

## Physicochemical characteristics of smoked cooked linguças made with ostrich meat trimmings

[Características físico-químicas de linguças cozidas defumadas elaboradas com aparas de carne de avestruz]

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### ABSTRACT

The aim of this study was to evaluate the physicochemical characteristics of three formulations of smoked cooked linguças, only differing in the lean meat used: (Formula 1 — 100% ostrich meat; Formula 2 — 50% ostrich meat + 50% pork; and Formula 3 — 50% ostrich meat + 50% chicken), elaborated with ostrich meat trimmings. The formulas showed slightly higher moisture content (62.00-64.41%) than the maximum allowed in the legislation for cooked linguças (60%) (Brasil, 2000). However, their protein content (19.99-22.14%) was at least 42% higher than the minimum required level (14%); the fat content (11.82-14.25%) was less than half the maximum permitted level (35%) in the same legislation, and at least 45% less than three well-known smoked cooked linguça brands commercialized in Brazil; and the energy value (194.89-208.19 Kcal%) was at least 31% less than the same smoked linguça brands; thus the three ostrich smoked linguça formulas elaborated could be claimed “light” in fat content and energy value (European Union, 2006; Brasil, 2012). The present study showed that ostrich meat trimmings can be successfully used to elaborate healthy, “light”, smoked cooked linguças, competing in the market with traditional smoked cooked linguças, and adding value in the ostrich meat chain.

Keywords: *struthio camelus*, moisture, fat, protein, ash

### RESUMO

O objetivo do estudo foi avaliar as características físico-químicas de três formulações de linguças cozidas defumadas, que somente diferiram em relação à carne magra utilizada: (Fórmula 1 — 100% carne de avestruz; Fórmula 2 — 50% carne de avestruz + 50% carne suína; e Fórmula 3 — 50% carne de avestruz + 50% carne de frango), elaboradas com aparas de carne de avestruz. As fórmulas apresentaram teor de umidade levemente superior (62,00-64,41%) ao máximo permitido na legislação para linguças cozidas (60%) (Brasil, 2000). No entanto, seu teor de proteína (19,99-22,14%) foi no mínimo 42% maior que o nível mínimo exigido (14%); o teor de gordura (11,82-14,25%) foi menos da metade do conteúdo máximo permitido (35%) na mesma legislação e pelo menos 45% inferior ao teor de gordura de três marcas bem conhecidas de linguças cozidas defumadas comercializadas no Brasil; e o valor energético (194,89-208,19kcal%) foi no mínimo 31% menor que as mesmas marcas de linguças defumadas; com isso, as três fórmulas de linguças cozidas defumadas de carne de avestruz poderiam ser rotuladas como “light” em relação ao teor de gordura e valor energético (European Union, 2006; Brasil, 2012). O presente estudo mostrou que as aparas de carne de avestruz podem ser utilizadas com sucesso na elaboração de linguças cozidas defumadas “light”, saudáveis, competindo no mercado com linguças defumadas tradicionais, e adicionando valor à cadeia de carne de avestruz.

Palavras-chave: *struthio camelus*, umidade, gordura, proteína, cinzas

## INTRODUCTION

In Western societies, ostrich (*Struthio camelus*) meat is reckoned as a delicacy, which is usually served grilled, cooked, or dried (biltong, South African dried and cured ostrich meat) (Böhme *et al.*, 1996; Fernández-López *et al.*, 2003). Furthermore, ostrich meat is regarded and marketed as a healthy alternative to other red meats, due to its favourable nutritional characteristics: low levels of sodium, collagen and intramuscular fat content; favourable fatty acids profile (polyunsaturated fatty acids (PUFA)/saturated fatty acids (SFA) and  $\omega$ -6/ $\omega$ -3 ratios); and high levels of iron, zinc, vitamin B6, B12, and E (Fisher *et al.*, 2000; Lombardi-Boccia *et al.*, 2002; Fernández-López *et al.*, 2003; Fernández-López *et al.*, 2006; Karakök *et al.*, 2010; Poławska *et al.*, 2011; Xavier Medina and Aguilar, 2014).

Currently, ostrich meat worldwide production level stands around 12,000 and 15,000 tons, with a growing trend in the last two decades, and South Africa, ostrich production pioneer, still accounts for 60% of this production (Xavier Medina and Aguilar, 2014). Moreover, in 2015, 1,299 ostriches were slaughtered in abattoirs approved by the Brazilian Ministry of Agriculture, Livestock and Supply, with an increasing trend when compared with the previous years (Quantidade ..., 2016).

