Repeated option was used to account for repeated measurements. Least square means for protected F-Tests ($P < 0.05$) were separated using the diff option.

Results

As concentration of sodium ascorbate increased, the pH of treatment solutions increased (0.5% = 6.68; 1% = 6.82; 1.5% = 6.97). Muscle pH was not influenced ($P > 0.05$) by topical ascorbate treatment (*longissimus* pH = 5.8). There was a concentration x storage time interaction ($P < 0.05$) for vertebrae marrow a* values (Tab.). Compared with initial colour measurements, no vertebrae discoloration ($P > 0.05$) was observed on day 5 of storage. However, on day 9 of storage, untreated vertebrae were discoloured and less red ($P < 0.05$) than vertebrae on day 0 and 5. Ascorbate (0.5, 1.0 or 1.5%) improved vertebrae redness on day 9 and minimised discoloration ($P < 0.05$). More specifically, compared with initial colour on day 0, there was no change ($P > 0.05$) in a* during storage for vertebrae treated with ascorbate. Thus, vertebrae treated with sodium ascorbate were more red ($P < 0.05$) than untreated vertebrae on day 9 of storage.

Compared with initial colour measurements, *longissimus* treated with either 0 or 0.5% ascorbate were less red ($P < 0.05$) on days 5 and 9 of storage (Tab. 1). However, no discoloration (no decrease in a*; $P > 0.05$) was observed during storage for *longissimus* treated with 1.0 and 1.5% ascorbate. No difference ($P > 0.05$) was observed between 1.0 and 1.5% ascorbate throughout the storage period.

Discussion

Surface discoloration (including both muscle and bone marrow) of lamb loin chops packaged in PVC was prevented by 1.0 and 1.5% sodium ascorbate. These results are in agreement with previous research, which suggests that ascorbic acid can be used to improve the colour stability of beef bone marrow (GROBBEL et al., 2006; MANCINI et al., 2004, 2005, 2006). Effective concentrations used in these studies ranged from 3 to 10%. MANCINI et al. (2007) also noted that sodium erythorbate (0.5 to 1.5%) improved the colour stability of beef vertebrae. RAINES et al. (2006) and NICOLALDE et al. (2006) concluded that topical ascorbic acid improved the colour stability of pork vertebrae.

Ascorbate can function as both an antioxidant and a prooxidant. As a result, concentrations that improve colour stability depend on several factors (LEE et al., 1997 and 1999; SHIVAS et al., 1984). Research assessing the effects of ascorbic acid on the colour of lamb muscle is limited in comparison with research detailing the role of ascorbic acid in beef colour. In general, concentrations between 1 and 10% have been reported to be effective for minimising beef muscle discoloration (MITSUMOTO et al., 1991ab; HARBERS et al., 1981). Inconsistency in concentrations of ascorbic acid that improve colour stability could be attributed to the presence and concentration of metals within a food (DECKER, 1998). Ascorbic acid's beneficial effect on colour stability is often attributed to its ability to function as a reducing agent (LEE et al., 1999). Bone discoloration results from red blood cell disruption and haemoglobin oxidation (GILL, 1996; LANARI et al., 1995). Therefore, ingredients such as ascorbate and ascorbic acid that limit methaemoglobin formation should improve the colour stability of cut lamb bones.

Practical importance

Surface discoloration (including both muscle and bone marrow) of lamb loin chops packaged in PVC can be minimised by topical application of 1.0 and 1.5% sodium ascorbate. Reducing agents can function as both an antioxidant and a prooxidant; therefore, careful attention should be given to concentration when selecting a topical ascorbate treatment. Minimising oxidation of both myoglobin and haemoglobin will improve the colour stability of bone-in lamb chops.

Tab.: Effects of topical sodium ascorbate treatment on the surface redness (a*) of lamb bone-in loin chops over-wrapped with PVC and stored at 2 °C.

