



Chemical composition and apparent digestibility of the ostrich offal meal for Nile tilapia

Priscila Juliana Pinsetta Sales^{1*}, Wilson Massamitu Furuya² and Pedro Fernando Romanelli¹

¹Departamento de Engenharia e Tecnologia de Alimentos, Universidade Estadual Paulista "Júlio de Mesquita Filho", Rua Cristóvão Colombo, 2265, 15054-000, São José do Rio Preto, São Paulo, Brazil. ²Departamento de Zootecnia, Universidade Estadual de Ponta Grossa, Praça Santos Andrade, Ponta Grossa, Paraná, Brazil. *Author for correspondence. E-mail: pripinsetta@yahoo.com.br

ABSTRACT. This study aimed to produce and nutritionally characterize the ostrich offal meal, and to evaluate its digestible value for Nile tilapia. The relevance of the study lies in the possibility of using by-products from the food industry as alternative food for animals. For this, chemical and microbiological analyses were performed, as well as digestibility trial in the meal produced with ostrich offal for Nile tilapia. The levels found for protein, lipids, gross energy and minerals were 71.08%, 16.54%, 5115 kcal kg⁻¹ and 5.62%, respectively. Microbiological analysis showed absence of *Salmonella* spp. in the product. The digestibility of protein was 90.41%, and of energy was 77.65%, while the phosphorus availability was 80.18%. Therefore, the ostrich offal meal proved to be a by-product with good nutritional profile and significant digestibility to be used in diets for Nile tilapia.

Keywords: by-product, alternative feed, digestible value.

Composição química e coeficiente de digestibilidade aparente da farinha de vísceras de avestruz para tilápia-do-Nilo

RESUMO. O presente trabalho foi desenvolvido com objetivo de produzir e caracterizar nutricionalmente a farinha de vísceras de avestruz, e avaliar seu valor digestível para tilápia-do-Nilo. A relevância do estudo está na possibilidade de aproveitamento alternativo de subprodutos da indústria alimentícia na produção de alimento para animais. Para tanto, realizaram-se análises químicas, análise microbiológica e ensaio de digestibilidade na farinha produzida de vísceras de avestruz para tilápias-do-Nilo. Os teores encontrados para proteína, lipídios, energia bruta e minerais foram 71,08%, 16,54%, 5.115 kcal kg⁻¹ e 5,62%, respectivamente. A pesquisa microbiológica resultou na ausência de *Salmonella* sp. no produto analisado. A digestibilidade da proteína foi de 90,41% e da energia 77,65%, ao passo que a disponibilidade do fósforo foi de 80,18%. Verifica-se, portanto, que a farinha de vísceras de avestruz é um alimento com bom perfil nutricional e relevante digestibilidade, podendo ser utilizado em rações para tilápia-do-Nilo.

Palavras-chave: subproduto, alimento alternativo, valor digestível.

Introduction

The slaughter of ostriches, as well as all other animals, generates by-products that are not consumed by humans, and need to be processed and used, lowering the costs with waste treatment and preventing environmental pollution.

There is an important factor, for food industry, in the views of economic, technological, nutritional, and environmental public health, since the waste can be used as protein sources of animal origin, reducing costs for treatment (PRICE; SCHWEIGERT, 1994), which directly influences the price of meat.

In recent years, the ostrich meat (*Struthio camellus*) has been gradually included in the Brazilian industry, as already occurs for some years in several countries. Some slaughterhouses have distributed their products

to a large number of supermarkets and restaurants, enabling the technological exploitation of their by-products (COSTA et al., 2008).

The ostrich breeding enables the exploitation of the diversity of its products such as meat, feathers, oil, leather and eggs.

Nile tilapia meat is appreciated by consumers due to its good quality, with no spines in the fillet, being recommended for filleting (BOSCOLO et al., 2004). The intensification of Nile tilapia production was stimulated by the drop of fishing and the growing demand for fish as a way to acquire a healthy meat (SANTOS et al., 2007). It is a species that easily accepts feed, since the larval period, and is considered very versatile to adapt to both the cultivation without using technology and high-tech production (MEURER et al., 2002). This species features rustic character, and

supports environments with low oxygen and high stocking density (MEURER et al., 2008).