Since approximately one-third of the lean meat from the ostrich carcass consists of meat trimmings, derived from deboning (Harris *et al.*, 1993), which are less noble and valuable than the ten major muscles, meat trimmings' use as a raw material for ostrich meat products is very important to increase the profitability of the ostrich industry (Mckenna *et al.*, 2003). Besides, ostrich meat's relatively high pH makes it an ideal meat for the elaboration of cooked meat products, since its natural water holding capacity is high, decreasing the use of moisture retaining agents, such as phosphates in the formulation (Fisher *et al.*, 2000; Fernández-López *et al.*, 2003). Thus, several authors have successfully used ostrich meat in the elaboration of a number of meat products (Böhme *et al.*, 1996; Fisher *et al.*, 2000; Fernández-López *et al.*, 2003; Hoffman and Mellett, 2003; Lee and Kang, 2003; Mckenna *et al.*, 2003; Dicks *et al.*, 2004; Capita *et al.*, 2006; Fernández-López *et al.*,

2006; Hautrive *et al.*, 2008; Mastromatteo *et al.*, 2009; Cavalheiro *et al.*, 2010; Nascimento *et al.*, 2012; Souza *et al.*, 2012).

Linguiça is one of the most consumed meat products in Brazil (Milani *et al.*, 2003). It is a meat product, cured sausage, made of livestock meat, fat (optional) and other ingredients, stuffed into natural or artificial casings, and submitted for processing, i.e. smoked (cooked or dried), or fresh. Livestock meat and salt are the required ingredients, while the optional ones include fat, water, vegetable or animal protein, sugar, plasma, intentional additives, flavours, spices, and condiments. Linguiça has recognizable texture, colour, flavour, and aroma (Brasil, 2000).

The physicochemical characteristics of cooked linguiças should be: Moisture (max.): 60%; Fat (max.): 35%; Protein (min.): 14%; and Calcium (in dry base) (max.): 0.3%, according to the Technical Regulation of Identity and Quality (RTIQ) of Linguiça, annex 3 of Normative Instruction No 4 of 31 March 2000, of the Ministry of Agriculture, Livestock and Supply (Brasil, 2000).

To be claimed "light" in one or more nutrients content or energy value the product must show at least 25% and 30% reduction in the respective level compared with a similar product according to Brasil (2012) and Commission... (2006), respectively.

The aim of this study was to evaluate the physicochemical characteristics (moisture, protein, fat and ash contents) of three formulations of smoked cooked linguiças elaborated with ostrich meat trimmings, derived from deboning.

## MATERIAL AND METHODS

Ostrich meat were obtained from 12 to 14 months old birds, pork and lard from 8 months old animals, and chicken from 45 days old birds, which were slaughtered in processing plants under the Federal Inspection Service (SIF) of the Brazilian Ministry of Agriculture, Livestock and Supply, Brazil, using industrial slaughtering techniques. Ostrich meat and pork used were meat trimmings obtained from deboning the carcasses, while chicken derived from the leg.

### *Physicochemical characteristics...*

All meat and lard batches were vacuum-packed and frozen at -18°C until processed.

The smoked cooked linguiças were prepared according to a simple traditional formula with 73.1% lean meat, 14.47% lard, 1.52% sodium chloride, 0.09% sucrose, 0.18% garlic powder, 0.04% black pepper powder, 0.03% chilli powder, 0.53% white wine, 0.04% nutmeg powder, 8.92% iced water, 0.28% cure mix (sodium nitrite), 0.28% antioxidant mix (sodium erythorbate), 0.23% smoke powder, and 0.30% sodium polyphosphate.

Three formulations of smoked cooked linguiças were prepared, only differing in the lean meat used: Formula 1 — 100% ostrich meat; Formula 2 — 50% ostrich meat + 50% pork; and Formula 3 — 50% ostrich meat + 50% chicken.