Storage time (d)	Ascorbate (%)	Marrow color	Muscle color
0	Control[1]	29.0[a]	24.2[a]
	Standard error[2]	1.1	0.5
5	Control	28.3[a]	21.5[b]
	0.5	28.2[a]	22.5[b]
	1.0	28.8[a]	24.1[a]
	1.5	28.5[a]	23.8[a]
	Standard error[2]	1.2	0.5
9	Control	23.9[b]	20.3[c]
	0.5	26.6[a]	21.9[b]
	1.0	27.1[a]	24.1[a]
	1.5	27.5[a]	23.7[a]
	Standard error[2]	1.2	0.5

[a-c] Least square means in a column with different letters are different ($P < 0.05$); [1] Control = 0% topical ascorbate treatment. Initial color on day 0 was evaluated 30 minutes after topical ascorbate treatment. No significant difference was noted between ascorbate treatments and control on day 0; [2] Standard error for a* values within a day.

Source: MANCINI et al. Fleischwirtschaft International 2/2011

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Authors' addresses

R. Mancini (PhD) (richard.mancini@uconn.edu) and R. Ramanathan (MS), Dept. of Animal Science, University of Connecticut, 3636 Horsebarn Hill Road Ext., Storrs, CT, 06269-4040. P. Joseph (MS), Dept. of Animal and Food Sciences, University of Kentucky, W. P. Garrigus Building, Lexington, KY, 40546. K. Petersson (PhD), Dept. of Fisheries, Animal and Veterinary Sciences, 20A Woodward Hall, 9 East Alumni Avenue, Kingston, RI, 02881.

Improving quality in Iberian "Chouriço Grosso" using autochthonous starter cultures

Keywords

- *Lactobacillus sakei*
- *Staphylococcus xylosus*
- Meat starter
- Iberian sausage
- Chouriço Grosso
- Control quality

By M. Elías, A.C. Agulheiro-Santos and A.V. Carrascosa

"Chouriço Grosso" is a traditional and high quality Portuguese sausage made of meat from a rustic and fatty Alentejano pig breed in the south east region of Portugal. At a traditional factory, 4 batches, with 25 kg, each, were prepared to produce "Chouriço Grosso" using different starter inoculations: 1 – with 10^8 cells/g of *Lactobacillus sakei* and 10^8 cells/g of *Staphylococcus xylosus*, 2 – with 10^8 cells/g of *Lactobacillus sakei*, 3 – with 10^8 cells/g of *Staphylococcus xylosus*, 4 – control, not inoculated.

Using five samples from each batch of cured sausages (n = 5), some chemical and physical analysis (pH, a_w, chromatic coordinates L*, a* and b*), rheological tests (texture profile analyse and cutting test), sensorial evaluation (colour intensity, off colours, aroma intensity, off aromas, taste intensity, off tastes, tenderness, juiciness and global evaluation) and microbiological analysis (mesophylic aerobic counts, psychrotrophics, yeasts, lactic acid bacteria, *Micrococcaceae*, *Enterobacteriacea*, *Enterococcus faecalis*, coliforms and *E. coli*) were carried out.

The control batch, when compared to the remaining three batches, revealed higher pH, a_w, L* and b* values, and a lower a* value. The control batch also exhibited significantly lower values ($p<0.05$), when compared to the inoculated batches, as far as the texture parameters are concerned (hardness, cohesiveness, springiness, resilience, gumminess, chewiness and cutting force) and presented significantly higher values ($p<0.05$) for pejorative sensorial attributes (off colour, off aroma, off taste and global evaluation). According to microbiological results, the psychrotrophics, *Enterobacteriaceae*, *Enterococcus faecalis*, coliforms and *E. coli* counts were significantly higher ($p<0,05$) in the control batch. This experiment allowed revealing the important role of the studied autochthonous cultures in order to promote microbiological and sensorial quality in this kind of food.

