ELSEVIER

Food Chemistry 69 (2000) 195–200

Food Chemistry

www.elsevier.com/locate/foodchem

Analytical, Nutritional and Clinical Methods Section

Characterization of chorizo de Pamplona: instrumental measurements of colour and texture

Olga Gimeno, Diana Ansorena, Iciar Astiasarán*, José Bello

Departamento de Bromatología, Tecnología de Alimentos y Toxicología Facultad de Farmacia, Universidad de Navarra, 31080-Pamplona, Spain

Received 5 August 1999; accepted 7 October 1999

Abstract

A study of standardization of chorizo de Pamplona by instrumental measurements of colour and texture was carried out in five different commercial brands of this typical Spanish dry fermented sausage. Parameters related to colour showed little variability among brands, especially in L^* and a^* values. The higher variability of b^* could be related to the different amounts of paprika used in the formulations. Low ranges of variation were found in texture parameters. Some observed differences, especially in cohesiveness were significantly correlated with the pH of the products. Multivariate analysis, based on colour and texture parameters, led to 2 principal components which explained 80.80% of the total variance. Brands 1 and 5 appeared to be the most similar in function of the first component, which was mainly defined by hardness followed by gumminess, a^* and b^*.

Keywords: Dry fermented sausages; Chorizo de Pamplona; CIE $L^*a^*b^*$; Texture profile analysis

1. Introduction

The chorizo de Pamplona is a dry fermented sausage from the north of Spain (Navarra-Pamplona) with pleasant sensorial characteristics whose consumption has been extended in all of the country. Its characteristics of composition and elaboration are defined in the actual legislation of the "Dry cured sausages Standard Quality" (Boletin Oficial del Estudo 21 Marzo, anexo 3, 1980). In this order, maximum percentages for moisture, hydroxyproline, carbohydrates and fat and a minimum of the meat protein are established. Characteristics of the product such as colour or flavour are just described as "typical" or "pleasant" showing a lack of knowledge for its standardization. Some papers have tried to contribute to the chorizo de Pamplona standardization through sensorial and physico-chemical analysis. Sensory analysis of commercial brands of chorizo de Pamplona has been correlated with physico-chemical parameters such as pH, water activity, heme pigments, fat index (Santamaria, Lizarraga, Astiasaran & Bello, 1992) and with nitrogen fractions (Santamaria, Lizarraga, Iriarte, Astiasaran & Bello, 1994). However, these works did not show objective measurements of organoleptic properties such as colour, texture or flavour. Dellaglio, Casiraghi and Pompei (1996) in a review about studies of salami, noted that most of them were mainly concerned with the microbiological aspects of maturation and safety, whereas the effects of technological parameters and the influence of chemical and physical characteristics on consumer perception of quality, have rarely been investigated. However, in recent years, studies related to quality of traditional dry fermented sausages by physical, chemical and sensorial analysis have been carried out (Meynier, Novelli, Chizzolini, Zanardi & Gandemer, 1999; Riva, Ferlin & Pompei, 1988). In general, there is a lack of information about colour and texture instrumental measurements of dry fermented sausages which could contribute efficiently to their characterization.

In the present work, instrumental measurements of colour and texture and composition of chorizo de Pamplona have been studied in order to improve the present legislation.

2. Material and methods

The most important five commercial brands of chorizo de Pamplona were chosen for the sampling.

* Corresponding author. Tel.: +34-48-425600 ext 6405; fax: +34-48-425649.

E-mail address: iastiasa@unav.es (I. Astiasarán).

0308-8146/00/$ - see front matter
PII: S0308-8146(99)00239-3

Four sausages (pieces about 1 kg weight) of every selected commercial brand were randomly purchased at the supermarket. The common ingredients used in this type of product are: lean pork meat, pork back fat, salt, sugars (dextrin, lactose, dextrose), sodium ascorbate, nitrites and/or nitrates, red pepper, spices, colorants (Ponceau 4R E-124) and exogenous proteins (powdered milk or sodium caseinate). The technological process includes: mincing of lean pork meat and pork back fat in a cutter to a particle size reduction of 3 mm, mixing with the other ingredients in a vacuum kneading machine, stuffing into artificial casings and a posterior fermentation, smoking and drying process, during a period of about 30 days.

