Bromatological, microbiological and sensory comparison of two different formulations of sausages made with rabbit (*Oryctolagus cuniculus*) meat

Comparación bromatológica, microbiológica y sensorial de dos formulaciones de salchichas elaboradas con carne de conejo (Oryctolagus cuniculus)

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Abstract

The aim of this study was to evaluate two different formulations of sausage made from rabbit meat, using as an extender in the first chontaduro flour (*Bactris gasipaes*) and the second modified corn starch. Both formulations were constituted by 60% of rabbit meat, 12% pork fat and 4% of the respective extender, the remainder corresponded to ice and other spices. Bromatological analyzes were performed, which showed 60.90% protein, 33.65% fat, 4.46% ash and 0.99% carbohydrate (dry basis) for rabbit meat, 15.96% protein, 13.55% fat, 4.10% ash, 3.42% carbohydrate and 60.63% moisture for sausages made with the addition of chontaduro flour and 14.54% protein, 11.53% fat, 3.81% ash, 3.99% carbohydrate and 63.42% moisture for sausages made with the addition of modified corn starch. The products obtained were subjected to microbiological test consisting of the analysis of the traditional parameters of quality and safety, as well as sensory measurements using affective tests of preference, of extent of satisfaction and of acceptance, which allowed us to conclude that the sausages presented safety features to humans and also enjoyed great success thanks to its organoleptic characteristics, making them product type "Premium" according to NTC 1325.

Key words: Bromatological analysis, meat agroindustry, nutritional value, sausage products, sensory evaluation.

Resumen

En este estudio se evaluaron dos formulaciones diferentes de salchichas elaboradas con carne de conejo, utilizando como extendedores harina de chontaduro (*Bactris gasipaes*) y almidón modificado de maíz. Ambas formulaciones consistieron en 60% de carne de conejo, 12% de grasa de cerdo y 4% del respectivo extensor, el porcentaje restante correspondió a hielo y condimentos. Los análisis bromatológicos mostraron los contenidos siguientes (base seca): (1) en carne = 60.90% de proteína, 33.65% de grasa, 4.46% de cenizas y 0.99% de carbohidratos; (2) en salchichas elaboradas con adición de harina de chontaduro = 15.96% de proteína, 13.55% de grasa, 4.10% de cenizas, 3.42% de carbohidratos y 60.63% de humedad; y (3) en salchichas elaboradas con adición de almidón modificado de maíz = 14.54% de proteína, 11.53% de grasa, 3.81% de cenizas, 3.99% de carbohidratos y 63.42% de humedad. Las pruebas microbiológicas consistieron en el análisis de los parámetros tradicionales de calidad y seguridad, además de mediciones sensoriales utilizando pruebas afectivas de preferencia, de grado de satisfacción y de aceptación que permitieron concluir que las salchichas elaboradas presentaron características de inocuidad para el ser humano y de gran

aceptación gracias a sus buenas propiedades organolépticas, resultando productos tipo Premium según la NTC 1325.

Palabras clave: Agroindustria cárnica, análisis bromatológico, evaluación sensorial, productos animales procesados, valor nutritivo.

Introduction

The rabbit (*Oryctolagus cuniculus*) is native to Europe where it spread across the Mediterranean and North Africa to the world (Sierra Baza Project, 2004). It is estimated that in Europe its breeding is widespread in rural and suburban areas, as a process of self-production of peasant communities (FAO, 2001). In the countries of Latin America consistent efforts have been made to create the foundations for a stable and lasting rabbit culture mainly in rural areas, looking with this to place these countries within the first places in the lists of commercial trade of rabbit meat, to take advantage of free trade and globalization of markets (Orrego *et al.*, 2007).

The consumption of animal protein in the world is represented in more than 90% by pork, poultry and cattle. Despite the problems of zoonosis present in these groups of animals, consumption of non-traditional meats has not experienced significant increases. The trend to increased consumption of rabbit meat is due to consumer awareness to improve their eating habits (Urizar, 2006); in addition because of its low cost is an alternative in developing countries (Oeidrusbc *et al.*, 2009). Among its features stand out a high percentage of protein of high biological value; low fat, especially cholesterol, appropriate proportion of unsaturated fats (mono and polyunsaturated) and high richness in important minerals such as iron and calcium and vitamins like niacin and vitamin B12 (Bixquert and Gil, 2005).

Traditionally, rabbit meat is consumed directly, but there is the possibility of developing processed meat-type products, by which an added value would be achieved. Among these products are sausages, usually made from pork, beef or chicken, but rarely based on non-traditional meats such as rabbit (Sebranek *et al.*, 2005; Qiu *et al.*, 2013). Flours and starches are components of sausages that act as extenders or binders and contribute to improve the texture of these since they act as thickeners, colloidal stabilizers and/or gelling agents. They are also used as absorbent and water binding agents in the manufacture of sausages.

Native starch is a stabilizer of good texture and regulator in food systems, but has limitations such as low shear strength, heat resistance, thermal decomposition and high tendency to retrogradation, which limits its use in certain food applications (Singh *et al.*, 2007). For these reasons it is necessary to look for new alternatives suitable for industrial processing, including chontaduro flour and modified corn starch (Bhupinder *et al.*, 2012).

This study aimed to evaluate the bromatological, microbiological and sensory characteristics of two different formulations for the manufacture of sausages.

Materials and methods

The sausages were prepared from rabbit meat from New Zealand White breed. As bromatological parameters, the contents of: Dry matter, crude protein, fat, ash, carbohydrates, crude fiber, and gross energy (cal/g) were measured in percentage. Microbiological measurements were made according to the parameters defined in the Colombian Technical Standard NTC 1325 (Icontec, 2008). Sensory parameters were evaluated by affective comparison tests. Manufacturing processes and sensory and bromatological analyses were carried out in the laboratories of Meat Technology and Animal Nutrition at the Universidad Nacional de Colombian at Palmira and microbiological analyses were performed in a commercial laboratory in the city of Cali.

Microbiological analysis

Among these counts for: *Escherichia coli*, total coliforms, sulfite-reducing *Clostridium*, molds and yeasts, mesophilic aerobic bacteria, coagulase-positive *Staphylococcus*, *Bacillus cereus* and *Salmonella* (NTC 1325) were included.

Bromatological analyses

For these analyses moisture content (AOAC 934.01 No. 1990), dry matter (AOAC 934.01 No. 1990), ash (AOAC 942.05 No. 1990), fat (AOAC 920.34 No. 1990) gross protein (Kjeldahl), carbohydrates (%), crude fiber (Van Soest, 1980) and gross energy (calorimeter bomb) were determined.

Sensory evaluation

Affective tests on preference, satisfaction and acceptance were made. The degree of satisfaction was determined with one hundred consumers who were offered both samples randomly and asked their score on a seven-point scale from 'I like it a lot', to 'I dislike it very much', the degree of acceptance and preference was equally qualified with one hundred consumers.

The resulting data of the sensory type surveys were subjected to analysis of variance (ANOVA) and comparison of means was made using the Tukey test. Bromatological and microbiological tests were performed in triplicate, in a factorial design with two factors (chontaduro flour and modified corn starch) and a significance level of $P < 0.05$, with use of SPSS Statistics 19, 2010.

Origin of supplies

Rabbit meat came from animals raised in the town of La Calera (Cundinamarca), technically sacrificed and kept refrigerated. Chontaduro flour was obtained from fruits purchased in the local market in the municipality of El Tambo (Cauca) and modified corn starch was supplied by the company National Starch Food Innovation.

Production of chontaduro flour

Chontaduro was initially subjected to baking for 40 min under conditions of increased pressure. Later, in the Laboratory of Phytochemistryof the Universidad Nacional de Colombia at Palmira, the pulp was separated into 1 cm^2 pieces which were introduced in plastic Falcon tubes which were to a freezing temperature of -20 °C, before beginning the process of lyophilization on a Freezone LW machine, with Labconco Freezone 195 vacuum pump at a condenser temperature of -50 °C and internal pressure of 0.12 mbar for 48 h. Finally, it was passed through a mill IKA M-20 s3 and vacuum packed on a packer Egarvac S.C.P. Basic B located in the Meat Technology Laboratory of the Universidad Nacional at Palmira, where it was stored in a dark, dry place to prevent oxidation of fats.

