EFFECT OF THE USE OF NATURAL OR ARTIFICIAL CASINGS ON THE RIPENING AND SENSORY QUALITY OF DRY SAUSAGE.

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INTRODUCTION

Quality of raw fermented sausages is influenced by a number of parameters which govern sausage ripening; among them especial attention has been paid to temperature, relative humidity and air velocity (Klettner and Rödel, 1978; Baumgartner et al., 1980; Mendoza et al., 1983). The influence on ripening and sausage quality of a variety of ingredients has been even more extensively studied. However, despite our knowledge of the properties of diverse sausage casings is rather good (Effenberger, 1985), the effect of the use of different kinds of casing on sausage quality is not well known. Rödel and Klettner (1980) reported small differences on dry sausage ripening by effect of using natural or artificial casing, while Böhme (1984) described large differences in quality among cooked sausages related to the use of diverse casing materials.

Though, both reports deal with sausages lacking a mould cover, which has been repeatedly shown to exert a noticeable influence on dry sausage quality (Dragoni and Cantoni, 1984; Grazia et al., 1986; Lücke, 1986).

Thus, we have studied the effect of using either a natural pork casing or an artificial fibrous collagen casing on the ripening and sensory quality of a mouldy dry fermented sausage. For this study, a sausage of high comercial interest in Spain known as «fuet» was selected, whose determinant characteristics are those of a small calibre, coarse and mouldy salami.

MATERIALS AND METHODS

Sausages were prepared by a local manufacturer according to usual practice. Each sausage, averaging 340 g in weight, contained 70% lean pork, 25% pork back fat, 2.3% salt, lactose (1.7 g), glucose (680 mg), black pepper (680 mg), white pepper (680 mg), nutmeg (250 mg), sodium glutamate (340 mg), sodium ascorbate (170 mg), posphates (680 mg), nitrate and nitrite (85 mg), colouring (E-124, E-127) and starter culture (Pediococcus spp.). Mixture was stuffed into either pork or fibrous collagen casings of 34-38 mm diameter. Sausages were held 24 h at 28^{0}C (90% RH) and then transferred to a drying room, which was a well aerated chamber subject to natural climatic conditions, and ripened for 30 days. During this period temperature ranged from 11^{0}C to 14^{0}C and relative humidity varied from 75% to 80%. Samples were taken at different ripening times: 1, 5, 10, 15, 20, 25 and 30 days. A sufficient amount of sausage was ground after removing the casing to a particle diameter smaller than 1 mm, using a commercial meat grinder. The resultant mixture was used for all analyses.

Moisture determination. About 3 g of sample were exactly weighed and held at 102 $\pm$ 2^{0}C for 19 hours;

after cooling the sample was weighed again. Water content was expressed as the percentage of the difference between initial and final weight related to initial value.

Fat content was determined using a Soxhlet method (ISO/R 1443).

Nonprotein nitrogen determination. Ten g of sample were homogenised for 1 min in 35 ml distilled water using an Ultra-Turrax homogeniser. Seven ml 10% TCA were added to the homogenate and, after maintaining the mixture 2 h at 4°C, it was centrifuged for 20 min at 1000xg. The supernatant was filtered, evaporated and protein content determined by a Kjeldalh method (ISO/R 937).

Free fatty acids (FFA) determination. Fat extraction was carried out with chloroform-methanol solvent (2:1 vol/vol). Then 25 ml were removed and mixed with 25 ml 96% ethanol. The mixture was titrated with NaOH 0.1 N. The acidity was calculated as oleic acid (Pearson, 1976).

Microbiological analysis. Three casing portions of 1 cm^2 surface were taken from different areas of each whole sausage. Samples were suspended in sterile physiological solution and suitable dilutions were made before plating. Total superficial mould and yeast counts were determined on Sabouraud Chloramphenicol agar incubated at 20°C for 7 days. After microculture on Sabouraud agar, isolated moulds were identified by microscopical observation techniques according to Ramirez (1982). Yeasts were stained by Gram and Giemsa methods and observed microscopically.

Light microscopy of sausage cross sections. Samples for microscopical observation were taken at the end of sausage ripening. Five µm thick sections were cut from small pieces of sausage with a microtome and stained with hematoxiline-eosine. A Leitz (Dialux 20 EB) microscope was used for observing the stained sections and photographs were taken using a Nikon (model FX-35A) camera.