The determination of digestibility is a major tool to assess the nutritional quality of a diet or ingredient, as well as levels of undigested nutrients that make up the majority of waste accumulated in the aquatic environment (FURUYA; PEZZATO, 2001).

Once food accounts for the largest fraction of feed costs in intensive and semi-intensive systems (BOSCOLO et al., 2001), researches are needed on nutritional composition and digestibility of alternative protein ingredients.

The purpose of this study was to chemically characterize the meal produced with ostrich offals and evaluate its digestibility for the Nile tilapia through the indirect method using chromic oxide as indicator and collection of stool samples by sedimentation.

Material and methods

Thawed ostrich offals (*Struthio camellus*) were provided by Avestro Ostrich Products S/A, containing stomach, liver and lungs of ostriches. The apparent fat of the stomach was extracted, and all organs were sterilized by autoclaving at 121°C, 1.1 atm for 20 minutes. Subsequently, they were ground with a meat grinder using disk of 3 mm diameter. The material was dried in a forced ventilation oven at 70°C for 10 hours and then ground again.

Chemical analysis of protein was performed by the Kjeldahl method (AOAC, 1990), fat by Bligh and Dyer (1959), ash according to AOAC (1990), gross energy using a Parr bomb calorimeter for the method of Harris (1970). Analyses of calcium, phosphorus, *Salmonella* spp., and acidity were conducted in accordance with the Brazilian law (BRASIL, 2009). The pH analysis was made as Costa et al. (2008). Moisture was analyzed through the drying of the product for 10 hours at 80°C.

Acidity and pH data were analyzed using ANOVA and Tukey's multiple comparison test at 5% significance. Statistical tests were run using the SAS software (SAS, 1990).

The digestibility trial was conducted at CODAPAR - State University of Maringá. Thirty fish (150 ± 25 g) were distributed into six digestibility tanks, composing two treatments (with and without meal) with three replications.

It was used 80 liters-fiberglass aquaria, with valves set at the lowest end, where collectors are coupled for fish feces deposition. The stool collection was performed using the method modified from Guelpa, using 0.1% chromic oxide as an indicator added to the reference diet and to the tested food. The test diet was composed of 70% of

the basal diet and 30% of ostrich offal meal. The Table 1 lists the composition of the basal diet used in the experiment.

Table 1. Composition of the basal diet used in the digestibility trial.

Ingredient	%
Flour of meat and bones	37.90
Maize grain	39.40
Feather flour	3.00
Brewers rice	4.00
Corn germ	13.00
Blood meal	2.00
Mineral and vitamin ¹	0.30
Salt	0.20
Vitamin C ²	0.08
Antifungal-Mold Zap ³	0.10
Banox ⁴	0.02

¹Mineral and vitamin (DSM): composition for kg: Vitamin A = 1,200,000 UI; vitamin D3 = 200,000 UI; vitamin E = 12,000 mg; vit. K3 = 2,400 mg; vitamin B1 = 4,800 mg; vitamin B2 = 4,800 mg; vitamin B6 = 4,000 mg; vitamin B12 = 4,800 mg; folic acid = 1,200 mg; calcium pantothenate = 12,000 mg; vitamin C = 48,000 mg; biotin = 48 mg; colin = 65,000 mg; niacin = 24,000 mg; Fe = 10,000 mg; Cu = 600 mg; Mg = 4,000 mg; Zn = 6,000 mg; I = 20 mg; Co = 2 mg and Se = 20 mg; ²Vitamin C (Lutavit C[®]): 2-monophosphate calcium salt of ascorbic acid (3,500 mg of vitamin C kg⁻¹). ³Mold Zap Aquativa[®]. Composition: dipropionate ammonia, acetic acid, sorbic acid and benzoic acid - Alltech do Brasil Agroindustrial Ltda. ⁴Banox[®]. Composition: BHA, BHT, propyl gallate and calcium carbonate - Alltech do Brasil Agroindustrial Ltda.

The components used to manufacture both diets were ground using a knife-type grinder (0.5 mm sieve). They were mixed according to their formulation, moistened with 20% of water at 50°C, pelleted in meat grinder and dried in a forced air oven for 24h.

