STABILIZATION BY CHILLING OF SOBRASADA FROM CHATO MURCIANO PIGMEAT MANUFACTURED WITHOUT PRESERVATIVES

Estabilización mediante refrigeración de la sobrasada de cerdo Chato Murciano elaborada sin conservantes

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ABSTRACT

The stabilization by chilling of Sobrasada (a traditional Spanish raw sausage) was studied. Sobrasada was manufactured according traditional procedures using meat and fat from Chato Murciano pig, without added preservatives, stuffed into natural casings and stored at 4ºC and 85% relative humidity for 20, 60, 120 or 180 days. No microbiological starters were added. To determine the effects of storage time on Sobrasada, several physical (pH, water activity, CIELab colour and instrumental texture), chemical (proximate composition, proteolysis index, total acidity and peroxide value), microbiological (total viable counts, lactic acid bacteria, *Enterobacteriaceae*, yeasts and moulds) and sensory (appearance, colour, odour, flavour and texture) technological parameters were determined. According to results, the use of natural casing allowed moderate dehydration and no effective fermentation by endogenous lactic acid bacteria and other fermentative spices were observed, while *Enterobacteriaceae* not proliferated. Physical, chemical and sensory properties of Sobrasada remained quite stables at refrigeration. Only certain intensification of orange colour and an increase in hardness and adhesiveness were observed when dehydration was more evident. No additional proteolysis or lipid oxidation, and only minor acidification were observed during chill storage. Thus, unfermented Sobrasada manufactured without added preservatives can be stabilized for 180 days by chilling at 4ºC/85% R.H.

Key Words: Sobrasada, quality, chilling, paprika.

RESUMEN

En el presente trabajo se estudió la estabilización de la Sobrasada (un embutido crudo español) mediante aplicación de frío. La Sobrasada fue elaborada con carne y grasa de cerdo Chato Murciano mediante procedimientos tradicionales, sin conservantes añadidos, embutida en tripa natural y almacenada a una temperatura de 4ºC y una humedad relativa del 85% durante 20, 60, 120 o 180 días. No se añadieron cultivos fermentadores. Para determinar el efecto del tiempo de almacenamiento refrigerado sobre la calidad de la Sobrasada, se procedió a determinar diversos parámetros tecnológicos, físicos (pH, actividad de agua, color CIELab y textura instrumental), químicos (composición proximal, índice de proteolisis, acidez total e índice de peróxidos) microbiológicos (aerobios mesófilos totales, bacterias ácido lácticas, *Enterobacteriaceae*, mohos y levaduras) y sensoriales (aspecto, color, olor, sabor y textura). Según los resultados obtenidos, el empleo de tripa natural permitió una moderada deshidratación y no hubo una fermentación efectiva por parte de las bacterias lácticas u otras especies fermentativas presentes, mientras que *Enterobacteriaceae* no proliferaron. Las propiedades físicas, químicas y sensoriales de la Sobrasada permanecieron bastante estables en el producto refrigerado, sólo se observó cierta intensificación del color naranja, junto con sendos incrementos en la dureza y adhesividad cuando la deshidratación fue más evidente. Tampoco se detectó una proteolisis adicional, ni oxidación de lípidos, y sólo se observó una ligera acidificación del producto durante el almacenamiento refrigerado. Por tanto, la Sobrasada no fermentada, elaborada sin aditivos conservantes, puede ser estabilizada durante 180 días mediante refrigeración a 4ºC y 85%HR.

Palabras clave: Sobrasada, calidad, aplicación de frío, pimentón.