2.1. Chemical parameters

pH was determined using the potentiometer Orion Research Microprocessor Ionalyzer-901 using needle electrodes for solid samples (International Standards Organization, 1974). Moisture was determined according to the Association of Official Analytical Chemists method (Association of Official Analytical Chemists, 1984). Total fat was determined by an extraction technique with petroleum ether (Association of Official Analytical Chemists, 1990a). Protein was analyzed according to the Kjeldahl method (Association of Official Analytical Chemists, 1990b). The factor 6.25 was used for conversion of nitrogen to crude protein. The method used for ash determination was according to AOAC (Association of Official Analytical Chemists, 1997). Sodium and potassium levels were determined using a flame photometer according to the method AOAC (Association of Official Analytical Chemists, 1995a). Calcium and magnesium were determined by atomic absorption spectrophotometry according to the method (Association of Offical Analytical Chemists, 1995b).

2.2. Texture profile analysis (TPA)

A Universal TA-XT2i texture analyzer was used to conduct texture profile analysis (Bourne, 1978). Cubic samples of $1\times1\times1$cm were compressed twice to 60% of their original height with a compression platen of 75 mm diameter. Force-time curves were recorded at a crosshead speed of 5 mm/s and recording speed was also 5 mm/s. Hardness (*g*), springiness (mm), cohesiveness, gumminess (g) and chewiness (g×mm) were evaluated. These parameters were obtained using the available computer software.

2.3. Instrumental colour measurement

The samples were covered with a polythene film, with pressure to obtain a uniform, bubble-free surface. Reflectance spectra were determined with a UV/VIS Perkin–Elmer Lambda 5 spectrophotometer from 400 to 700 nm, using an integrating sphere with the conditions established by Ansorena, De Peña Astiasarán and Bello (1997). CIE $L^*a^*b^*$ parameters were calculated using the available software.

2.4. Data analysis

Four determinations for general composition and ten determinations for texture and colour parameters were measured in each piece. Results shown in the Tables are the means with standard deviations and the coefficient of variation. Differences among brands were analyzed through an ANOVA and a posteriori Tukey test with a 0.05 level of significance. Data analysis was carried out with the Statgraphics STSC Inc. program (version 4.0), a registered Trademark of Statistical Graphics Corp. Fat, protein, pH and textural parameters were subjected to correlation analysis (multivariate method) to determine possible statistical relationships between them. Principal components analysis (PCA) was applied to colour and texture parameters using the Statistical Software Statgraphics^R. PCA allowed reduction of the number of variables by finding linear combinations of those variable in order to explain most of the variability.

3. Discussion

CIE L*a*b* system values are shown in Table 1. Pagan-Moreno et al. (1992) in another type of chorizo, found lower values for L^* (34.72–41.53) and a^* (13.87–17.55), b* values being more similar (9.33–14.10). In meat and meat products lightness (L^*) seems to be the most informative parameter for colour changes (Mielnik & Slinde, 1983; Oellingrath & Slinde, 1985) but the importance of red (a^*) should not be ignored (Ferreira, Fernandes & Yotsuyanagi, 1994). Although some significant differences were found among different commercial brands, the total variability can be considered low especially for L^* (C.V. among brands = 5.66%) and

Table 1
Instrumental colour measurement[ab]

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5
L^*	46.87a	51.79bc	54.29c	52.32bc	49.28ab
	(1.70;3.63)	(1.21;2.34)	(2.58;4.75)	(1.54;2.94)	(1.54;3.12)
a^*	20.44a	25.90c	26.12c	25.84c	23.25b
	(0.71;3.47)	(1.17;4.52)	(0.25;0.96)	(0.17;0.66)	(1.20;5.16)
b^*	10.99a	17.70c	16.94bc	15.38bc	13.75ab
	(1.62;14.74)	(0.23;1.30)	(2.44;14.40)	(1.19;7.74)	(1.30;9.45)

[a] Mean value with standard deviation and coefficient of variation in parentheses.