The three smoked cooked linguiça formulas were processed in a pilot plant according to commercial processing. Ostrich meat, pork and lard were cut using a meat cutting bandsaw machine (Heavy Duty S1282HD, Skymesen®, Brazil). Chicken legs were manually deboned and skinned with the use of stainless steel knives. The meat and the lard were ground using a 106 millimetres (mm) meat grinder (MC-106, Ibrasmak®, Brazil), through a 12-mm plate, and mixed with the other ingredients in a mixer (MT-96, Incomaf®, Brazil) for approximately five minutes. The mixed product was put in the cold chamber (Engepom®, Brazil) for curing (two hours). The mass was vacuum-stuffed (RS 1040, Incomaf®, Brazil) into 28 mm natural pork casings, twisted and tied off in 10 centimetres (cm) links. The linguiças links were draped on smoke-sticks, eight to nine links forming a loop. The draped smoke-sticks were placed on a smoke-tree, which was transferred to the smoke-house (EMI 01CPVI, Incomaf®, Brazil), and the linguiças were cooked for approximately 40 minutes, until 74°C were reached in the geometric centre of the linguiças. The products were showered with cold water for three minutes, and chilled by refrigeration in the cold chamber (Engepom®, Brazil) during two hours. The smoked linguiças were vacuum-packaged (300

B, Selovac®, Brazil), placed in isothermal bags with re-freezable ice blocks and carried to the storage location. They were stored in a refrigerator (CRC12, Consul®, Brazil) at 3 ± 2°C until the day of analysis.

For the physicochemical analyses, all parameters were tested in quintuplicate. Moisture was determined by Instituto Adolfo Lutz methods (Métodos..., 2008) and ash, protein, and fat content were determined by AOAC methods (Official..., 2005). Moisture (g water/100 g sample) was determined by drying 5 g of sample at 105°C to constant weight. Ash content (g ash/100 g sample) was determined at 550°C for 2h. Protein (g protein/100g sample) was analysed according to the Kjeldahl method. Factor 6.25 was used for conversion of nitrogen to crude protein. Fat (g fat/100 g sample) was calculated by weight loss after a 6-hours extraction with petroleum ether in a Soxhlet apparatus. Energy value (kcal/100g sample) was calculated according to Atwer coefficients (Carbohydrates: 4kcal/g, Protein: 4kcal/g, and Fat: 9kcal/g) (Brasil, 2003).

For the statistical analyses, each parameter was tested in quintuplicate. Descriptive analysis was used to calculate means, standard deviations, minimum and maximum values. Kruskal-Wallis test was used to determine significant differences ( $P < 0,05$ ) between treatments. Mann-Whitney *U* test was used to determine significant differences between treatments in multiple comparisons two to two, with the significance level of 0,05 divided by the number of comparisons two to two performed ( $P < 0,017$ ). Pearson product-moment correlation coefficient was performed to measure the degree of linear dependence between two variables. The statistical analyses were done using SPSS, version 17, for Windows.

### **RESULTS AND DISCUSSION**

Results of physicochemical composition of the smoked cooked linguiça formulas are presented in Table 1. Differences in composition of the different formulas are attributed to the type of lean meat used as it was the only variable.

Table 1: Smoked cooked linguiça's physicochemical composition (%)

	Formula 1	Formula 2	Formula 3
Moisture (%)	62.39 ± 3.51	62.00 ± 2.09	64.41 ± 1.32
Fat (%)	12.92 ± 0.33 <sup>a</sup>	14.25 ± 0.28 <sup>b</sup>	11.82 ± 0.30 <sup>c</sup>
Protein (%)	20.41 ± 3.44	19.99 ± 3.22	22.14 ± 1.18
Ash (%)	3.77 ± 0.10 <sup>a</sup>	3.14 ± 0.03 <sup>b</sup>	3.49 ± 0.05 <sup>c</sup>
Energy (Kcal) (%)	197.96 ± 12.36	208.19 ± 13.78	194.89 ± 6.00

Formula 1 – 100% ostrich meat; Formula 2 – 50% ostrich meat, 50% pork; Formula 3 – 50% ostrich meat, 50% chicken. Values in the same line bearing different letters are significantly different (P<0.05).

No differences have been found for moisture content between the three smoked cooked linguiça formulations, which were slightly higher than the 60% maximum moisture content in cooked linguiças established in the legislation (Brasil, 2000). Similarly, Nascimento *et al.* (2012) did not find differences for moisture content between three fresh linguiça formulas elaborated with ostrich meat and mixed with pork and chicken. However, Fernández-López *et al.* (2003); Fernández-López *et al.* (2006); Hautrive *et al.* (2008); and Cavalheiro *et al.* (2010), found differences in moisture content between meat products elaborated with ostrich meat and with other meat types. According to Fernández-López *et al.* (2003) the inverse relation between fat and moisture content is well known. Lastly, the moisture content in the formulas could be decreased by reducing the amount of iced water and/or sodium polyphosphate – a moisture retaining agent – in the formula.