INTRODUCTION

Sobrasada is a Spanish sausage manufactured with chopped pork, seasoned with sodium chloride, paprika and other minor spices, after which it is mixed and stuffed. Sobrasada can be processed using different industrial practices. Sobrasada is usually subjected to moderate drying and can be fermented or not using microbial starters. Traditional sausage is stuffed into natural casings (*caecus*) to improve its acceptance. The typical sensory attributes of Sobrasada are a paprika flavour and odour, slight acidity, grainy appearance, orange-red colour and unctuous texture. The final quality of Sobrasada is affected by the raw materials used and manufacturing conditions. Fat is a major quality factor, since the fat content can vary between 40% and 70% (w:w) (Spanish Royal Decree 136/1993; 1994). The consistency can be more or less unctuous depending mainly on the fat content and its saturation. Lipids with too high degree of instauration can produce adverse effects on consistency, emulsion stability and may cause rancidity. Paprika (4-7% w:w) contributes strongly to its typical odour, flavour and colour. Nitrates and nitrites are used since antiquity to ensure the microbiological quality of meat products, and specifically to prevent Botulism. However, food policy current and emerging trends in consumption are intended to limit or eliminate the use of nitrites and nitrates in food due to the problems they have on health. They are already used commercial packs of spices and additives for Sobrasada without nitrates and nitrites.

Manufacturing conditions, such as the use of emulsifying agents or microbial starters, degree of chopping, mixing (air or vacuum), stuffing (air or vacuum; casings), ripening and chill storage can also affect the quality of Sobrasada, although few scientific studies on the composition and microbial quality are available (Ubach, Miguel & Puig, 1988; Puig, Mora, Ciscar & Estrades, 1989; Puig, 1989; Roselló, Barbas, Bernat & López, 1995). It is important to give enough time for the Sobrasada ingredients can interact with each other. For this reason, at least 20 days were recommended by local producers to homogenize the colour, flavour and texture in the pieces of sausage. When water-permeable casing were used, thus, consistency can increase due to the progressive dehydration post-stuffing (Llull, Simal, Benedito & Roselló, 2002). Microbial fermentation can also contribute for the development of determined quality traits of Sobrasada, especially if starter microbes are added. Lactic acid bacteria are the major group of fermentative microbes present in Sobrasada, while other fermentative bacteria, yeast and moulds reach lower counts (Ubach et al., 1988; Roselló et al., 1995). *Enterobacteriaceae* and other pathogenic bacteria such *as Bacillus cereus*, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomona* spp and *Salmonella enterica* also can proliferate in Sobrasada when the quality of spices and hygiene are not controlled (Ubach et al., 1988). Acidification favours flavour and contributes to protein coagulation, increasing firmness and cohesiveness (Campbell-Platt & Cook, 1995). Proteolysis influences both texture and flavour development due to the formation of several flavour compounds, including peptides, amino acids, aldehydes, organics acids and amines (Díaz, Fernández, García de Fernando, de la Hoz & Ordoñez, 1993; Naes, Holck, Axelsson, Anderson & Blom, 1995). Lipolysis and lipid oxidation contribute to aroma development, since these processes are responsible for the formation of aldehydes and ketones (Samelis, Aggelis & Metaxopoulos, 1993; Stahnke, 1995; Navarro, Nadal, Izquierdo & Flores, 1997).

A major problem of fatty meat products as Sobrasada is an excessive oxidation, which may cause unfavourable changes in the nutritional (loss of vitamins and essential amino acids) and sensory quality of these products (Domínguez & Zumalacárregui, 1991; Aguirrezábal, Mateo, Domínguez, & Zumalacárregui, 2000). Antioxidant agents, such as ascorbic acid, nitrite BHT or BHA can be added to Sobrasada to prevent rancidity. However, consumers are increasingly demanding healthier meat products, if possible, free of chemical additives, and this has led to increased interest in meat products manufactured with natural ingredients as preservatives. Several of the spices used in the manufacture of meat products may inhibit rancidity, often showing synergism (Madsen & Bertelsen, 1995). Paprika, the main spice used in Sobrasada, is an excellent source of carotenoids, especially xanthophylls. Certain carotenoids, including β-carotene and various xanthophylls, have been shown to have potent antioxidant effects (Aguirrezábal et al., 2000). This fact would be important for preventing rancidity in Sobrasada, as in other paprika-based meat products (Domínguez & Zumalacárregui, 1991). The combination of chilling and spices with good functional properties would allow Sobrasada to be manufactured without preservatives but still to present good keeping and good sensory qualities. The main question to elucidate was whether the microbiological and oxidative phenomena can be controlled by applying cold without adding preservatives. For this reason, the aim was to study if chilling treatment is sufficient or not to preserve the quality of unfermented Sobrasada, stuffed into natural casings and manufactured without preservatives.