Results and discussion

Composition of the flour from chontaduro

The results of the compositional analysis of the flour of chontaduro (Table 1) show that it has a very high percentage of dry matter (97%) feature that makes it a stable product in time, when stored in low humidity and low brightness (Godoy *et al.*, 2007).

Chontaduro flour has a high fat content, which varies according to extraction systems; Arguello *et al.* (1999) found values of 13.9% and Godoy *et al.* (2007) of 6% fat. In the present study, the fat content was 22.07%, because the drying of the fruit was performed by lyophilization, a method to obtain flour of better quality since the process only removes water and the other components of the fruit are preserved, including the oil, which in this case appears as fat.

Table 1. Bromatological analysis of chontaduro flour, in percentages.

Component	Flour from chontaduro pulp	S.D[a].
Dry matter	97.00	± 0.0240
Fat (oil)	22.07	± 0.0001
Carbohydrates	60.10	± 0.0012
Ashes	2.36	± 0.0025
Protein	6.06	± 0.0035
Fiber	10.41	± 0.0100

a. S.D. = standard deviation.

In the flour of chontaduro pulp used in this work, the contents of protein, ash, carbohydrates and fiber were respectively 5.06%, 2.36%, 60.1% and 10.41%; the high content of the latter component was due to the variety of chontaduro used. Zumbado and Murillo (1984) in flour of peeled pulp, from a variety of yellow chontaduro from the southern Pacific region of Costa Rica, found contents of 6.4% protein, 2.8% ash and 1.3% fiber. Godoy et al. (2007) from chontaduro samples collected in the same region where this study was conducted, found contents of carbohydrates (37.6%), protein (3.3%) and fiber (1.4%).

Composition of rabbit meat

Rabbit meat has a pale-pink color, is tender and easily digested, their muscle tissue is low in conjunctive fiber and therefore easily attacked by gastric juices (Janieri, 1987).

Compared with other species is richer in protein, vitamins and minerals; on the contrary, it is poor in fat with high proportion of polyunsaturated fatty acids (Recinos, 2007). The results of the compositional analysis (Table 2) showed a protein content of 60.90%, which depends, among other conditions, of the race and type of rabbit; Tobar *et al.* (2004) in non-domesticated rabbit meat revealed protein values of 21%. Proteins from rabbit meat are of a higher quality than those from vegetable sources and a have a high biological value, as the composition of its amino acids is similar to that required by man for protein synthesis (Lopez de Torre and Carballo, 1991). The fat was 10.15% on wet basis, a higher value than that found by Tobar et al. (2004) of 2.3% and Zotte and Szendro (2011) of 8.4%; while the carbohydrate content was low (0.99%).

Compositional analysis of sausages

The results of the compositional analysis of the processed sausages (Table 3) show that

Table 2. Bromatological analysis of rabbit meat, in percentages.

Component	Rabbit meat	S.D.[a]
Total dry matter	30.18	± 0.0160
Fat	33.65	± 0.0002
Carbohydrates	0.99	± 0.0032
Ahes	4.46	± 0.0025
Proteins	60.90	± 0.0030

a. S.D. = Standard deviation.

Table 3. Bromatological analysis of rabbit sausages made with two formulations.

Component	Chontaduro flour	S.D.[a]	Modified corn starch	S.D.
Moisture	60.63	± 0.0015	63.42	± 0.0018
Ashes	4.10	± 0.0028	3.81	± 0.0035
Proteina gross	15.96	± 0.0025	14.54	± 0.0025
Fat	13.55	± 0.0002	11.53	± 0.0002
Carbohydrates	3.42	± 0.0038	3.99	± 0.0045
FDN	2.33	± 0.0030	2.71	± 0.0035
Energy gross (cal/g)	5605.42	± 0.0060	5510.33	± 0.0085

a. S.D. = Standard deviation.

they have a protein percentage of 15.96% when the chontaduro flour was used, and 14.53% in those that modified maize starch is used. The reduction in the protein content, compared to only of rabbit meat, was possibly due to denaturation by heat treatment (80 ± 2 ° C), which is well known in this type of meat characterized by lower content of connective and fibrous tissue and therefore less resistant to these thermal processes.