[b] Within a row, different letters denote significant differences ($P<0.05$) between analyzed brands.

a^* (C.V. among brands = 10.12%). Dellaglio et al. (1996) studying Felino salamis, an Italian dry-cured sausage, found similar L^* values (39.10–47.27) and a^* values (22.13–30.08) but lower b^* values (5.68–8.90). The higher b^* (yellowness) values found in chorizo de Pamplona in this and in previous works (Ansorena et al., 1997; Ansorena, Zapelena, Astiasarán & Bello, 1998) are probably related to the presence of yellow carotenoids (β-carotene and cryptoxanthine) coming from paprika, a typical spice used in chorizo. Sarasibar, Sánchez-Monge and Bello (1989) pointed out that nitrificant salts decrease the intensity and stability of the colour of paprika, leading to a yellowish decoloration of red paprika at low pH. Moreover, the higher variability of b^* values found among samples (C.V. = 17.93) could be related to the different amounts of this spice used in the formulations in the different brands.

Sensorial properties can be affected by the technological process and obviously by the composition. General composition, and especially the contents of Na, K, Mg and Ca, were analyzed in the final products. In general, low fat levels and high water content lead to higher a^* values and lower L^* values (Claus, Hunt & Kashier, 1989; Hand, Hollingsworth, Calkins & Mandigo, 1987; Reagan, Liou, Reynolds & Carpenter, 1983). Other authors have found that the lower the protein content, the smaller was the a^* value (Bloukas & Paneras, 1993; Carballo, Mota, Barreto & Jimenez Colmenero, 1995). These authors explained this fact by the dilution of myoglobin consequent on the reduced protein content. In our study, fat content was similar for the five analyzed brands and no significant correlations were found with the colour parameters. Significant correlations were also not found between colour parameters and moisture or protein levels,

Table 2
Texture profile analysis[ab]

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5
Hardness (*g*)	7154.13c	5438.10ab	5475.96ab	5170.15a	6264.93bc
	(508.03;7.10)	(515.32;9.48)	(191.59;3.50)	(317.06;6.13)	(549.89;8.78)
Springiness (mm)	0.57ab	0.61b	0.59b	0.57ab	0.51a
	(0.04;7.02)	(0.03;4.92)	(0.02;3.76)	(0.06;10.53)	(0.02;4.35)
Cohesiveness	0.50b	0.51b	0.49b	0.45a	0.50b
	(0.01;2.00)	(0.02;3.92)	(0.03;6.12)	(0.02;4.44)	(0.01;2.00)
Gumminess (g)	3592.63c	2788.89ab	2697.65ab	2460.54a	3169.90bc
	(232.96;6.48)	(318.40;11.42)	(195.92;7.26)	(133.51;5.43)	(306.93;9.68)
Chewiness (g×mm)	2072.89b	1695.87ab	1640.17ab	1436.62a	1873.75ab
	(246.55; 11.89)	(265.64;15.66)	(64.53;3.93)	(190.60;13.27)	(283.13;15.11)

[a] Mean values with standard deviation and coefficient of variation in parentheses.
[b] Within a row, different letters denote significant differences ($P < 0.05$) between analyzed brands.

Table 3
pH and general composition[ab]

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5
pH	4.65ab	4.62ab	4.73b	4.89c	4.55a
	(0.01;0.21)	(0.01;0.22)	(0.11;2.32)	(0.04;0.82)	(0.01;0.22)
Moisture	31.62b	31.69b	33.82c	30.02a	31.56b
(%)	(0.48;1.52)	(0.77;2.44)	(0.56;1.67)	(0.56;1.86)	(0.32;1.01)
Fat	34.63a	36.32a	34.87a	36.75a	35.12a
(%)	(0.43;1.24)	(0.79;2.19)	(1.65;4.73)	(1.20;3.26)	(0.23;0.66)
Protein	18.68a	18.64a	20.4b	20.4b	19.1ab
(%)	(0.43;2.31)	(0.78;4.23)	(1.35;6.59)	(0.30;1.49)	(0.18;0.93)
Ash	4.67b	4.50ab	4.48ab	4.59ab	4.31a
(%)	(0.13;2.83)	(0.14;3.21)	(0.17;3.72)	(0.17;3.70)	(0.09;2.09)
Na	1.21a	1.32a	1.39a	1.39a	1.20a
(g/100g)	(0.10;8.26)	(0.07;5.30)	(0.01;7.08)	(0.07;5.03)	(0.11;9.17)
K	0.26a	0.28a	0.27a	0.24a	0.27a
(g/100g)	(0.02;7.69)	(0.03;10.71)	(0.03;11.11)	(0.03;12.50)	(0.02;7.40)
Ca	156.93ab	141.13ab	167b	155.98ab	128.80a
(mg/100g)	(14.09;8.98)	(19.94;14.13)	(2.99;1.79)	(18.55;11.90)	(11.62;9.02)
Mg	61.91d	60.08cd	45.95ab	49.49bc	37.56a
(mg/100g	(4.62;7.46)	(4.77;7.94)	(4.87;10.60)	(8.03;16.20	(2.38;6.35)