MATERIALS AND METHODS

Sobrasada manufacture and sampling

Sobrasada was manufactured with meat and fat from Chato Murciano pigs, an autochthonous Spanish breed employed to produce fatty carcasses. Castrated pigs were fed with barley, wheat, maize, soybean flour, peas, bran, lucerne, butter and molasses and were slaughtered at 16-18 months and 180 kg live weight. Two batches of Sobrasada were manufactured following traditional local procedures. The ingredients used were (g per 100g): lean pork (23.1), dorsal and gluteus backfat (69.4), sodium chloride (2.2), paprika (5), garlic (0.2) and wild marjoram (0.1). No preservatives were added. Salt and spices were provided by Muñoz y Pujante S.L. (Murcia, Spain). Fat and meat were chopped (4mm) using a mincing machine M.A. Ortega MC-32 (Hospitalet de Llobregat, Spain). Minced meat and fat were mixed with salt and spices using an air mixer Talsa MIX55PT (Xirivella, Spain) to obtain Sobrasada, which was stuffed into pig casings (approximately 25cm long and 8.5cm diameter) using an air stuffing machine Talsa H15A (Xirivella, Spain). After 20 days, time recommended by local producers to reach an acceptable development of aroma and taste, Sobrasada was chilling at 4ºC and 85% relative humidity. Then, four different chill storage times were checked (20, 60, 120 or 180 days). For microbiological, physicochemical and sensory assays, Sobrasada was sliced (1cm thickness and 8.5cm diameter). Samples were packed under vacuum and preserved at 2ºC prior to analysis.

Microbiological analysis

Total viable bacteria, lactic acid bacteria (LAB), yeasts and moulds were counted at the four control times. *Enterobacteriaceae* was used as hygiene index. Ten grams of sample were aseptically taken and homogenized with 90ml of Peptone Water 0.1% (w/v) (Oxoid Ltd. CM0087, Basingstoke, Hampshire, United Kingdom) in a Stomacher (IUL Instruments, GMBH, Königswinter, Germany) for 3min. Serial decimal dilutions were made and then plated in duplicate for bacterial counts. Total viable bacteria (expressed as log cfu/g) were counted on Plate Count Agar (Oxoid Ltd. CM0325, Basingstoke, Hampshire, United Kingdom) according to ISO 4833 (2003). Lactic acid bacteria (log cfu/g) were counted on double-layer Man Rogosa Sharpe Agar (MRS) (Oxoid Ltd. CM0361, Basingstoke, Hampshire, United Kingdom) according to ISO 15214 (1998). Both aerobic mesophilic bacteria and lactic acid bacteria were incubated for 72h at 30ºC in a 207 incubator (Selecta, Barcelona, Spain). *Enterobacteriaceae* counts (log cfu/g) were determined on double layer Violet Red Bile Glucose Agar (VRBG) (Oxoid Ltd. CM0485, Basingstoke, Hampshire, United Kingdom) after 24h incubation at 37ºC in a BE500 incubator (Memmert, Schwabach, Germany) according to ISO 21528-2 (2004). Yeasts and moulds (log cfu/g) were determined on Rose-Bengal Chloramphenicol Agar (Oxoid Ltd. CM0549, Basingstoke, Hampshire, United Kingdom) after 5 days incubation at controlled room temperature of 25ºC according to ISO 7954 (1988).