Sensory analysis. Sausages were evaluated for 19 quality-related sensory parameters at the end of ripening by a panel of twenty semi-trained members. A 9-point scale was used, 9 denoted highest value for each parameter evaluated and 1 denoted lowest value. Analyses were performed in three separate sessions; in each of them a different group of sensory parameters was evaluated. First whole sausages were presented to panelists for valoration of external perception. Thereafter panelists evaluated 3 mm sausage slices for cut external perception and finally similar slices, after removing the casing, were presented to each panel member for mouth perception evaluation.

RESULTS AND DISCUSSION

«Fuet» sausages were ripened under natural conditions (11-14°C; 75-80% R.H.) for 30 days after a short phase of fermentation at 28°C for 24 hours (90% R.H.). Along the whole fermentation and ripening period the following physical and chemical parameters were measured: moisture content, pH, free fatty acids and nonprotein nitrogen.

Figure 1 shows moisture evolution along sausage ripening for both casing materials used. It appears evident that

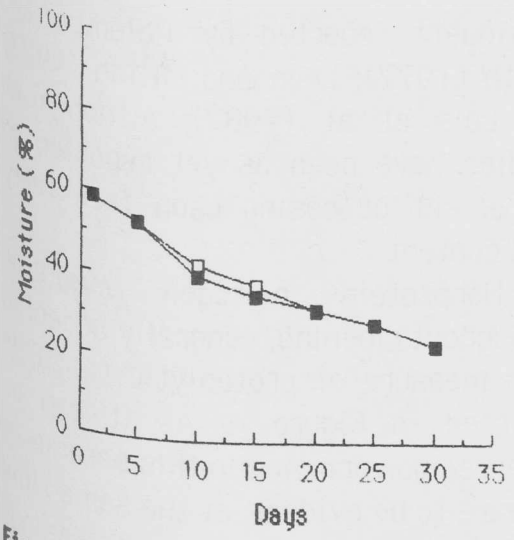

Figure 1.- Evolution of moisture content (%) throughout sausage ripening. (■ natural casing, □ artificial casing).

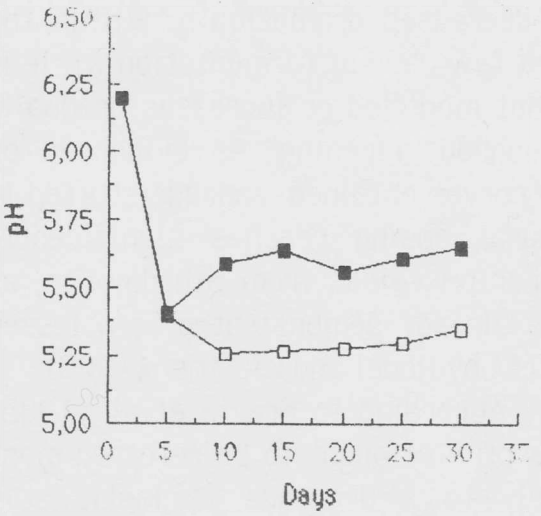

Figure 2.- Changes of pH during ripening process. (■ natural casing, □ artificial casing).

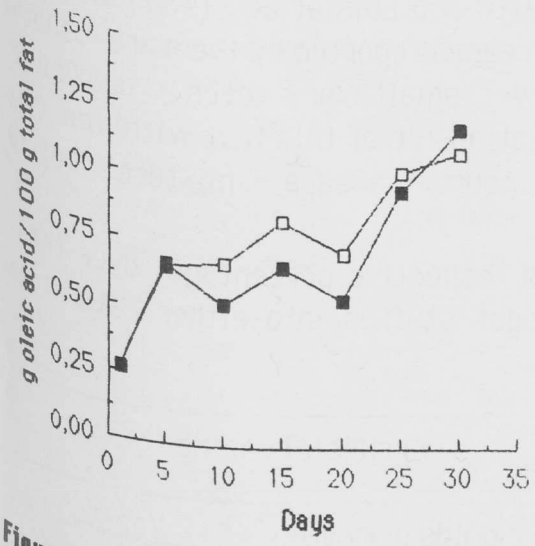

Figure 3.- Evolution of Free Fatty Acids, expressed as percent of oleic acid/100 g of fat, along ripening. (■ natural casing, □ artificial casing).