[a] Mean values with its standard deviation and coefficient of variation in the parenthesis.
[b] Within a row, different letters denote significant differences ($P < 0.05$) between analyzed brands.

although some significant differences were found for these components among brands (Table 3).

Results of texture profile analysis are shown in Table 2. As with colour parameters, some significant differences can be observed between different brands. Dellaglio et al. (1996), in commercial Italian dry cured sausages, found a C.V. of 67.4% for modulus (N/cm^2), concluding that products of very different consistency could be found on the market. In the chorizo de Pamplona, hardness showed a low C.V. in each brand analyzed. The variability among different brands can also be considered low (C.V. = 13.75%). Gumminess and chewiness showed a coefficient of variation similar to hardness (C.V. = 13.83% for chewiness and C.V. = 15.11% for gumminess) and the variabilities for springiness and cohesiveness were even lower (C.V. = 7.02 and 4.08%, respectively).

Table 4
Multivariate correlations between parameters

	Fat	pH	Protein
Hardness	−0.49[a]	−0.50[a]	−0.43
Springiness	0.22	0.29	0.15
Cohesiveness	−0.15	−0.79[c]	−0.37
Gumminess	−0.46[a]	−0.58[b]	−0.49[a]
Chewiness	−0.42	−0.50[a]	−0.37

[a] Significant at $P < 0.05$.
[b] Significant at $P < 0.01$.
[c] Significant at $P < 0.001$.

Textural properties have been related in meat products to fat, salt and pH values. Some studies in frankfurters showed that hardness decreased with increasing fat (Hand et al., 1987; Matulis, Floyd, Sutherland & Brewer, 1995). On the other hand, Jimenez Colmenero, Carrascosa, Barreto, Fernández and Carballo (1996), in bologna sausages, observed that, when the fat level was reduced there was a significant decrease in the penetration force. In another paper, Matulis, Mckeith, Sutherland and Brewer (1995) pointed out that fat content had limited effects on sensory hardness at pH < 5.2. Slight significant correlations were found between fat and some textural parameters (hardness and gumminess). However, as no significant differences were found in the amount of fat between the different brands of chorizo de Pamplona, this factor could not be the reason or origin for the observed differences in texture. Decreases

