LWT - Food Science and Technology 65 (2016) 164–172

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Texture, colour and optical characteristics of a meat product depending on smoking time and casing type

Estefanía Ledesma [a, b], Amanda Laca [a], Manuel Rendueles [a, *], Mario Díaz [a, **]

[a] Department of Chemical Engineering and Environmental Technology, University of Oviedo, Faculty of Chemistry, C/Julián Clavería s/n, 33071, Oviedo, Principality of Asturias, Spain

[b] Research, Development and Innovation (R&D+i) Department, El Hórreo Healthy Food S.L, C/Las Cabañas 43-45, 33180, Noreña, Principality of Asturias, Spain

ARTICLE INFO

Article history:
Received 22 June 2015
Received in revised form
20 July 2015
Accepted 30 July 2015
Available online 4 August 2015

Keywords:
Chorizo
Smoked meat products
Casing
Colour
Texture
Microstructure

ABSTRACT

Synthetic casings have recently been found to prevent the penetration of carcinogenic compounds in meat products during smoking, in contrast to natural casings. In this paper, physical characteristics of 48 chorizos encased in natural (ChN) and synthetic (ChS) casings, during 11 days of direct smoking, were compared by means of texturometry, colourimetry, moisture, Scanning Electron Microscopy and Fluorescence Stereo Microscopy analyses. The lightness (L*) of ChS is lower ($p = 0$) than ChN. During 5 days, ChS presented higher hardness and browning index, and less redness (a*), yellowness (b*) and chroma than ChN ($p < 0.05$). At 7 days, no differences ($p > 0.05$) were found in a*, b*, hue angle or chroma. Except at 1 day, no differences ($p > 0.05$) were found in their moisture. Physical characteristics were suitable in both cases, but synthetic casing reduces production time, prevents the penetration and accumulation of soot particles in mass cavities, and enables the standardization of chorizo.

1. Introduction

The consumption of meat and meat products, which contain important levels of protein, vitamins, minerals and essential micronutrients, is growing in developing countries. Meat processing provides the opportunity to add value, reduce prices, improve food safety and extend shelf life. However, unsuitable processing can lead to undesirable health effects and environmental impact (EC, 2013; FAO, 2013). Chorizo is a typical Spanish meat product. In northern Spain and other European countries, chorizo is exposed to direct smoking with the main aim of prolonging its shelf life and conferring sensorial characteristics (Lorenzo, Purriños, Bermúdez, Figueiredo, & García Fontán, 2011). During non-controlled smoking, however, chemical contaminants are also formed, such as polycyclic aromatic hydrocarbons (PAH), dioxins, formaldehyde, nitrogen and sulphur oxides (relevant in the formation of nitrosamines, for instance) and even heavy metals (CAC, 2009). PAH have been found to be carcinogenic for humans (ATSDR, 2009).

In order to protect consumers from PAH contamination, laws and codes of best practices in food processing have been proposed. Regulation (EU) No. 835/2011 of 19 August 2011 (EC, 2011) has recently reduced the maximum permissible content in BaP (a marker of the presence of PAH) in smoked meat and smoked meat products from 5.0 to 2.0 μg/kg in wet weight from 1/9/2014 on. The permissible sum of PAH4 (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene) in these foods has been reduced from 30.0 to 12.0 μg/kg in wet weight from 1/9/2014 on. The "Code of practice for the reduction of contamination of food with (PAH) from smoking and direct drying processes" (CAC/RCP 68/2009) advocates the control of certain variables to prevent PAH contamination. A number of studies have been carried out to test these variables, including the kind of fuel (Hitzel, Pöhlmann, Schwägele, Speer, & Jira, 2013; Pöhlmann, Hitzel, Schwägele, Speer, & Jira, 2012; Stumpe-Vīksna, Bartkevics, Kukare, & Morozovs, 2008), smoking method (Pöhlmann et al., 2012, Pöhlmann, Hitzel, Schwägele, Speer, & Jira, 2013a; Škaljac et al., 2014; Varlet et al., 2007), duration of smoking (Djinovic, Popovic, & Jira, 2008; Essumang, Dodoo, & Adjei, 2013; Ledesma, Rendueles, & Díaz, 2014), fat content (Pöhlmann, Hitzel, Schwägele, Speer, & Jira, 2013b), distance between the food and

* Corresponding author.
** Corresponding author.
E-mail addresses: mrenduel@uniovi.es (M. Rendueles), mariodiaz@uniovi.es (M. Díaz).

http://dx.doi.org/10.1016/j.lwt.2015.07.077
0023-6438/

the heat source, position of the food in relation to the heat source (Pöhlmann et al., 2013b), temperature during smoking and direct drying (Pöhlmann et al., 2012), cleanliness and maintenance of equipment, and design of the smoking chamber and the equipment used for producing the smoke/air mixture (Pöhlmann et al., 2013a). Moreover as a post-smoking treatment, CAC (2009) advocates cleaning the product by rinsing or immersing it in water to remove soot and particles containing PAH from the surface of the food. It has been found that the greatest amount of BaP (and probably other PAH) is deposited in the casing of the meat product, subsequently migrating into the product (Andrée, Jira, Schwind, Wagner, & Schwägele, 2010; Djinovic et al., 2008; García-Falcón, & Simal-Gándara, 2005; Ledesma et al., 2014; Santos, Gomes, & Roseiro, 2011). Some authors have reported that the use of different types of casing influences the PAH content of meat products (Filipovic & Toth, 1971; Toth, 1973). Recent studies (Gomes, Santos, Almeida, Elias, & Roseiro, 2013; Ledesma, Rendueles, & Díaz, 2015; Škaljac et al., 2014) have concluded that the use of synthetic instead of natural casings contributes to reducing PAH levels in smoked meat products. The causes of this effect have been attributed to differences in the morphology and porosity of natural (16.63%) and synthetic (66.84%) casings (Ledesma et al., 2015). In addition to health effect, the food organoleptic profile is an important characteristic for the consumers. Thereby, the influence of natural and synthetic casings on the organoleptic properties of meat products and the physical penetration of soot particles and impurities during smoking process must to be check to define which kind of casing is better for human consumption. Only a few studies have been done from that perspective, such as in some smoked frankfurter-type sausages (Pöhlmann et al., 2013b), but it has never been studied in Spanish chorizo from Principality of Asturias.