Physicochemical analysis

Physical (pH, water activity, colour and texture) changes during chill storage were measured. The pH was measured using a Micro-pH 2001 pHmeter equipped with a CAT 52-02 electrode (Crison Instruments, S.A., Barcelona, Spain). Water activity (a_w) was measured at 25ºC using a Thermoconstanter Novasina TH200 Water Activity Meter (Axair AG 8808, Pfäffikon, Switzerland). CIELab colour was measured just after cutting using a Minolta Chroma Meter CR-400 (Minolta Co., Osaka, Japan), obtaining the following coordinates: Lightness (L*), Redness (a*), Yellowness (b*), Chroma (C*) and Hue angle (H*); $C^* = (a^{*2} + b^{*2})^{1/2}$. $H^* = tg^{-1} (b^*/a^*)$. Four measurements per slice were made. For texture measurement, an instrumental Penetration Test (PT) was performed using a QTS-25 texture analyzer (Brookfield CNS Farnell, Borehamwood, Hertfordshire, England) equipped with a 25 kg load cell. A cylindrical probe of 20 mm diameter was used. Pro v. 2.1 Software was used for data collection and calculations. Sliced samples of 1.5cm thickness were measured at 20ºC. The testing conditions were: one cycle with return at test speed, cross-head moved at 50 mm/min constant speed, 0.05 N trigger point and 40mm target value. Texture variables evaluated were: hardness (N), adhesiveness (Ns) and stringiness length (mm). Four measurements per sample were made.

Proximate composition changes and ageing indexes were determined. Moisture (g kg-1) was determined after dehydration (ISO 1442: 1997).

Total fat (g kg-1) was determined by the Soxhlet extraction procedure (ISO 1443: 1973). Total nitrogen (TN) (g kg-1) was determined according to Kjeldahl method. The factor 6.25 was used for conversion of nitrogen to crude protein (ISO 937:1978). Non-protein nitrogen (NPN) (g kg-1) was determined by the Kjeldahl method after protein precipitation with trichloroacetic acid. The proteolysis index was calculated as g NPN per kg TN. Total acidity (TA) (g lactic acid per kg) was determined by titrating with NaOH using phenolphtalein as indicator. Total acidity was calculated using the following equation: TA= 0.009 x ml 0.1M NaOH, where 1ml of 0.1M NaOH was equivalent to 0.009 g of lactic acid (Solfield, 1975). Peroxide value (meq of oxygen per kg) was analyzed by using Iodometric (visual) endpoint determination according to ISO 3960 (2001).

Sensory analysis

The sensory quality of Sobrasada was evaluated by a trained panel. Prior to analysis, samples were spread on standardized pieces of bread (the usual way it is consumed in Spain) at 25ºC. Ten panellists chosen from the university community were selected and trained according to ISO 8586-1 (1992). There were four training sessions. In the first two sessions, the main sensory descriptors of Sobrasada, including off-flavours, were studied; the next two sessions were concerned with identifying, selecting and quantifying major sensory attributes. Sensory analysis was carried out according to ISO 4121 (2003). The acceptance was evaluated using five sensory descriptors: appearance, colour, flavour, odour and texture. The scale used was: 1 = very poor; 2=poor; 3: medium; 4: good; 5 = very good. The presence of acid and rancid flavour also was quantified. A linear scale was used: 1 = non-perceivable; 2 = perceivable; 3 = slight; 4 = moderate; 5 = strong. Each panellist evaluated two samples from four different chill storage times.

Statistical analysis

The statistical model was designed completely at random. Descriptive statistics were determined. Chill storage time was considered as treatment. The effects of chilling on the stability of Sobrasada were determined by one-way ANOVA (Scheffe homogeneity means Test). The computer statistics program used was Statistix 8.0 for Windows (Analytical Software, New York, USA).

RESULTS AND DISCUSSION

Table 1 show the evolution of the physical and chemical parameters of Sobrasada chilled at 4 ºC/85% RH for 20, 60, 120 or 180 days. Sobrasada suffered considerable dehydration during chill storage, the mean moisture content falling from 287 g kg^{-1} (day 20) to 187 g kg^{-1} (day 180). This fall agreed with the drying model determined for Sobrasada (ripening for 60 days) by Simal, Femenia, García-Pascual & Roselló (2003). Significant differences (P<0.05) in mean moisture between 20-60, 120 and 180 days were found. Puig et al. (1989) reported mean moisture values of 241 g kg-1 in Majorcan Sobrasada ripened during several weeks. Dehydration increased the relative content of fat and protein, which provided mean final percentages of 653 g kg-1 and 103 g kg-1, respectively. The pH remained stable throughout chill storage, with mean values of 5.3-5.4. These results agree with Puig et al. (1989). Aw decreased from 0.90 (day 20) to 0.85 (day 180) due to dehydration. Significant differences (P<0.05) in mean Aw between 20-60 and 120-180 days were found. Both pH and water activity values agreed with Roselló et al. (1995) (5.4 and 0.83, respectively, for Majorcan Sobrasada ripened at 14ºC for 120 days).