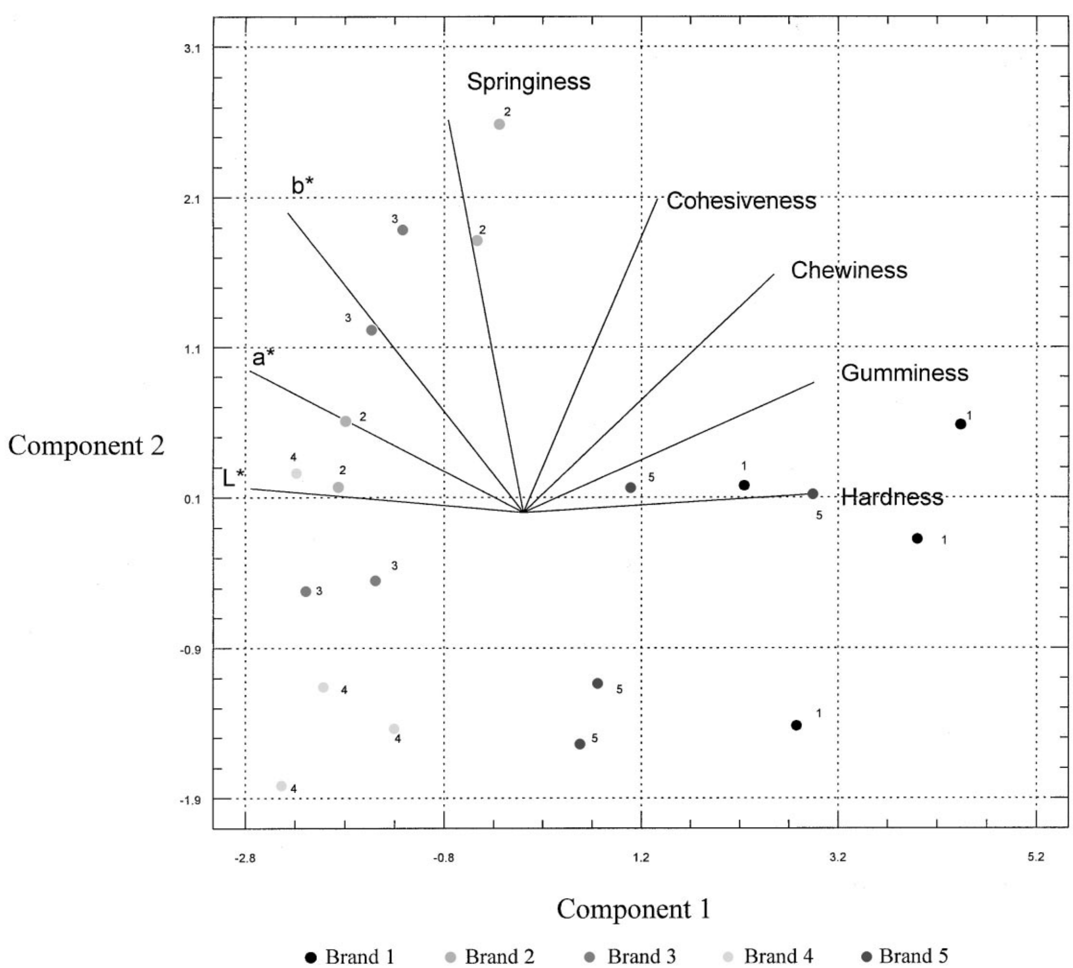

Fig. 1. Biplot for first two principal components.

in hardness, as a consequence of salt reduction, have been reported in frankfurters (Hand et al., 1987; Matulis, McKeith et al., 1995) and bologna (Seman, Olson & Mandigo, 1980). The results of the sodium analysis did not show significant differences among brands. This fact implies that similar amounts of NaCl were employed but did not explain the differences found in texture. Variation of texture has also been related to the use of other salts such as KCl, $CaCl_2$ and $MgCl_2$ (Seman et al., 1980; Sofos, 1982; Whiting & Richards, 1978). The analyses of K, Ca and Mg showed some differences in the amounts of Ca and Mg, probably as a consequence of the raw meat variability. These differences do not seem to be so great to be related to differences in texture.

Differences in pH values (Table 3) could explain the variability of texture among brands. Hardness, gumminess, chewiness, and especially cohesiveness showed significant negative correlations with pH (Table 4). Matulis, McKeith et al. (1995) pointed out that, if pH was reduced below the isoelectric point, more protein would be extracted, producing firmer frankfurters. All the analyzed samples showed pH values below 5.0. Protein content, and especially the amount of connective tissue also influence the texture of products. The total protein content was determined and no significant correlations were found with any of the textural parameters, with the exception of gumminess ($P<0.05$). Texture also depends on the amount of connective tissue, which has not been analyzed in this work.

Principal component analysis was carried out on the basis of the eight instrumental variables related to colour and texture. Hardness is the variable that showed the highest weight on the first component followed by gumminess, a^* and L^*. The second component is defined basically by springiness, cohesiveness and b^*. The distribution of the samples in the function of the first two components, which accounted for 80.80% of the total variance, is shown in Fig. 1. Brands 1 and 5 appeared to be the most similar in function of the first component.

In summary, results showed that, in relation to instrumental measurements of colour and texture, the analyzed commercial brands of chorizo de Pamplona were quite similar. An improvement of the actual legislation could be possible by including some of the analyzed parameters related to these properties, specifying their values and/or ranges.

Acknowledgements

We thank Prof. Mohino for scientific advice. We also thank Government of Navarra, Piuna, the Fundation Roviralta and the Fundación Empresa-Universidad for their financial support.

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