, extrato etéreo, matéria mineral, umidade, cálcio, fósforo e energia, seguindo metodologias AOAC e análise descritiva. Os resultados indicaram elevada estabilidade nos componentes energéticos e macronutricionais, com destaque para o alto teor de lipídios (69,2%) e baixa variabilidade. A proteína bruta apresentou média de 9,6% e a matéria mineral 19,8%, enquanto a energia manteve-se consistente (169,6 kcal/kg). Em contraste, cálcio e fósforo apresentaram maior variabilidade relativa. A elevada concentração lipídica está associada ao saco vitelínico residual, conferindo maior densidade energética. Conclui-se que pintinhos neonatos apresentam perfil nutricional altamente energético e relativamente estável, constituindo alternativa relevante para dietas de carnívoros.

Palavras-chave: Animal carnívoro; pintinho; presas inteiras; valor nutricional

ABSTRACT

The nutrition of captive carnivores remains limited by the scarcity of data on the bromatological composition of whole prey. In this context, the present study aimed to characterize the nutritional composition of one-day-old *Gallus gallus domesticus* chicks, evaluating their potential as a dietary resource. Five composite samples (n = 5), consisting of homogenized whole-organism material, were analyzed for crude protein, ether extract, mineral matter, moisture, calcium, phosphorus, and energy, following AOAC methodologies and descriptive analysis. The results indicated high stability in energy and macronutrient components, with emphasis on the high lipid content (69.2%) and low variability. Crude protein averaged 9.6% and mineral matter 19.8%, while energy content remained consistent (169.6 kcal/kg). In contrast, calcium and phosphorus exhibited greater relative variability. The elevated lipid concentration is associated with the residual yolk sac, conferring higher energy density. It is concluded that neonatal chicks present a highly energetic and relatively stable nutritional profile, representing a relevant alternative for carnivore diets.

Keywords: Carnivorous animal; neonatal chicks; nutritional value; whole prey

INTRODUCTION

Gallus gallus domesticus (Linnaeus, 1758), commonly referred to as the domestic chicken, is a panmictic species belonging to the order Galliformes and the family Phasianidae, characterized by predominantly diurnal habits (Barbosa-Filho et al., 2007). Due to the substantial increase in global poultry meat consumption, the intensification and optimization of production systems have become imperative, aiming to maximize zootechnical efficiency and ensure the economic sustainability of the production chain in order to meet the growing demand (Rocha, 2008).

It is estimated that approximately 7% of mammal, bird, reptile, and amphibian species maintained in captivity are distributed among zoos, rehabilitation centers, research institutions, and commercial breeding facilities (Carciofi et al., 2011). However, the maintenance of these animals is still constrained by significant gaps in knowledge regarding their specific nutritional requirements, often leading to the adoption of dietary parameters based on domestic species with physiological, anatomical, or behavioral characteristics similar to those of wild animals. Furthermore, most available studies focus on the feeding ecology of free-ranging species (Queiroz et al., 2019; Couto et al., 2021; Silva & Couto, 2021), while research addressing the bromatological characterization of whole prey used in animal nutrition has only recently advanced (Couto et al., 2025; Couto et al., 2026; Couto et al., 2026a).

Traditionally, rodents and birds have been widely used as the primary dietary base for carnivores maintained in captivity (Bird & Ho, 1976). However, the trophic diversity observed in both generalist and specialist species highlights the inclusion of other taxonomic groups in their diets, such as amphibians, as demonstrated in recent studies (Peixoto-Couto et al., 2020; Couto et al., 2024; Couto et al., 2024a). In this context, the present study aims to characterize the bromatological composition of captive-reared *Gallus gallus domesticus* chicks, evaluating their potential as a dietary resource for the formulation of feeding strategies for carnivorous animals.

MATERIALS AND METHODS

The study was conducted at Biotério Pantanal, a facility dedicated to the production of frozen whole prey intended for feeding captive carnivorous animals,

approved by CONCEA (protocol 01/2024). For this study, the species *Gallus gallus domesticus* was used, exclusively comprising one-day-old chicks.