Minor acidification, proteolysis and lipid oxidation were observed at chilling conditions. A low mean level of lactic acid was detected

Table 1. **Average values and standard deviations for physical-chemical parameters of Sobrasada chilled at 4ºC/85% RH for 20, 60, 120 and 180 days.**

	Chill storage time (days)			
	20	60	120	180
	M±SD	*M±SD*	*M±SD*	*M±SD*
Moisture g kg^{-1}	287.1±14.5 [a]	264.8±6.8 [a]	221.3±16.4 [b]	186.8±35.9 [c]
Lipids g kg^{-1}	525.6±18.5 [c]	546.8±21.3 [c]	615.1±16.8 [b]	652.7±29.4 [a]
Protein g kg^{-1}	87.25±7.91	90.34±7.02	91.60±10.33	102.57±16.88
Non protein nitrogen g kg^{-1}	0.83±0.14	0.81±0.1	0.91±0.1	0.94±0.08
pH	5.35±0.02	5.38±0.05	5.34±0.02	5.38±0.03
Water activity	0.90±0.01 [a]	0.88±0.00 [a]	0.86±0.01 [b]	0.85±0.01 [b]
Proteolysis index g kg^{-1}	59.54±7.02	58.17±6.76	62.67±4.51	59.96±3.74
Lactic acid g kg^{-1}	0.35±0.03 [c]	0.44±0.03 [b]	0.51±0.05 [ab]	0.57±0.06 [a]
Peroxide value meq O_2 kg^{-1}	0.00±0.00	3.19±3.07	3.79±6.05	0.00±0.00
L CIE units	54.77±1.64 [a]	52.04±1.26 [bc]	53.86±1.10 [ab]	50.76±2.07 [c]
a* CIE units	27.74±1.54 [b]	29.47±1.07 [ab]	30.83±1.99 [a]	28.46±1.97 [ab]
b* CIE units	44.16±1.38 [a]	44.61±2.37 [a]	44.42±4.92 [a]	35.38±6.83 [b]
Chroma CIE units	52.16±1.71 [a]	53.471±2.44 [a]	54.079±5.16 [a]	45.49±6.50 [b]
Hue angle CIE units	57.88±1.27 [a]	56.53±0.95 [a]	55.13±1.33 [a]	50.73±3.70 [b]
Hardness N	3.63±1.06 [c]	4.51±0.50 [bc]	5.19±0.53 [ab]	6.28±1.26 [a]
Stringiness length mm	14.83±4.42	14.97±3.47	18.53±6.00	17.91±5.66
Adhesiveness Ns	15.76±2.07 [a]	20.20±3.11 [ab]	26.37±8.21 [b]	36.36±6.26 [c]

[a] Means with different superscripts were significantly different ($P<0.05$).

during chill storage, increasing from 0.4 g kg^{-1} (day 20) to 0.6 g kg^{-1}(day 180), representing a significant increases (P<0.05) in mean values between day 20 and day 180. Levels of 5-7 g of lactic acid per kg^{-1} have been described for Chorizo, a dry sausage manufactured with pork and paprika, without microbial starters added (Salgado, García-Fontán, Franco, López & Carballo, 2005; Capita, Llorente-Marigómez, Prieto & Alonso-Calleja, 2006). No additional proteolytic activity was observed during the chilling period. The proteolysis index was constant around 60 g kg^{-1}, which can be considered low compared with fermented meat products (Salgado et al., 2005; Sanz, Flores, Toldrá & Feria, 1997). This observation may be related with the low temperature, Aw and protein content of Sobrasada, which did not favour the activity of protease enzymes (Ordóñez & de la Hoz, 2001). Peroxide compounds were practically absent throughout the chill storage. Levels of 9-19 meq O_2 per kg^{-1} fat have been described for chorizo (Franco, Prieto, Cruz, López & Carballo, 2002; Salgado et al., 2005). This lack of peroxide compounds could be explained by the inhibition of lipid oxidation by refrigeration and by the antioxidant activity of paprika, while garlic might also play a minor antioxidant role (Aguirrezábal et al., 2000). Paprika is rich in antioxidant phenolic compounds, such as tocopherols and carotenoids, including β-carotene and various xanthophylls. Capsanthin is the main carotenoid present in Sobrasada (Oliver, Palou & Pons, 1998).