There were differences between all three formulas for fat content. Formula 2 showed the higher fat content and the Formula 3 the lower, slightly less fat content than Formula 1. However, it is worthwhile to note that the ostrich meat and pork used were meat trimmings, which are supposed to have more fat content than the role muscle, while the chicken used was the skinless leg meat; probably, if the skin was used it would increase the fat content in Formula 3. Nascimento *et al.* (2012) did not find differences between formulas with ostrich meat mixed with pork and chicken. However, Fernández-López *et al.* (2003); Mckenna *et al.* (2003); Fernández-López *et al.* (2006); Hautrive *et al.* (2008); and Cavalheiro *et al.* (2010) found differences in fat content between meat products with ostrich meat and other types of meat. In addition, Mckenna *et al.*

*al.* (2003); Hautrive *et al.* (2008); and Cavalheiro *et al.* (2010) quoted that fat content decreases as ostrich meat content increases.

The fat content in the ostrich smoked linguiça formulas, between 11.82% and 14.25%, was less than half the maximum limit allowed in the legislation (Brasil, 2000), 35%, and was probably in great part due to the use of lard in the formulation, 14.47%, which according to National... (2016) is 100% fat, while ostrich meat fat content is 1.6% according to Palcari *et al.* (1998), and 3.57% according to Fisher *et al.* (2000). Furthermore, the three formulas produced could claim to be “light” in fat content (Commission..., 2006; Brasil, 2012) as they showed at least 45% less fat content than three well-known smoked linguiças brands commercialized in Brazil, which showed among 26 and 34% of fat content in their nutrition facts label.

There were no differences between the three formulas for protein content. Moreover, their protein content was at least 42% higher than the minimum limit required in legislation (Brasil, 2000). Similarly, Hautrive *et al.* (2008); and Nascimento *et al.* (2012) did not find protein content differences between formulas. However, Fernández-López *et al.* (2003); Mckenna *et al.* (2003); and Fernández-López *et al.* (2006) found higher protein content in formulas with ostrich meat than in formulas with other livestock meats. In addition, Nascimento *et al.* (2012) observed the trend of increasing protein content as ostrich meat in the formula increased, whereas the opposite trend was observed by Hautrive *et al.* (2008).

There were differences between all three formulas for ash content, with Formula 1

showing the higher ash content and Formula 2 the lower. Nascimento *et al.* (2012) did also find differences between formulas. In contrast, Fernández-López *et al.* (2003); Fernández-López *et al.* (2006); and Cavalheiro *et al.* (2010), did not find differences between formulas. However, Cavalheiro *et al.* (2010) found a slight increasing trend in ash content as ostrich meat increased in formulas. The higher ash content when compared with raw ostrich meat, that range from 1.07% (Sales and Hayes, 1996) to 2.42% (Karakök *et al.*, 2010) is probably due to the use of salt and spices in the formulas as reported by Fisher *et al.* (2000); Fernández-López *et al.* (2003); and Fernández-López *et al.* (2006).

No differences have been observed between the three formulas for energy value, kilocalories (Kcal), which ranged between 194.89 and 208.19 Kcal%, and the three formulas could be claimed “light” in energy value (Commission..., 2006; Brasil, 2012) as they showed at least 31% less energy value than three well-known smoked cooked linguíça brands commercialized in Brazil, which showed among 302 and 370 Kcal% in their nutritional facts label.

### CONCLUSION

Despite the fact that the three formulas of smoked cooked linguíça elaborated with ostrich meat trimmings in the present study showed higher moisture content than the limit allowed in the Technical Regulation of Identity and Quality of Linguíça, at Normative Instruction No 4 of 31 march 2000 of Brazilian Ministry of Agriculture, Livestock and Supply (Brasil, 2000), the protein content was at least 42% above the minimum limit required and fat content was at least 50% below the maximum limit allowed. Thus, the higher moisture content did not reduce the nutritional value of the linguíças. The smoked cooked linguíças elaborated in this study could claim to be “light” in fat content and energy value, meeting the consumer's demands for healthy products. To decrease the moisture content in the formulas it would be necessary to reduce the amount of iced water and/or sodium polyphosphate – a moisture retaining agent – in the formula. In summary, the present study showed that ostrich meat trimmings can be successfully used in the elaboration of smoked cooked linguíças, which could compete in the market with traditional smoked cooked linguíças,

both adding value in the ostrich meat chain, offering more options for the consumption of ostrich meat products and offering a “light” smoked cooked linguíça, a healthier option for the consumers of one of the most consumed meat products in Brazil.