All breeding stock were maintained under controlled temperature conditions according to species-specific requirements. Animals were fed twice daily with species-appropriate feed, and water was provided ad libitum through automatic drinkers. Prior to slaughter, animals were subjected to electrical stunning (electronarcosis) to ensure insensibilization, followed by rapid freezing in an ultra-low temperature freezer.

The study was based on five composite biological samples (batches L1–L5), each consisting of a pooled homogenate of multiple chicks. Each batch was treated as a single experimental unit, obtained through whole-organism homogenization to minimize individual variability and provide representative estimates of nutritional composition. The experimental design followed a single-group descriptive approach with five technical/biological composite replicates ($n = 5$).

Samples were analyzed for calcium (Ca), phosphorus (P), crude protein (CP), ether extract (EE), mineral matter (MM), moisture content (MC), and energy. Calcium and phosphorus were determined using standard mineral analysis procedures. Crude protein was estimated based on total nitrogen content multiplied by the conventional conversion factor ($N \times 6.25$). Ether extract was used as an indicator of lipid content, mineral matter represented total ash content, and moisture content was determined gravimetrically. Energy content was estimated and expressed in kcal/kg. Data analysis was performed using R software, and descriptive statistics, including mean, standard deviation (SD), coefficient of variation (CV), and 95% confidence intervals (95% CI), were calculated for all variables. Given the absence of experimental treatment groups, the study was strictly descriptive in nature.

Initially, all prey batches were sectioned into smaller fragments to enhance drying efficiency. The material was weighed and dried in forced-air circulation ovens at temperatures ranging from 65 to 70°C, not exceeding 75°C. Pre- and post-drying weights were recorded for each batch. Drying was conducted for 72 hours, after which the material was ground using a ball mill in 30 g portions. This equipment, constructed of stainless steel, was selected to prevent contamination by metals, particularly iron, zinc, and copper.

Each sample batch was subsequently homogenized, sealed in hermetic ziplock bags, properly labeled, and sent to the bromatology laboratory.

In the bromatology laboratory, samples were analyzed to quantify total dry matter, crude protein, ether extract, and mineral content following AOAC (2000) procedures. Calcium and phosphorus contents were also determined on a dry matter basis. Based on the bromatological composition, gross energy values (kcal/kg) were estimated using the equation:

$$\text{Gross Energy (kcal/g)} = \text{Ether Extract (g)} \times 9 \text{ kcal} + \text{Protein (g)} \times 4 \text{ kcal} + \text{Carbohydrates (g)} \times 4 \text{ kcal}.$$

RESULTS AND DISCUSSION

The nutritional composition of the pooled chick samples is summarized in Table 1. Overall, the results demonstrate a marked heterogeneity among nutrients, with clear differences in the magnitude of variability across the evaluated parameters.

As shown in Table 1, calcium and phosphorus exhibited the highest relative dispersion among all variables. Calcium showed a mean concentration of 0.24%, with a standard deviation of 0.089, corresponding to a high coefficient of variation (37.27%) and a 95% confidence interval of 0.24 ± 0.11 . Similarly, phosphorus presented a mean value of 0.26%, with a standard deviation of 0.055 and a coefficient of variation of 21.07%, as well as a 95% confidence interval of 0.26 ± 0.07 . These results indicate that mineral fractions showed greater variability within the pooled biological material.

In contrast, macronutrient-related components showed greater compositional stability. Crude protein had a mean of 9.6% (SD = 0.55; CV = 5.71%), with a relatively narrow 95% confidence interval of 9.6 ± 0.68 . Ether extract showed a high mean value of 69.2%, but low variability (SD = 1.30; CV = 1.88%) and a 95% confidence interval of 69.2 ± 1.62 . Mineral matter also exhibited low dispersion, with a mean of 19.8% (SD = 0.84; CV = 4.23%) and a 95% confidence interval of 19.8 ± 1.04 .

Moisture content showed intermediate variability, with a mean of 2.6%, a standard deviation of 0.55, and a coefficient of variation of 21.07%, resulting in a 95% confidence interval of 2.6 ± 0.68 . Energy content showed the lowest relative variation among all evaluated parameters, with a mean value of 169.6 kcal/kg, a standard deviation of 1.14,

and a coefficient of variation of only 0.67%, corresponding to a narrow 95% confidence interval of 169.6 ± 1.41 .