Sobrasada colour was orange due to the interaction of fat and paprika, among other factors. The evolution of CIELab coordinates showed some changes of colour during the chill storage. Lightness is usually the least repetitive measurement of colour in coarse-minced sausages. The most significant decrease (P<0.05) in L* was between 20 and day 180. Results for both redness (a*) and yellowness (b*) were less conclusive, although the evolution of Chroma and Hue angle showed an intensification of the orange colour of Sobrasada during the final stage of chill storage, when dehydration was most intense. Significant (P<0.05) decreases in mean Chroma and Hue were found at day 180 with respect to all previous control days. No colour data for Sobrasada were cited in the consulted literature. Chill storage also affected hardness and adhesiveness. Significant (P<0.05) increases in means hardness and adhesiveness were found for day 120 with respect to day 20, while, no significant (P>0.05) differences in mean stringiness length were observed at any time during chill storage. Increasing dehydration made Sobrasada fattier and perhaps this fact favoured its adhesive properties. The loss of water would also have contributed to increasing the consistency. An increase in hardness has been described previously for Sobrasada (Llull et al., 2002) and chorizo (González-Fernández, Santos, Rovira & Jaime, 2006).

Table 2 shows the microbial counts in Sobrasada chilled at 4 ºC/85% RH for 0, 60, 120 and 180 days. The highest microbial counts were obtained at day 20, although no counts above 6 log cfu g^{-1} were obtained for any of the microbes studied. The mean total viable counts (TVC) fell from 5.9 (day 20) to 5.2 log cfu g^{-1} (day 180). Significant differences (P<0.05) in mean TVC were found between 20-60, 120 and 180 days. Lactic Acid Bacteria (LAB) were the main bacteria of the studied groups. LAB counts decreased during the chill storage from 5.5 (day 20) to 4.9 (day 180). Significant differences (P<0.05) in mean LAB counts between 20-60-120 and 180 days were found. According to this, LAB counts reached were coherent to unfermented meat product. In the usual conditions of pH and temperature at least 7 log cfu g^{-1} of LAB must be checked to produce effective fermentation in dry-fermented sausages (Carrascosa, 2001). LAB counts were coherent with the pH and lactic acid values obtained. Roselló et al. (1995) reported 10^8 – 10^9 cfu g^{-1} of TVC and LAB and 10^5 of *Micrococcaceae* for Majorcan

Table 2. **Average values and standard deviations for microbial counts (log cfu g $^{-1}$) of Sobrasada chilled at 4ºC/85% RH for 20, 60, 120 and 180 days.**

	Chill storage time (days)			
	20	60	120	180
	M±SD	*M±SD*	*M±SD*	*M±SD*
Total viable count	5.87±0.54 [a]	5.67±0.48 [ab]	5.24±0.20 [b]	5.19±0.27 [b]
Lactic acid bacteria	5.50±0.65 [a]	4.94±0.56 [ab]	4.63±0.10 [ab]	4.87±0.33 [b]
Enterobacteriaceae	1.96±0.32 [a]	0.64±0.71 [b]	n.d	n.d
Yeasts and moulds	5.77±0.69	4.94±0.75	5.11±0.58	4.86±0.50

[a] Means with different superscripts were significantly different (P<0.05).
n.d: non detected