Fats showed percentages of 13.55% and 11.53%, respectively for the sausage made with chontaduro flour and those made with modified corn starch. This result agrees with Cury et al. (2011) who found a content of 12.6% in rabbit meat sausages (Cury et al., 2011). This percentage is similar to that found in raw rabbit meat and shows that the flours do not present a significant fat content. In the case of sausages made from modified corn starch (0.05% fat) the fat contents were similar to those observed for sausages made with chontaduro flour, leading to the conclusion that the fat content of rabbit meat is distributed among the formulation components and therefore the percentage remains in the sausage, although a slight decrease occurs due to absorption of fat by the modified corn starch. The rabbit sausage with higher percentage of fat was the one that included chontaduro flour among its components, which was expected due to the high concentration of lipids in the flour. For this reason, scalded sausage meat products have high fat content, with a maximum of 28% as stipulated in ISO 1325 (Icontec, 2008) standard.

Carbohydrate contents were 3.42% in chontaduro flour sausages and 3.99% in those with modified corn starch; whereas rabbit meat presented only 0.99%. The gross energy was higher in sausages than in rabbit meat. Using the chontaduro flour the gross energy was 5.605.42 cal/g and with modified corn starch was 5.510.33 cal/g, higher than the values found by Escobedo (2007) of 1600-2000 cal/g.

Microbiological and sensory analysis

Sausages refrigerated at 2 ± 2 ° (Table 4) both from chotaduro flour and modified corn flour had microorganism levels below those allowed in the Colombian Technical Standard NTC 1325 (Icontec, 2008). Affective tests were done by tasting samples (pieces) grilled at 90 °C, using as degrees of acceptance and preference: 1 -I dislike it very much, 2 -I dislike a lot, 3 -I dislike slightly, 4 -nor I like, or dislike, 5 -I like slightly, 6 -I like a lot, and 7 -I like very much. The survey results were statistically processed and frequency analysis showed that the evaluators preferred the sausage made from modified corn starch, although without differences (P> 0.05) in relation to those processed with chontaduro flour.

Conclusions

- The content of protein in chontaduro flour can be considered an excellent extender in the manufacture of

Table 4. Microbiological analysis for rabbit sausages made with two formulations.

Microrganism	Permissible NTC 1325 value	With chontaduro flour	With modified corn starch
***Escherichia coli* count (UFC/g)**	400	3	3
Total coliforms (UFC/g)	1100	16	13
Sulfite-reducing *Clostridium* spore count (UFC/g)	300	10	10
Yeast and mold counts (UFC/g)	—	10	1500
Mesophilic aerobic bacteria count (UFC/g)	30000	100	6000
***Salmonella* detection**	Absence	Absence	Absence
Coagulase-positive *Staphylococcus* count (UFC/g)	100	100	100
***Bacilus cereus* count (UFC/g)**	—	100	100

sausages of rabbit meat; however for its use is necessary to reduce the fat content (22.7%) by previous extraction of the oil present in it.

- According to the chemical composition analysis, rabbit meat shows a protein percentage of 18.38%, higher than most of the known meats. By its fat content (10.15%) it can be described as lean type.
- For its sensory characteristics, both types of sausages were fully accepted by the evaluators and their microbiological properties met the current standard NTC 1325, which qualify them as Premium type.

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References

AOAC (Association of Official Analytical Chemists). 1990. Direct method. Numbers 920.34, 934.01, 942.05.

Argüello, H.; Corredor, G.; and Chaparro, O. L. 1999. Uso del chontaduro en la elaboración de raciones para la alimentación animal. Universidad Nacional de Colombia sede Leticia. Asociación Municipal de Usuarios Campesinos de Leticia (AMUC). 25 p.

Bhupinder, K.; Fazilah, A.; Rajeev, B.; and Alias, K. 2012. Progress in starch modification in the last decade. Food Hydrocolloids 26 (2):398 - 404.

Bixquert, M. and Gil, R. 2005. Propiedades nutricionales y digestibilidad de la carne de conejo. Carne de conejo: Equilibrio y salud. *Rev. Cient. Nutr.* 1:7 – 11.

Cury, K.; Martínez, A.; Aguas, Y.; and Olivero, R. 2011. Caracterización de carne de conejo y producción de salchicha. *Rev. Col. Cienc. Anim.* 3 (2):269 – 282.