For collection of feces, fish were fed six times a day and, after the first three days of feeding, the feces began to be collected six times a day to avoid leaching. This was done until the accumulation of a sufficient amount to perform the analysis. Fish were feed with small amounts until apparent satiety, to prevent deposition of feed at the bottom of the aquaria. The water of each aquarium was completely renewed daily in the early morning. Fecal material was stored in plastic pots and kept in a freezer until drying in a forced air oven at 52°C for 48h.

The calculations of apparent digestibility of protein and energy of the ostrich by-product were made according to the equations used by Nose (1960).

$$CDA_{(n)} (\%) = 100 - \left[100 \left(\frac{\%Cr_2O_{3r}}{\%Cr_2O_{3f}} \right) \times \left(\frac{\%N_f}{\%N_r} \right) \right]$$

where:

CDA(n) = coefficient of apparent digestibility of the nutrient;

%Cr₂O_{3r} = % of chromic oxide in feed;

%Cr₂O_{3f} = % of chromic oxide in feces;

%Nr = Nutrient or energy in feed;

%Nf = Nutrient or energy in feces.

From the determination of apparent digestibility of nutrients and energy of the test diet and reference diet, it was determined the apparent digestibility of crude protein, gross energy of food, according to the equation proposed by Forster (1999).

$$CDA_N = \frac{[(a+b) \times CDAdc - (a) \times CDA_{dr}]}{b}$$

where:

CDAn = coefficient of apparent digestibility of the nutrient;

CDAdc = coefficient of apparent digestibility of the combined diet;

CDA_{dr} = coefficient of apparent digestibility of the basal diet;

a = contribution of the nutrient or energy of the reference diet to the content of the nutrient or energy of the feed combined;

b = contribution of the nutrient or energy by the test ingredient for the nutrient content of the reference feed;

a + b = total energy or nutrient in the test diet.

Chromic oxide content, used as an indicator, was determined by digestion with nitric and perchloric acids and read with a spectrophotometer, according to Furukawa and Tsukahara (1976).

Results and discussion

The research of *Salmonella* spp. resulted in the absence of microbial strains. It revealed that the sterilization and handling of the product were adequate, since these steps represent a risk for contamination through inadequate equipment and handling.

The Table 2 lists the physical and chemical composition of ostrich offal meal produced in the experiment. The moisture present in a meal influences the quality, since a higher activity of water provides an enabling environment for the development of microorganisms. In the present study the value found was considered adequate. Similar results were reported by Costa et al. (2008), for chicken offal meal (5.53%) and lower values for emu offal meal (3.58%) and ostrich offal meal (3.52%), all dried for 6 hours at 80°C. The divergence of results may be explained by the different compositions of offal meals from processing industries, which implies in different parameters of drying of the products.

The high amount of protein presented in the Table 2 is due to the feedstock used, partially defatted before processing. It resulted in a greater proportion of protein in the product analyzed

chemically, when compared to the lower values reported by other authors, like 46.72% of protein for chicken offal meal (NUNES et al., 2005) and 47.59% in the ostrich offal (COSTA et al., 2008).

Table 2. Physical and chemical composition of the ostrich offal meal.

Parameter	Unit	Value
Moisture	%	5.81
Protein	%	71.08
Fat	%	16.54
Ash	%	5.62
Gross energy	kcal kg ⁻¹	5,115

Among the results presented, the fat resulted in a value close to that obtained by Souza et al. (2000) and slightly lower than reported by Brumano et al. (2006), for chicken offal. However, it should be highlighted the partial removal of fat during processing performed at laboratory scale, a method found to replace the pressing used in the industry.

The gross energy is relevant in the composition of a feed, and this study registered a satisfactory caloric value, close to that found by Meurer et al. (2003) and Pezzato et al. (2002) with poultry by-product meal.

The amount of minerals was similar to Souza et al. (2000) for chicken offal meal, but different from the value found by Nunes et al. (2005), 24.06%, in a product of the same origin. The range between the results is because the poultry by-product meal may include or not feet and heads, resulting in different amounts of minerals.