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### REFERENCES

- BÖHME, H.M.; MELLETT, F.D.; DICKS, L.M.T.; BASSON, D.S. Production of salami from ostrich meat with strains of *Lactobacillus sake*, *Lactobacillus curvatus* and *Micrococcus* sp. *Meat Sci.*, v.44, p.173-180, 1996.
- BRASIL. Ministério da Saúde. Resolução RDC n.54, de 12 de novembro de 2012. Dispõe sobre o regulamento técnico sobre informação nutricional complementar. *Diário Oficial da União*, Brasília, 13 nov. 2012. Seção 1, p.122.
- BRASIL. Ministério da Saúde. Resolução RDC n 360, de 23 de dezembro de 2003. Aprova regulamento técnico sobre rotulagem nutricional de alimentos embalados, tornando obrigatória a rotulagem nutricional. *Diário Oficial da União*, Brasília, 26 dez. 2003. Seção 1, p.33.
- BRASIL. Ministério da Agricultura e do Abastecimento. Secretária da Defesa Agropecuária. Instrução Normativa n.4, de 31 de março de 2000. Aprova os regulamentos técnicos de identidade e qualidade de carne mecanicamente separada, de mortadela, de linguíça e de salsicha. *Diário Oficial da União* Brasília, 05 abr. 2000. Seção 1, p.6.
- CAPITA, R.; LLORENTE-MARIGÓMEZ, S.; PRIETO, M.; ALONSO-CALLEJA, C. Microbiological profiles, pH, and titratable acidity of chorizo and salchichón (two Spanish dry fermented sausages) manufactured with ostrich, deer, or pork meat. *J. Food Prot.*, v.69, p.1183-1189, 2006.
- CAVALHEIRO, C.P.; TERRA, N.N.; FRIES, L.L.M. *et al.* Physico-chemical characteristics of fermented cured sausage with the addition of ostrich meat associated to pork meat. *Ciênc. Rural*, v.40, p.447-452, 2010.