Traditional Portuguese sausages made of raw material from Alentejano pig breed are high quality products. This quality is mostly due to the exquisite sensorial characteristics of the products and their richness in oleic acid. In fact, its fat could contain up to 56% of oleic acid, considering the total amount of free fatty acids. The production of Alentejano pig sausages occurs in small enterprises, located in the Alentejo region, south east of Portugal. In those small enterprises, processes aren't yet efficiently controlled, which results in a wide variability in the range of products from the same producer. Thus, in order to achieve a constant quality, the use of starter cultures is recommended, being the role of starters often mencioned in previous research works. (HUGAS et al., 1997; AYMERICH et al., 2000; TYÖPPONEN et al., 2003; BENITO et al., 2008). Sausage batter inoculation with a starter culture composed of lactic acid bacteria (homofermentative *lactobacilli* and/or *pediococci*) and Gram-positive, catalase-positive cocci (non-pathogenic, coagulase-negative *staphylococci* and/or *kocuriae*) improves the quality and safety of the product and standardizes the production process (CAMPBELL-PLATT and COOK, 1995; LÜCKE, 1998, 2000; LEROY et al., 2006). Small and medium meat plants continue to use the traditional method of spontaneous fermentation without addition of starter cultures. In these cases microorganisms from the meat and from the environment are involved in meat fermentation and constitute the so-called "house flora" (SANTOS et al., 1998). Several traditional fermented sausages are often of superior quality compared to industrial sausages, inoculated with starter cultures and produced within strongly controlled processes. This occurs, partly, due to the properties of the raw material and the characteristics of the technology used but also to the specific composition of the "house flora" (GARCIA-VARONA et al., 2000; MORETTI et al., 2004; LEROY et al., 2006). Appropriate cultures have been selected according to the specific formulation of the batter and technology of sausage production process since environmental factors will interact to select a limited number of strains that are competitive enough to dominate the fermented process (REBECCHI et al., 1998). The indigenous *Lactic Acid Bacteria* (LAB) and *Micrococcaceae*, originated from several Alentejano pig sausages, are well adapted to the ecological conditions of meat cure process, controlling this process and inhibiting the growth of spontaneous microorganisms. The contribution of starter cultures for the safety of the sausages occurs because they are competitive enough to dominate pathogens and spoilage bacteria and also due to organic acids production, mainly lactic acid, and bacteriocins from LAB. Starters promote a rapid acidification reducing microbial risks in fermented sausages, however not all concerns can be solved, mainly in slightly fermented sausages (LEROY et al., 2006). *Pseudomonas*, *Enterobacteriaceae* and aerobic sporeformers are usually not of concern (SAMELIS et al., 1998; AYMERICH et al., 2003) but pathogens like *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* and *Listeria monocytogenes* could keep present in sausages (LEROY et al., 2006).

The purpose of this research work is to improve knowledge concerning the advantages of using autochthonous *Lactobacillus sakei* and *Staphylococcus xylosus* strains in producing a Portuguese traditional sausage called "Chouriço Grosso". This study is part of a pioneer and larger research work concerning the use of starter cultures in sausages from Alentejano pig breed.

Materials and methods

▶ Sausage technology and sampling

At a traditional factory, 100 kg of meat, rich in intramuscular fat thus avoiding the introduction of other kind of fat, were prepared in order to produce "Chouriço Grosso" (dry-cured sausage with cylindrical shape; around 5 cm diameter and about 30 cm long; made with meat and intramuscular fat from Alentejano pig breed, an autochthonous Portuguese breed). Cubic portions of meat, each one with 2.5 cm, were mixed with pimento (*Capsicum annuum* L.) paste (4%), garlic (*Allium sativum* L.) paste (4%), water (3.5%) and salt (3%). Four batches containing each 25 kg of this sausage mixture were prepared. One batch was inoculated with 10^8 cells/g of *Lactobacillus sakei* and 10^8 cells/g of *Staphylococcus xylosus*, a second batch was inoculated with 10^8 cells/g of

Received: 10 May 2010 | reviewed: 6 July 2010 | revised: 6 July 2010 | accepted: 9 July 2010