Overall, as presented in Table 1, the nutritional profile of the samples indicates a stable composition for energy and macronutrient-related variables, whereas mineral fractions, particularly calcium and phosphorus, as well as moisture content, exhibited greater relative variability within the pooled biological samples.

Table 1. Descriptive statistics of nutritional parameters in pooled chick samples, including mean, SD, CV, and 95% CI. Values are expressed as percentage (%) except energy (kcal/kg).

| Variable | Mean | SD | CV (%) | 95% CI |
|------------------|-------|------|--------|------------------|
| Calcium | 0.24 | 89 | 37.27 | 0.24 ± 0.11 |
| Phosphorus | 0.26 | 55 | 21.07 | 0.26 ± 0.07 |
| Crude Protein | 9.6 | 0.55 | 5.71 | 9.6 ± 0.68 |
| Ether Extract | 69.2 | 1.30 | 1.88 | 69.2 ± 1.62 |
| Mineral Matter | 19.8 | 0.84 | 4.23 | 19.8 ± 1.04 |
| Moisture Content | 2.6 | 0.55 | 21.07 | 2.6 ± 0.68 |
| Energy | 169.6 | 1.14 | 0.67 | 169.6 ± 1.41 |

Calcium and phosphorus play essential roles in the development, structural maintenance, and metabolic regulation of living organisms. Calcium is fundamental for the formation and mineralization of bone and dental tissues, and it also performs critical physiological functions, including blood coagulation, muscle contraction, and nerve impulse transmission, highlighting its importance in homeostasis and the proper functioning of biological systems (Waldron, 2019; Rorive, 2021).

Phosphorus, in turn, is directly involved in the regulation of biochemical processes, particularly through its role in phosphorylation reactions, which are responsible for the activation and deactivation of enzymes in complex metabolic pathways (Morris et al., 2021). Furthermore, the maintenance of phosphorus homeostasis is crucial for skeletal integrity in vertebrates, as this element, in association with calcium, constitutes the mineral matrix of bone tissue and is indispensable for its formation and maintenance (IOM, 2011).

In other vertebrate groups, such as mammals and amphibians, nutrient levels especially proteins, minerals, and energy tend to increase throughout ontogenetic development, such that juvenile and adult individuals exhibit greater nutritional density

compared to neonates. Conversely, younger individuals consistently present higher moisture content (Couto et al., 2025).

In birds, however, this pattern presents important physiological particularities. During the final stage of embryonic development, the yolk serves as the primary nutrient source, and in the last days of incubation, the residual yolk is progressively internalized into the abdominal cavity, forming the internal yolk sac (Romanoff, 1960; Noble and Ogunyemi, 1989). At this stage, the yolk contains approximately 50% lipids, predominantly in the form of acylglycerols (Lambson, 1970). At hatching, the yolk sac may represent 15–25% of the chick's body weight, playing a fundamental role in energy maintenance during the first hours of life (Anthony et al., 1989).

Considering body mass, one-day-old chicks weigh approximately 35–45 g. When compared to rodents commonly used in carnivore nutrition, individuals of similar body mass exhibit marked differences in bromatological composition, particularly due to their higher ether extract content, which may be up to approximately 8% greater than that of rodents of equivalent weight. Moreover, when considering strictly the neonatal stage disregarding body mass differences (rats: 4 g; mice: 2 g; chicks: 35–45 g) chicks exhibit substantially higher lipid levels, reaching values up to approximately 17% greater, in addition to presenting higher energy density, often exceeding more than twice the values observed in neonatal rodents.

CONCLUSION

The characterization of the bromatological composition of whole carcasses of *Gallus gallus domesticus* chicks, encompassing protein, lipid, energy, moisture, mineral matter, calcium, and phosphorus contents as a function of age and body weight, represents a significant advancement in the formulation of diets for carnivorous animals. This approach not only contributes to the establishment of a consistent and standardized database for future research, but also provides essential technical support for animal nutrition professionals, enabling the development of more precise diets tailored to the specific nutritional requirements of captive carnivores. Furthermore, by considering different prey categories, this perspective promotes greater nutritional diversity, with direct implications for the health, performance, and welfare of these animals.

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