- COMMISSION Regulation (EC), 2006. N. 1924/2006 of 20 December 2006. Nutrition and health claims made on foods. *Official Journal of the European Union*, Bruxelles, 2006. p.L404/9.
- DICKS, L.M.T.; MELLETT, F.D.; HOFFMAN, L.C. Use of bacteriocin-producing starter cultures of *Lactobacillus plantarum* and *Lactobacillus curvatus* in production of ostrich meat salami. *Meat Sci.*, v.66, p.703-708, 2004.
- FERNÁNDEZ-LÓPEZ, J.; JIMÉNEZ, S.; SAYAS-BARBERÁ, E. *et al.* Quality characteristics of ostrich (*Struthio camelus*) burgers. *Meat Sci.*, v.73, p.295-303, 2006.
- FERNÁNDEZ-LÓPEZ, J.; SAYAS-BARBERÁ, E.; NAVARRO, C. *et al.* Physical, chemical, and sensory properties of bologna sausage made with ostrich meat. *J. Food Sci.*, v.68, p.1511-1515, 2003.
- FISHER, P.; HOFFMAN, L.C.; MELLETT, F.D. Processing and nutritional characteristics of value added ostrich products. *Meat Sci.*, v.55, p.251-254, 2000.
- HARRIS, S.D.; MORRIS, C.A.; JACKSON, T.C. *et al.* *Ostrich meat industry development, final report to: American Ostrich Association*. Texas: Agricultural Extension Service. 1993. Available in: <[https://www.researchgate.net/publication/267362105\\_Ostrich\\_Meat\\_Industry\\_Development](https://www.researchgate.net/publication/267362105_Ostrich_Meat_Industry_Development)>. Accessed in: 12 Dec. 2015.
- HAUTRIVE, T.P.; OLIVEIRA, V.R.; SILVA, A.R.D. *et al.* Physicochemical and sensorial analyses of ostrich hamburger. *Ciênc. Tecnol. Aliment.*, v.28, Suppl., p.95-101, 2008.
- HOFFMAN, L.C.; MELLETT, F.D. Quality characteristics of low fat ostrich meat patties formulated with either pork lard or modified corn starch, soya isolate and water. *Meat Sci.*, v.65, p.869-875, 2003.
- KARAKÖK, S.G.; OZOGUL, Y.; SALER, M.; OZOGUL, F. Proximate analysis. Fatty acid profiles and mineral contents of meats: A comparative study. *J. Muscle Foods*, v.21, p.210-223, 2010.
- LEE, S.W.; KANG, C.S. Effects of moisture content and drying temperature on the physicochemical properties of ostrich jerky. *Nahrung/Food*, v.47, p.330-333, 2003.
- LOMBARDI-BOCCIA, G.; MARTINEZ-DOMINGUEZ, B.; AGUZZI, A. Total heme and non-heme iron in raw and cooked meats. *J. Food Sci.*, v.67, p.1738-1741, 2002.
- MASTROMATTEO, M.; LUCERA, A.; SINIGAGLIA, M.; CORBO, M.R. Microbiological characteristics of poultry patties in relation to packaging atmospheres. *Int. J. Food Sci. Technol.*, v.44, p.2620-2628, 2009.
- MCKENNA, D.R.; MORRIS, C.A.; KEETON, J.T. *et al.* Consumer acceptability of processed ostrich meat products. *J. Muscle Foods*, v.14, p.173-179, 2003.
- MÉTODOS físico-químicos para análise de alimentos. 4.ed. São Paulo: Instituto Adolfo Lutz. 2008. [1020p.].
- MILANI, L.I.G.; FRIES, L.L.M.; PAZ, P.B. *et al.* Bioproteção de lingüiça de frango. *Ciênc. Tecnol. Aliment.*, v.23, p.161-166, 2003.
- NASCIMENTO, R.S.; FONSECA, A.B.M.; FRANCO, R.M.; MIRANDA, Z.B. Lingüiças frescas elaboradas com carne de avestruz: características físico-químicas. *Ciênc. Rural*, v.42, p.184-188, 2012.
- NATIONAL nutrient database for standard reference. [California]: USDA. (Basic Report 04002, Lard.). Available in: <[ndb.nal.usda.gov/ndb/foods/show/635?format=Abridged&reportfmt=pdf&pdfQvs=%7B%7D](http://ndb.nal.usda.gov/ndb/foods/show/635?format=Abridged&reportfmt=pdf&pdfQvs=%7B%7D)>. Accessed in: 24 Feb. 2016.
- OFFICIAL methods of analysis. 18.ed. Gaithersburg: AOAC. 2005.
- PALEARI, M.A.; CAMISASCA, S.; BERETTA, G. *et al.* Ostrich meat: physico-chemical characteristics and comparison with turkey and bovine meat. *Meat Sci.*, v.48, p.205-210, 1998.
- POŁAWSKA, E.; MARCHEWKA, J.; COOPER, R.G. *et al.* The ostrich meat: an updated review. II. Nutritive value. *Anim. Sci. Pap. Rep.*, v.29, p.89-97, 2011.
- QUANTIDADE de Abate Estadual por Ano/Espécie. Ministério da Agricultura, Pecuária e Abastecimento. Available in: <[http://sigsif.agricultura.gov.br/sigsif\\_cons/ap\\_abate\\_estaduais\\_cons?p\\_select=SIM](http://sigsif.agricultura.gov.br/sigsif_cons/ap_abate_estaduais_cons?p_select=SIM)>. Accessed in: 04 fev. 2016.
- SALES, J.; HAYES, J.P. Proximate, amino acid and mineral composition of ostrich meat. *Food Chem.*, v.56, p.167-170, 1996.
- SOUZA, V.L.F.; SASAKI, J.Y.; FRANCO, M.L.R.S. *et al.* Processing, physicochemical, and sensory analyses of ostrich meat hamburger. *Ciênc. Tecnol. Aliment.*, v.32, p.450-454, 2012.
- XAVIER MEDINA, F.; AGUILAR, A. Ostrich meat: nutritional, breeding, and consumption aspects. The case of Spain. *J. Food Nutr. Res.*, v.2, p.301-305, 2014.