Evaluation of Colour and Texture of Chorizo at Different Drying Levels by Quick-Dry-Slice Process (QDS process®)

G. Ferrini, MD Guardia, J.Arnau and J. Comaposada, IRTA, *Food Processing and Engineering*

***Abstract*—The quality of dried meat products may depend on the drying technology used. The purpose of this study was to evaluate the colour and texture of a traditional Spanish fermented sausage "Chorizo" using different drying levels obtained by QDS process® technology. Instrumental colour and texture were determined from fermented chorizo (non dried) and also from the slices at 27, 30 and 33 % dried weight loss. Sensory analysis from dried slices was carried out. L*, a*, b* colour parameter decreased as moisture was decreased. Stress relaxation parameters (F_0, Y_2 and Y_{90}) increased as moisture decreased. Sensorial analysis showed a similar tendency regarding colour intensity and hardness. Therefore, colour and texture of chorizo are affected by a dried weight loss between 27 and 33 %. From an industrial point of view, it is important to control the drying level homogeneity of the slices from the same batch.**

Institut de Recerca i Tecnologia Agroalimentàries, Monells, E- 17121 (corresponding author Josep Comaposada phone: +34-972-630052 (1470); fax: +34-972-630373); e-mail: Josep.Comaposada@irta.cat).

***Index Terms*—drying, fermented sausages, meat, sensory analysis, QDS process**

I. Introduction

DRY-cured meat products are well-known for their unique sensory characteristics. However, the traditional methods are very time consuming but can be reduced by accelerating the drying period, which is the most time consuming part of the process. A Quick-Dry-Slice Process (QDS process®) based on a continuous system that combines both convective and vacuum drying [1] could accelerate the drying of slices after the desired pH is reached in fermented sausages. The aim of this study was to evaluate colour and texture of Chorizo at different drying levels using QDS process® technology.

II. Materials and Methods

A. Preparation of fermented sausages

One batch of chorizo (8 pieces) was elaborated. A mixture of lean and fat meat was minced separately (model PM114, Castellvall S.A., Castellar del Vallès, Barcelona. Spain) at 16 and 12 mm, respectively, and mixed under vacuum with common additives (salt, curing salts (salt, preservative (E-250)), paprika, lactose, dextrose, spices, antioxidant (E-316), colour (E-124), powdered skimmed milk and starter) at 0 ºC for 2 min in a mixer (model AVT50, Castellvall S.A., Castellar del Vallès, Barcelona. Spain). There were stuffed into 70-mm diameter artificial collagen casings (1.8 kg of weight), fermented at 21–23 ºC and a relative humidity of 90–95% until the pH (Crison GLP 21, Crison Instruments, S.A., Alella, Spain) decreased at 4.6, for a maximum of 3 days. Sausages were separated in to two groups (Figure 1). Group A was refrigerated at 1 ± 2ºC for 24 h for an instrumental colour and texture analysis of the sausages after fermentation. Then vacuum packed (model EV-25, Tecnotrip S.A., Terrassa, Spain) and frozen at -10 ºC for at least one week. Group B was vacuum packed and kept frozen at -10 ºC for at least one week for colour and texture analysis after drying.

B. Dry cured process

Slices 1.5 mm thick for QDS process® [1] were obtained from frozen sausages. Each batch for drying (at specific drying weight loss: 27, 30, 33 %) contained 30 slices from different parts of the same sausage (Figure 1). Drying time was from 33 to 43 min and the temperature of the slices was around 8 ºC at the vacuum drying stage (pressure 40 mbar). Dried slices were vacuum packed in plastic bags (Sacoliva S.L., Castellar del Vallés, Barcelona. Spain). Each pack contained 10 overlapping slices (15 mm thick). Then, they were stored in darkness at 2 ±1ºC for 15 days until the colour and texture measurements were carried out.

C. Colour analysis

One colour measurement was taken at each surface of the 12 non dried samples (group A), on the upper and lower surface of each of the 36 packs of 10 dried slices (group B). Each pack of dried slices was considered a sample (Figure 1). A Minolta Chroma Meter CR-300 (Minolta, Co., Ltd., Japan) was used, with a 50 mm port size, illuminant D65 and a 2º standard observed. CIE Lab L*, a* and b* values were determined as indicators of lightness, redness and yellowness.

D. Instrumental texture test

One specimen from each sample was carved with scalpel into parallelepipeds of 20 mm × 20 mm × 15 mm (length × width × height). The specimens were then stored for 24 h at 20 ºC before carried out the instrumental texture analysis. The stress relaxation (SR) test was performed using Universal Analyser TA.TX2 (Stable Micro system Ltd., Surrey, England) with a 5 kg load cell and 50 mm diameter compression plate following the method previously described by Morales et al. [2]. The specimens were compressed to 25% of their original height and a crosshead speed of 1 mm/s. The force versus time after the compression was recorded at a speed of 50 point per second for 90 s (relaxation time). The relaxation curves obtained for each specimen were normalized, i.e., the force decay Y(t) calculated as follow: $Y(t) = F_0 - F(t) / F_0$, where F_0 (kg) is the time initial force and F (t) is the force recorded after t seconds of relaxation. The force decay at 2 s (Y_2) and 90 s (Y_{90}) were calculated. This strategy permitted the analysis of both colour and texture of the same sample.

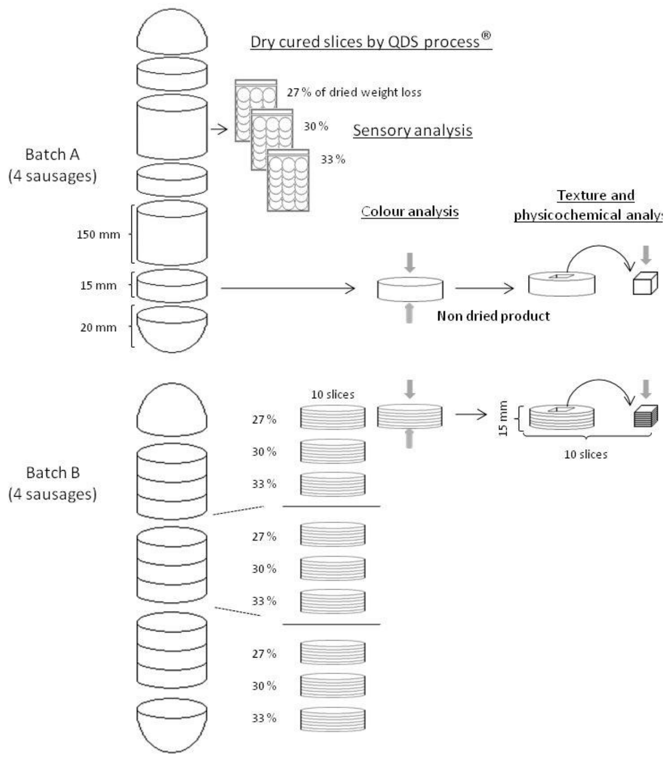

Figure 1. Sampling and analysis procedures used during the experiment

E. *Physicochemical analysis*

The water content [3] and water activity at 25 ºC (AquaLab CX-2 instrument. Decagon Devices, Inc., Washington, USA) of minced samples (specimens included) were determined.

F. *Sensory analysis*

Six selected and trained assessors [4], [5] performed the sensory analysis on the slices of chorizo. The guideline for the descriptors had been carried out by open discussion in three previous sessions. The descriptors retained were: colour intensity (intensity of darkness of the lean), acid taste (basic taste sensation elicited by an acid), intensity of chorizo flavour (intensity of flavour characteristic of chorizo sausages), cohesiveness (tactile texture attribute related to the strength of the interval bonds of chorizo components) and hardness (force required to bite through the sample). A non-structured scoring scale [6] was used, where 0 meant absence of the descriptor and 10 meant high intensity of the descriptor. Sensory evaluation was carried out in 4 sessions and a complete block design was used [7], where each taster assessed all the treatments (27%, 30% and 33% of drying weight loss in each session. Samples were coded with three random numbers and were presented to the assessors balancing the first order and the carry over effects [8].

G. *Statistical analysis*

Results were analyzed using the GLM procedure of SAS version 9.1 [9]. Colour and texture data and drying weight loss level were included in the model as a main factor. The sample was the experimental unit ($P \leq 0.05$). Data from the Quantitative Descriptive Analysis was performed over the mean score (6 assessors) for each chorizo sausage. The model included the type of chorizo (27%, 30 and 33%) and the taste session as fixed effects ($P \leq 0.10$). Means were compared using Tukey test.

III. RESULTS AND DISCUSSION

Fermentation of the sausages caused a decrease in the pH of chorizo from 5.96±0.04 to 4.62 ±0.07. It is well known that the variation in pH during the fermentation period influences factors such as colour [10] and the ability of the meat to retain water [11]. Drying slightly affected the pH, reaching pH 4.78 at water loss of 33%. Other studies have shown that pH increases because of drying [12]. Table 1 shows significant differences between the water contents, and although they are considered small (4.70 to 4.78), L* values decreases with increasing pH. Generally, in meat, a low pH results in a lighter colour, while a higher pH will give a darker colour.

Moisture and water activity decreases with increasing drying weight loss (Table 1), as expected. Colour is affected by moisture, Table 1 shows the tendency of decreasing L*, a*, b* with moisture decrease. Some studies have reported the effect of water content on colour. In this sense, Comaposada et al. [13] showed that when water content decreased L* decreased and a* and b* values increased. Chasco et al. [14] pointed out that main changes in the colour of sausage processing took place during fermentation stage, although the nitrosation of the myoglobin pigment continued during the whole drying process (4 weeks). L* values in the before mentioned study did not shown any relationship to water content, while a* and b* decreased at the end of drying process. From the results reported in Table 1, it could be considered generally that differences of drying weight loss from 27 to 33 % result in significant differences ($P \leq 0.05$), while minor differences in drying weight loss (from 27 to 30 % or from 30 to 33%) are not so clear. Similarly, sensorial analysis did not found significant differences at different drying weight loss, although it is shown that at lower moisture, colour intensity is higher (P ≤0.1), which could also be related to the lower lightness (darker) found in the instrumental colour analysis.

Table 1. LSmeans of physicochemical, instrumental colour and stress relaxation parameters of chorizo samples at 27, 30 and 33% of dry weight loss

	After Fermentation[1]	Drying weight loss, %			
		27	30	33	RMSE[2]
Moisture (%)	59.8	43.1[a]	40.2[b]	39.4[b]	0.598
a_w	0.962	0.904[a]	0.890[ab]	0.868[b]	0.010
pH	4.62	4.70[b]	4.73[ab]	4.78[a]	0.033
L*	49.8	45.9[a]	44.9[a]	42.3[b]	1.593
a*	28.9	25.2[a]	24.6[ab]	23.9[b]	1.117
b*	17.8	15.4[a]	14.3[b]	13.7[b]	0.798
F_0 (kg)	1.52	2.93[b]	3.63[b]	4.65[a]	0.754
Y_2	0.85	2.25[b]	2.94[b]	3.95[a]	0.745
Y_{90}	1.18	2.55[b]	3.24[b]	4.25[a]	0.746

[ab] Within row, least square means with a common letter are not significantly different (*P* ≤0.05)
[1]Not included in the statistical model
[2]Root means square error of the lineal model

Stress relaxation (SR) test parameters are related to moisture. F_0, Y_2 and Y_{90} increase when moisture decreases (Table 1). Similarly, sensory hardness shows a tendency when moisture decreases. As it has been stated in other studies SR test can be a good indicator of the texture [15, 16]. Regarding hardness, no significant differences were found within 27 and 30 % drying water loss. However, 33 % was significantly higher in comparison to 27 and 30% (P ≤0.05).

Cohesiveness, acid taste and intensity of chorizo flavour were also evaluated (Table 1), but no significant differences were found (P ≥0.1).

Table 2. LSmeans of sensory attributes of chorizo at 27, 30 and 33 % of drying weight loss

	Drying weight loss, %			
	27	30	33	RMSE[1]
Colour intensity	5.9	5.8	6.5	0.343
Hardness	3.9	4.0	4.1	0.540
Cohesiveness	4.1	4.1	4.6	0.458
Acid taste	3.7	3.3	3.3	0.256
Intensity of chorizo flavour	5.3	5.4	5.6	0.339

[1]Root means square error of the lineal model

IV. CONCLUSION

Colour and texture are affected by moisture between 27 and 33 % drying weight loss. Therefore, from an industrial point of view, differences between moisture of the slices during QDS processing may result in differences in quality. For that reason, it is important to control the drying water loss homogeneity of the slices into the same batch.

ACKNOWLEDGEMENT

This work was funded in part by the Consorcios Estratégicos Nacionales en Investigación Técnica (CENIT) of Ministerio de Ciencia e Innovación (CENIT-2007-2016-FUTURAL), and in part by Metalquimia and Casademont companies.

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