Escobedo, E. 2007. Caracterización de la demanda de productos del conejo en el expendio de la Facultad de Medicina Veterinaria y Zootecnia de la Universidad Michoacana de San Nicolás de Hidalgo. Tesis Médico Veterinario Zootecnista. Universidad Michoacana de San Nicolás de Hidalgo, Morelia. 48 p.

FAO. 2001. Recognizes the increasingly important role of rabbit breeding. Global rabbit production exceeds 1 million tons. In: http://www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2001/pren0157.htm. 09-28-12.

Godoy, S. P.; Pencue, L.; Ruiz, A.; and Montilla, D. C. 2007. Clasificación automática del chontaduro (*Bactris gasipaes*) para su aplicación en conserva, mermelada y harinas. *Rev. Biotec.* Sector Agrop. Agroind. 5(2):137 - 146.

Icontec (Instituto Colombiano de Normas Técnicas y Certificación). 2008. Norma Técnica Colombiana NTC 1325. Industrias Alimentarias. Productos Cárnicos Procesados No Enlatados. Quinta actualización.

Janieri, A. 1987. La calidad nutritiva de la carne de conejo. *Econ. Prod.* 24(1):27 – 29.

López de Torre, G. and Carballo, B. M. 1991. Manual de bioquímica y tecnología de la carne. Madrid. A. Madrid Vicente, Ediciones. 171 p.

Oeidrusbc. 2009. Estudio sobre la cunicultura en el Estado de Baja California (entrevista a productores). In: http://www.oeidrus-bc.gob.mx/oeidrus_bca/biblioteca/Estudios/pecuarios/doctoConejo.pdf. 06-03-2012.

Orrego, G.A.; Mesías, L. A.; Almeida, G.; Ramírez, D.; and Sarmiento, G. E. 2007. Diseño e implementación de un modelo técnico administrativo para la conformación de la mini-cadena productiva cunícula dentro de la cadena de cárnicos en Santander. Bucaramanga. CIMEP. p. 22. Proyecto Sierra de baza. 2004. Conejo (Oryctolagus cuniculus). In: http://www.sierradebaza.org/Fichas_fauna/04_11_conejo/conejo.htm. 09-28-12.

Qiu, C.; Zhao, M.; Sun, W.; Zhou, F.; and Cui, C. 2012. Changes in lipid composition, fatty acid profile and lipid oxidative stability during Cantonese sausage processing. Meat Sci. 93(3):525 - 532.

Recinos, M. R. 2007. Utilización de carne de conejo (*Oryctolagus cuniculus*) en la elaboración de dos tipos de jamón ahumado. Tesis Licenciada Zootecnista. Universidad de San Carlos de Guatemala. Guatemala. 26 p.

Sebranek, J. G.; Sewalt, V. J.; Robbins, K. L.; and Houser, T. A. 2005. Comparison of a natural rosemary extract and BHA/BHT for relative antioxidant electiveness in pork sausage. Meat Sci. 69:289 - 296.

Singh, J.; Kaur, L.; and McCarthy, O. J. 2007. Factors influencing the physico-chemical, morphological, thermal and rheological properties of some chemically modified starches for food applications –A review. Food Hydrocolloids 21 (1):1 - 22.

Tobar, N. S. 2004. Características microbiológicas y nutricionales de carnes chojineadas y aspectos antropológicos relacionados. Tesis Nutricionista. Universidad de San Carlos de Guatemala. Guatemala. 87 p.

Urizar, J. 2006. Mercado Internacional de carne de conejo. Argentina: Secretaría de Agricultura, Ganadería, Pesca y Alimentos. In: http://www.sagoya.mecom.gov.ar/new/0-07programas/apoyo/Mercado % 20 % de % 20 Carne % 20 de %20 Conejo % 20 2006. Pdf. 04-02-2013.

Van Soest, P.J. and Robertson, J.B. 1980. Systems of analysis for evaluating fibrous feeds. In: Standardization of Analytical Methodology in Feeds. Ottawa: International Research Development Center. 60 p.

Zumbado, M. E. and Murillo, M. G. 1984. Composition and nutritive value of pejivalle (*Bactris gasipaes*) in animal feeds. Rev. Biol. Trop. 32(1):51 - 56.

Zotte, A. D. and Szendro, Z. 2011. The role of rabbit meat as functional food. *Meat Sci.* 88(3):319 – 331.