Sobrasada manufactured without microbial starters and ripened at higher temperature. Low *Enterobacteriaceae* counts were detected at day 20 (2.0 log cfu g^{-1}), but had disappeared by day 120. This fact could be related with the great sensitivity of *Enterobacteriaceae* to falls in Aw, since no acidification was observed. According to Roselló et al. (1995), *Enterobacteriaceae* are detected when raw materials are manipulated in the early stages of Sobrasada manufacturing, but disappear at 30 days of ripening. Ubach et al. (1988) reported *Enterobacteriaceae* counts between 10-102 cfu g-1 in fermented Sobrasada. Yeast and mould counts remained moderate and stable throughout chill storage, reaching mean values of 4.9-5.8 log cfu g^{-1}. Roselló et al. (1995) reported similar counts for yeast and moulds. No significant differences (P>0.05) in mean yeast and mould counts were found between any control days.

Table 3 shows the sensory scores in Sobrasada chilled at 4ºC/85% RH for 20, 60, 120 and 180 days. The chilling time affected the appearance and colour. A significant (P<0.05) improvement in mean appearance was found between 20-60 and 120-180 days. Mean colour scores were also higher (P<0.05) at 180 days than at 20-60 days. Dehydration provided Sobrasada cuts with a more intense orange colour which was much appreciated by the panellists. Odour and flavour remained stable under these chill storage conditions, reaching medium-high values. No statistical differences (P>0.05) for mean odour and flavour scores were observed during chill storage. No rancid flavour was detected. A slight acid flavour was detected and little but significant differences (P<0.05) in mean acid flavour scores were found between 20 and 180 days. This slight acid flavour of Sobrasada was coherent with the pH and lactic acid levels checked. Mean texture scores were similar at all control times. Neither, the dehydration associated with chill storage or the changes in hardness and adhesiveness affected the texture score. According to the panellists, the texture of Sobrasada was similar throughout chill storage. The sensory analysis suggests that chilling stabilized the sensory properties of unfermented Sobrasada. No sensory studies of Sobrasada were found in the consulted literature.

Table 3. **Average values and standard deviations for sensory scores of Sobrasada chilled at 4ºC/85% RH for 20, 60, 120 and 180 days.**

	Chill storage time (days)			
	20	60	120	180
	M±SD	*M±SD*	*M±SD*	*M±SD*
Appearance	3.68±0.67 [ab]	3.36±0.84 [b]	4.21±0.70 [a]	4.33±0.69 [a]
Colour	3.37±0.83 [b]	3.50±0.65 [b]	3.71±0.61 [ab]	4.17±0.38 [a]
Odour	3.79±0.92	3.43±1.02	4.00±0.78	4.00±1.08
Flavour	3.89±0.74	3.64±0.84	4.14±0.86	4.06±1.06
Acid flavour	1.05±0.05 [b]	1.58±1.00 [ab]	1.62±0.87 [ab]	1.82±1.01 [a]
Rancid flavour	1.05±0.05	1.08±0.29	1.31±0.75	1.18±0.39
Texture	3.68±0.89	3.86±0.77	4.00±0.78	4.00±0.97

[a] Means with different superscripts were significantly different (P<0.05).
Scale for appearance, colour, taste, aroma and texture: 1 = very poor; 2=poor; 3: medium; 4: good; 5 = very good
Scale for acid and rancid taste: 1 = non-perceivable; 2 = perceivable; 3 = slight; 4 = moderate; 5 = strong.

CONCLUSIONS

Physical, chemical and sensory properties of Sobrasada remained quite stables at 4ºC/85% HR for 180 days. The combination of chilling and stuffing into natural casing favoured moderate dehydration and no effective fermentation by lactic acid bacteria was observed, while *Enterobacteriaceae* not proliferated at 4ºC, ensuring the shelf life of Sobrasada. No additional proteolysis or lipid oxidation, and only minor acidification were observed. The high content of paprika in Sobrasada could prevent the oxidation during chill storage. The sensory quality of Sobrasada was hardly affected by storage time, and only certain intensification of orange colour and an increase in hardness and adhesiveness were observed when dehydration was more evident. Thus, it is possible to stabilize the quality of unfermented Sobrasada stuffed into natural casings by mean of chilling, and it is not necessary to add preservative additives.

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