Table 3 shows the apparent digestibility coefficients (ADC) and values of digestible energy, digestible protein and available phosphorus in the ostrich offal meal for Nile tilapia (based on natural material).

Table 3. Values of ADC, digestible energy, digestible protein and available phosphorus in the ostrich offal meal for Nile tilapia.

	ADC (%)	Digestible value
Energy	77.65	3,721.80 kcal kg ⁻¹
Protein	90.41	64.26%
Phosphorus	80.18	0.49%

The coefficient of protein digestibility of the ostrich offal meal was close to that reported by Guimarães et al. (2008), in chicken by-product meal for tilapia with 100 grams. The energy digestibility was similar to that found in chicken offal meal (MEURER et al., 2003). Furthermore, Pezzato et al. (2002) achieved the value of 69.20% for gross energy digestibility in chicken offal meal.

Some results were divergent for the same parameter in the same product evaluated for a single species, probably due to different compositions of the meals, since each slaughterhouse uses certain types of

by-products to manufacture the meal. In this study, we used a raw material with low mineral content, which probably contributed to the higher digestibility of energy and protein of the ostrich offal meal.

Once the offal meal produced in the present study had no phosphorus in the form of phytic acid, the meal presented high phosphorus availability (80.18%). This is important from a commercial point of view, since it reduces the need for inclusion of inorganic sources of phosphorus to the diet for tilapia, to meet the requirements of this species.

Conclusion

The by-product of ostrich proved to have a relevant nutritional value and high digestibility when used to feed Nile tilapia. This allows its use in the feed for this fish species, easing the formulation of complete diets derived from the rational use of the by-products of food industry.

Acknowledgements

The authors thank to CAPES for financial support.