The aim of the present study was to compare the physical characteristics (texture, colour, moisture and morphology) of Spanish chorizos encased in natural and synthetic casings during direct smoking time in order to determine which casing is better for producing high quality chorizos, safe for human consumption.

2. Materials and methods

2.1. Preparation of meat products

Two kinds of meat products were prepared for this study: chorizo encased in natural casing (ChN), and chorizo encased in synthetic casing (ChS). Twenty-four chorizos of each kind were manufactured at the El Hórreo Healthy Food S.L. meat company using pork loin (46.8 g/100 g), pork jowl (46.8 g/100 g), salt (1.8 g/100 g), garlic (1 g/100 g), sweet or spicy paprika (2 g/100 g) and herbs (1.6 g/100 g), all of which were minced, mixed and encased. Antioxidants such as sodium citrate or sodium ascorbate, colourings such as carmine, emulsifiers such as sodium triphosphate, food preservatives such as sodium nitrite and other food additives were used to ensure the microbiological stability and quality of the foodstuff. Nutritional analysis of the product was carried out by the Principality of Asturias Meat Industry Association Technological Centre for Supporting Innovation (Spanish acronym, ASINCAR), providing the following results: 31.41 g/100 g moisture content, 22.98 g/100 g protein, 37.94 g/100 g fat, 2.85 g/100 g carbohydrates, 4.82 g/100 g ash and pH 5.2.

A batch of chorizo was processed with the aim of reproducing industrial manufacturing conditions. The minimum amount of chorizo considered as an industrial production volume is 50 kg. If an insufficient amount of chorizo is introduced in the smoking chamber, it could be exposed to an excess of smoke. Thus, 50 kg of raw chorizo ingredients were minced, mixed, marinated and stuffed to obtain 200 strings of chorizo, of which 12 strings (containing 48 chorizos) were analysed. All the selected samples were placed in the same position in the direct smoking chamber at the same distance from the smoke source, namely 10 m. Only oak wood was used for direct smoking of the chorizos. Temperature and humidity parameters in the direct smoking chamber ranged between 7 and 17 °C and 49–100 % respectively, depending on weather conditions and intermittent smoking. One string of each kind of chorizo was sampled at the following smoking times: 0, 1, 4, 5, 7 and 11 days, between 7th and 18th November. Once smoked, the chorizos were hung from a cardboard tube inside a box, avoiding any contact of the materials.

2.2. Apparatus

2.2.1. Fluorescence Stereo Microscope

The external and internal surfaces (once the casing was removed) of the chorizos were studied using a Fluorescence Stereo Microscope (Leica M205 FA, Wetzlar, Germany) to determine the microscopic morphology of the samples.

2.2.2. Texture measurement

In this study, the hardness of ChN and ChS during smoking time (0, 1, 4, 5, 7, and 11 smoking days) was analysed in triplicate. Whole chorizo samples were placed on the heavy duty platform of the texture analyser (TA.XTPlus, Hamilton, MA, USA) and the arm of the texture analyser moved down to penetrate the product before returning to its initial position. A TA-18 rounded end probe with a 12.7 mm diameter stainless steel ball was used for this purpose.

2.2.3. Colour measurement

Chorizo colour measurements (L^*, a^*, b^* CIELAB values) were carried out using an UltraScan VIS spectrophotometer (HunterLab, Reston, VA, USA). The instrument was standardized using a white title and calibration was tested using a green ceramic plate. The Hunter L^*, a^*, and b^* values correspond to lightness, black (−l) or white (+l), greenness (−a) or redness (+a), and blueness (−b) or yellowness (+b), respectively. The colour measurements were performed on chorizos at room temperature (20 ± 2 °C). Three different samples of each kind of chorizo (ChN and ChS) were selected after different days of smoking (0, 1, 4, 5, 7 or 11) and colour parameters were measured 30 times for each chorizo per smoking day.

Total colour change (ΔE; Eq. (1)), hue angle (Eq. (2)), chroma (saturation index; Eq. (3)), and browning index (BI; Eq. (4)) were calculated using Hunter L, a, and b values (Bozkurt & Bayram, 2006; Homco-Ryan et al., 2004; Laca, Sáenz, Paredes, & Díaz, 2010; Maskan, 2001) as:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} = \sqrt{\left(L^* - L_0^*\right)^2 + \left(a^* - a_0^*\right)^2 + \left(b^* - b_0^*\right)^2} \quad (1)$$

$$\text{Hue angle} = \tan^{-1}\left(\frac{b}{a}\right) \quad (2)$$

$$\text{Chroma} = \sqrt{a^2 + b^2} \quad (3)$$

$$BI = \frac{[100 \times (x - 0.31)]}{0.17} \quad (4)$$

where: