INFLUENCE OF RIPENING CONDITIONS ON THE pH, COLOUR AND TEXTURE DEVELOPMENT OF SPANISH *SALCHICHÓN.*

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Background.
Spanish salchichon is a stuffed cured meat product, obtained with minced pork or/and beef meat seasoned with curing salt, in some extent similar to salami. In the industrial processing, after starting the product fermentation, a relatively long (3-4 weeks) drying-ripening step was carried out in chambers at controlled temperature (10-45 ºC), relative humidity (65-90 %) and air velocity (0.1-2.0 m/s) (Stiebing, 1988) till a moisture content of 40-45 % was reached. Throughout this period the development of the characteristic flavour, colour and texture of the product takes place (Visier, 1986). Temperature is a determining factor in the process length (Coretti, 1982; Lücke, 1985), although the three ripening variables (temperature, relative humidity and air velocity) affect the development of quality characteristics of the salchichon.

Objectives.
The aim of this work is to analyse the influence of the ripening variables on the changes in pH, colour, and texture of salchichon in relation with the changes in moisture content, for a constant formulation of the product obtained in a single batch.

Methods.
Preparation of samples and experimental design.
Large-White pork meat with pH of 6.1 was used as raw material. This was cut into small pieces and frozen (-18ºC) till formulation. Partially thawed meat was minced and mixed with the other formulation ingredients (potassium nitrate and nitrite, sodium chloride, paprika, skim milk powder and freeze-dried starter cultures) previously diluted in distilled water, in a cutter machine at 4 ºC. Afterwards, the meat mass was left to ferment for 48 h at 5-7 ºC. Then, mass was stuffed in reconstituted (in 3 % lactic acid) collagen casings. The initial size of the salchichon pieces was 6 cm diameter and 19 cm length with a weight of about 500 g.
Previous to drying, a fermentation step was performed at 73 % relative humidity, 25 ºC and 0.3 m/s air velocity in the maturation chamber. The next curing-drying step was carried out in a multi-compartment chamber where ripening variables were set according to the experimental design. Two levels of each variable were considered; relative humidity: 63 and 73 %, temperature: 15 and 21 ºC and air velocity: 0.3 and 0.7 m/s, this yielding 8 different treatments. Throughout ripening (398 h), moisture content, pH, texture and colour were analysed for each treatment.
Analytical determination.
Objective measurements of texture were taken by using a double compression test and by analysing the typical parameters of a Texture Profile Analysis (TPA), (Bourne, 1968): Hardness (H), Springiness (S), Cohesiveness (C), Chewiness (Ch) and Gumminess (G). An Instron 4501 Machine was used with a compression plunger. Compression rate was 10 mm/min and maximum relative deformation was 50 %. For texture measurements cylindrical samples of 2.5 cm diameter and 1.4 cm height were taken out from the centre of the *salchichon* with a borer and tempered at 25 ºC.
Moisture content was determined in the inner cylindrical samples by drying till constant weight according to ISO R-1442 (1979).
Colour in the internal surface of the samples (in a transverse cut) was evaluated from the reflection spectrum in terms of CIELab (L^*, a^*, b^*) and psychometric (hue: h^*_{ab} and chrome: C^*_{ab}) coordinates. A Hunter Ultrascan equipment was used for measuring and D65illuminant/10º observer was taken as reference system.
Determinations of pH were realised with a membrane pulsing electrode (CRISON 406) by direct punction in the centre of the product.

Results and discussions.
In the pH development throughout ripening very small differences can be appreciated among the different treatments. For all cases a fast change in the pH occurred in the first 50 h (from 6.1 to 5.5), while an almost constant value (ranging between 5.2-5.3) was reached after 200 h.. No notable influence of temperature was detected on the pH development despite the results reported by other authors (Baldini, 1981; Stiebing, 1988). In this sense it is remarkable that in the period where the pH changes, drying behaviour in all treatments corresponds to the constant rate period, so product temperature must be the wet bulb temperature in all cases, without notable differences among treatments (Beserra et al. 1998).

Texture development
Figs. 1a to 1e show the values of the TPA parameters as a function of moisture content for the different treatments. The plot of textural parameters as a function of sample moisture would allow us better to detect possible differences in the gel structure, associated to ripening in different conditions. Hardness (peak force measured during the first compression) increases in line with the drying-ripening development (Fig. 1a) as a consequence of the protein gel formation and its progressive aggregation due to water loss. Fig. 1a shows no notable differences among sample hardness behaviour at different ripening conditions in the studied range. However a single significant linear relationship can be established between hardness and sample moisture for all treatments.
Development of springiness (percentage of sample high recovery after the first compression) and cohesiveness (area ratio of the second and first curve compression) for the different treatments appeared in Figs. 1b and 1c respectively. A fast increase in both

parameters can be observed during the first period of ripening till sample moisture reached about 60-61 %. This period corresponds to about the first 200 h of drying at which time the pH also attained an asymptotic value of 5.3 and protein gel was formed. From this moisture value all samples achieved constant values of S and C independent of tested ripening conditions. In the increasing S and C period a greater dispersion in the distribution of the experimental points in the plot could be observed. This can be attributed to fluctuations in the protein gel state, associated with different factors, but not clearly affected by the experimental variables in the studied range.

The combined parameters Gumminess (Hardness x Cohesiveness) and Chewiness (Gumminess x Springiness) increase linearly in line with the moisture reduction (Figs. 1d and 1e), also independently of ripening conditions.

Colour development.

Figs. 1f to 1h show the development of colour psychometric co-ordinates luminosity (L*), chrome (C^*_{ab}) and hue (h^*_{ab}) in the CIEL*a*b* colour space, as a function of the sample moisture content for each treatment. Colour development in cured meat products is greatly affected by the curing salts through complex reactions occurring throughout ripening. Nevertheless, water content also affects colour and therefore, this variable has been taken as the advance index of ripening-drying of the samples. Fig. 1f shows a fast sample browning in the first period (about 64 d), reaching an almost stable value of L* from the control at 136 d in all cases. Differences among treatments are not significant taking into account the standard deviations of experimental measurements. Only the treatment at 15ºC, 63 % relative humidity and 0.7 m/s air rate seems to promote a slightly higher darkening of the product.

The chromatic co-ordinate a* slightly increases throughout the first 200 h of drying and afterwards decreases till near the initial value. Nevertheless b* co-ordinate exponentially decays from 13.7 to about 6-7 during ripening. As a result chrome and hue change as shown in Figs. 1g and 1h. An exponential decrease of chrome and hue in line with drying can be observed with notable differences among different treatments. As occurs for L*, the main changes in C^*_{ab} and h^*_{ab} take place in the first ripening period till about 50 d.

Conclusions

In the studied range, drying conditions, temperature, relative humidity and air rate did not significantly affect psychometric colour co-ordinates and TPA parameters of *salchichon*, time and moisture content being the determining variables of textural and appearance parameters.

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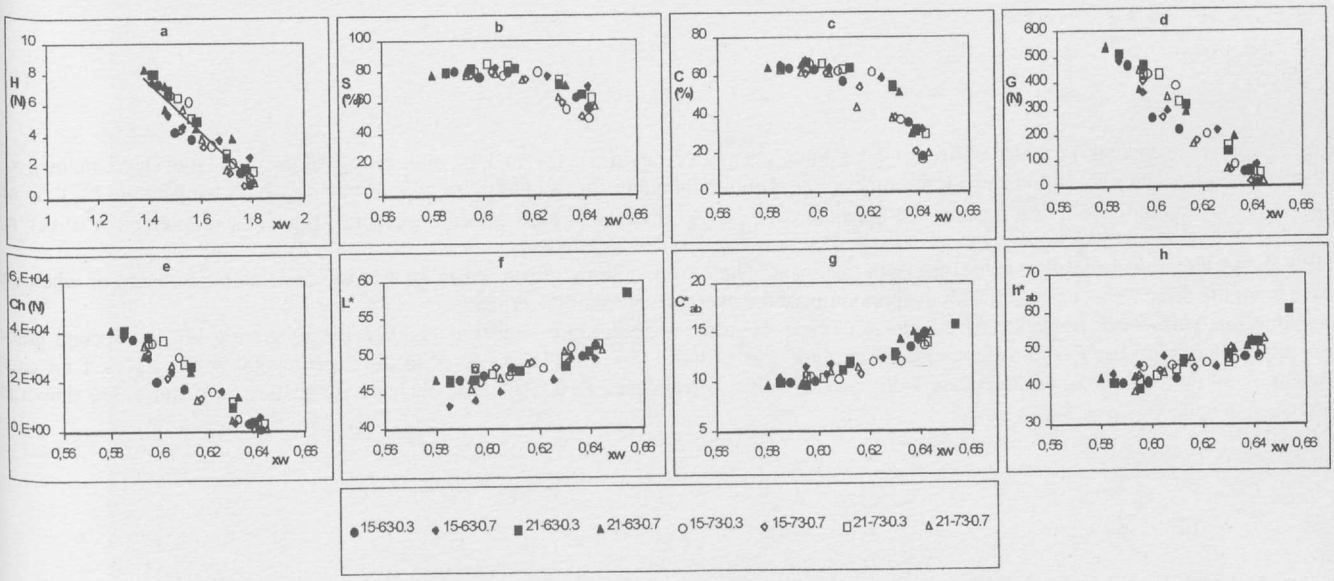

Figure 1.- Development TPA parameters (a to e) and colour co-ordinates (f to h) throughout ripening in the internal part of *salchichon* for the different treatments (temperature-relative humidity-air velocity)