References

- AOAC-Association of Official Analytical Chemistry. **Official methods of analysis**. 15. ed. Arlington: AOAC International, 1990.
- BLIGH, E. G.; DYER, W. J. A rapid method of total lipid extraction and purification. **Canadian Journal of Biochemistry and Physiology**, v. 37, n. 8, p. 911-917, 1959.
- BOSCOLO, W. R.; HAYASHI, C.; MEURER, F.; SOARES, C. M. Farinhas de peixe, carne e ossos, vísceras e crisálida como atráctantes em dietas para alevinos de tilápias do Nilo (*Oreochromis niloticus*). **Revista Brasileira de Zootecnia**, v. 30, n. 5, p. 1397-1402, 2001.
- BOSCOLO, W. R.; HAYASHY, C.; MEURER, F. Digestibilidade aparente da energia e proteína das farinhas de resíduo da filetagem da tilápiado-Nilo (*Oreochromis niloticus*) e da corvina (*Plagioscion squamosissimus*) e farinha integral do camarão canela (*Macrobrachium amazonicum*) para a tilápiado-Nilo. **Revista Brasileira de Zootecnia**, v. 33, n. 1, p. 8-13, 2004.
- BRASIL. Ministério da Agricultura e Abastecimento. Sindicato Nacional de Indústria de Alimentação Animal. Associação Nacional dos Fabricantes de Rações. **Compêndio brasileiro de alimentação animal**. São Paulo: ANFAR/CBNA/SDR, 2009.
- BRUMANO, G.; GOMES, P. C.; ALBINO, L. F. T.; ROSTAGNO, H. S.; GENEROSO, R. A. R.; SCHMIDT, M. Composição química e valores de energia metabolizável de alimentos protéicos determinados com frangos de corte em diferentes idades. **Revista Brasileira de Zootecnia**, v. 35, n. 6, p. 2297-2302, 2006.
- COSTA, D. P. S.; ROMANELLI, P. F.; TRABUCO, E. Aproveitamento de vísceras não comestíveis de aves para elaboração de farinha de carne. **Ciência e Tecnologia de Alimentos**, v. 28, n. 3, p. 746-752, 2008.
- FORSTER, I. A note on the method of calculating digestibility coefficients of nutrients provided by single ingredients to feed of aquatic animals. **Aquaculture Nutrition**, v. 5, p. 143-145, 1999.
- FURUKAWA, A.; TSUKAHARA, H. On the acid digestion method for the determination of Chromic Oxide as an index substance in the study of digestibility of fish feed. **Bulletin of the Japanese Society Scientific Fisheries**, v. 32, n. 6, p. 502-506, 1976.
- FURUYA, W. M.; PEZZATO, L. E. Coeficientes de digestibilidade aparente da energia e nutrientes de alguns ingredientes pela tilápiado-Nilo, *Oreochromis niloticus* (L.) (linhagem tailandesa). **Acta Scientiarum**, v. 23, n. 2, p. 465-469, 2001.
- GUIMARÃES, I. G.; PEZZATO, L. E.; BARROS, M. M. Amino acid availability and protein digestibility of several protein sources for Nile tilapia, *Oreochromis niloticus*. **Aquaculture Nutrition**, v. 14, n. 5, p. 396-404, 2008.
- HARRIS, L. E. **Os métodos químicos e biológicos empregados na análise de alimentos**. Gainesville: Universidade da Flórida, 1970.
- MEURER, F.; HAYASHI, C.; BOSCOLO, W. R.; SOARES, C. M. Lipídeos na alimentação de alevinos revertidos de tilápiado-Nilo (*Oreochromis niloticus* L.). **Revista Brasileira de Zootecnia**, v. 31, n. 2, p. 566-573, 2002.
- MEURER, F.; HAYASHI, C.; BOSCOLO, W. R. Digestibilidade aparente de alguns alimentos protéicos pela tilápiado-Nilo (*oreochromis niloticus*). **Revista Brasileira de Zootecnia**, v. 32, n. 6, p. 1801-1809, 2003.
- MEURER, F.; HAYASHI, C.; BARBERO, L. M.; SANTOS, L. D.; BOMBARDELLI, R. A.; COLPINI, L. M. S. Farelo de soja na alimentação de tilápiado-Nilo durante o período de reversão sexual. **Revista Brasileira de Zootecnia**, v. 37, n. 5, p. 791-794, 2008.
- NOSE, T. On the digestion of food protein by goldfish (*Carassius auratus* L.) and rainbow trout (*Salmo irideus* G.). **Bulletin of Freshwater Fisheries Research Laboratory**, v. 10, n. 1, p. 11-22, 1960.
- NUNES, R. V.; POZZA, P. C.; NUNES, C. G. V.; CAMPESTRINI, E.; KÜHL, R.; ROCHA, L. D.; COSTA, F. G. P. Valores energéticos de subprodutos de origem animal para aves. **Revista Brasileira de Zootecnia**, v. 34, n. 4, p. 1217-1224, 2005.
- PEZZATO, L. E.; MIRANDA, E. C.; BARROS, M. M.; PINTO, L. G. Q.; FURUYA, W. M.; PEZZATO, A. C. Digestibilidade aparente de ingredientes pela tilápiado-Nilo. **Revista Brasileira de Zootecnia**, v. 31, n. 4, p. 1595-1602, 2002.
- PRICE, J. F.; SCHWEIGERT, B. S. **Ciencia de la carne y de los productos carnicos**. Zaragoza: Acribia, 1994.
- SANTOS, V. B.; FREITAS, R. T. F.; LOGATO, P. V. R.; FREATO, T. A.; ORFÃO, L. H.; MILLIOTI, L. C. Rendimento do processamento de linhagens de tilápias

(*Oreochromis niloticus*) em função do peso corporal. **Ciência e Agrotecnologia**, v. 31, n. 2, p. 554-562, 2007.

SAS-Statistical Analysis Systems Institute. **SAS user's guide**: statistics version. Cary: SAS Institute, 1990.

SOUZA, J. R. S. T.; CAMARÃO, A. P.; RÊGO, L. C. Degradabilidade ruminal da matéria seca e proteína bruta de subprodutos da agroindústria, da pesca e de abatedouros de caprinos. **Brazilian Journal of Veterinary Research and Animal Science**, v. 37, n. 2, 2000. Available from: <<http://www.revistasusp.sibi.usp>.

br/scielo.php?script=sci_arttext&pid=S141395962000000200015&lng=pt&nrm=iso>. Access on: Jan. 14, 2011.

Received on April 6, 2011.

Accepted on September 13, 2011.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.