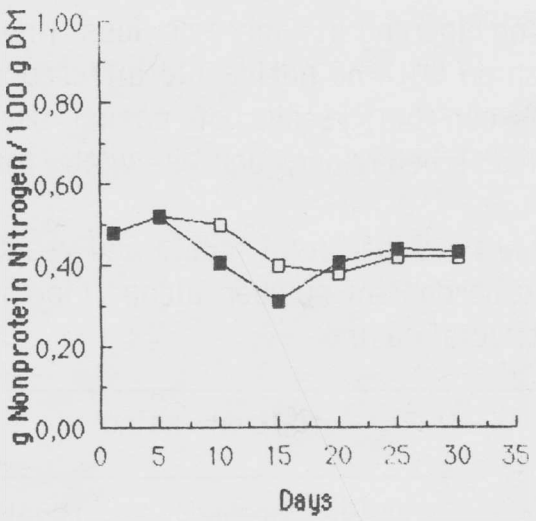

Figure 4.- Changes of nonprotein nitrogen fraction during sausage ripening. (■ natural casing, □ artificial casing).

in both cases moisture content undergoes an important decrease, in agreement with previous reports for similar sausages (Rödel and Klettner, 1980; Baumgartner et al., 1980; Lois et al., 1987), non dependent on the type of casing used in accordance with their almost identical permeabilities to water vapour as described by Effenberger (1985).

Changes in pH along ripening for both types of sausage are shown in Figure 2. In agreement with most prior research reports (Baumgartner et al., 1980; Rödel and Klettner, 1980; Barranco et al., 1985; Lois et al., 1987)

pH decreases dramatically within the first few days of fermentation while it is not modified or increases gradually throughout ripening. As evidenced by the curves obtained, sausage stuffed in natural casing reaches significantly higher pH values from 5th day on, as was already demonstrated to a lesser extent by Rödel and Klettner (1980).

According to Grazia et al. (1985) this pH rise ought to be referred most likely to a decrease in lactic acid content rather than to ammonia formation, and it is to be related to mould mycelia colonization of sausage mass and casing.

As shown in Figure 3 free fatty acid content increases considerably along ripening in a more or less lineal fashion with no noticeable differences between both types of casing used. General behaviour agrees with that previously reported by Palumbo and Smith (1977), León and Millán (1977) and Lois et al. (1987), although no studies have been as yet reported on the effect of casing upon free fatty acid content.

Nonprotein nitrogen evolution throughout ripening, generally accepted as a measure of proteolytic reach, is depicted in Figure 4. As it can be observed no variation in this parameter appears to be evident, at the same time that no differences between casings used are noticeable. This somehow surprising result is in disagreement with those described by Dierick et al. (1974), Bello et al. (1974), León et al. (1978) and Lois et al. (1987), although increases reported by them are usually very small or even negligible. Relationship of this fact with the use in our sausage mixture of a

Table 1.- Superficial mould and yeast counts and respective percentage over total microorganism number along ripening of sausages stuffed into either natural or artificial casing.

	Natural casing				Artificial casing			
	Moulds (Penicillium)		Yeasts		Moulds (Penicillium)		Yeasts	
Days	No/cm^2	%	No/cm^2	%	No/cm^2	%	No/cm^2	%
1	4.16×10^2	47.05	1.64×10^2	18.54	2.37×10^2	0.65	1.80×10^4	50.20
5	2.22×10^3	20.83	8.90×10^4	80.20	4.16×10^5	50.29	4.10×10^5	49.4
10	1.49×10^6	71.34	6.00×10^5	20.09	1.05×10^6	42.59	1.40×10^6	57.41
15	2.06×10^6	83.07	4.20×10^5	16.95	1.72×10^6	59.67	1.16×10^6	39.84
20	2.49×10^6	94.28	1.50×10^5	5.72	2.28×10^6	73.43	8.20×10^5	26.54
25	1.92×10^6	92.16	1.30×10^5	6.40	1.13×10^6	65.38	6.00×10^5	34.62

Pediococcus starter culture is nevertheless not known.

Microorganism identification and counting on sausages along ripening has been carried out only in both casings peeled away from sausage content, since the influence of the presence and number of Lactobacilli and Micrococci or related Bacteria on sausage quality has been already sufficiently investigated for this type of sausage.

Table 1 presents data obtained on counts of total moulds (Penicillium spp.) and total yeasts present in natural and artificial casings along ripening of respective sausages. Moulds are present to a little extent immediately after stuffing in both skins, while they increase thereafter their number. This rise is more rapid in artificial casing, but counts from 10th day on behave in a similar manner. At the end of ripening their number is slightly higher in natural casing, constituting a much larger percentage of total microorganisms present than in artificial casing.

Yeasts are by far more abundant in artificial casing at the first day of ripening, being their numbers always slightly higher than that of natural casing until the end of ripening and, contrary to moulds, their percentage of total microorganisms present is larger than in natural casing.

Although no available data have been found in the literature to discuss our findings, it has been repeatedly shown the importance of moulds (Dragoni and Cantoni, 1984; Grazia et al., 1986, Lücke, 1986) and yeasts (Comi and Cantoni, 1980) on ripening of dry sausage, modifiying positively its sensory quality.

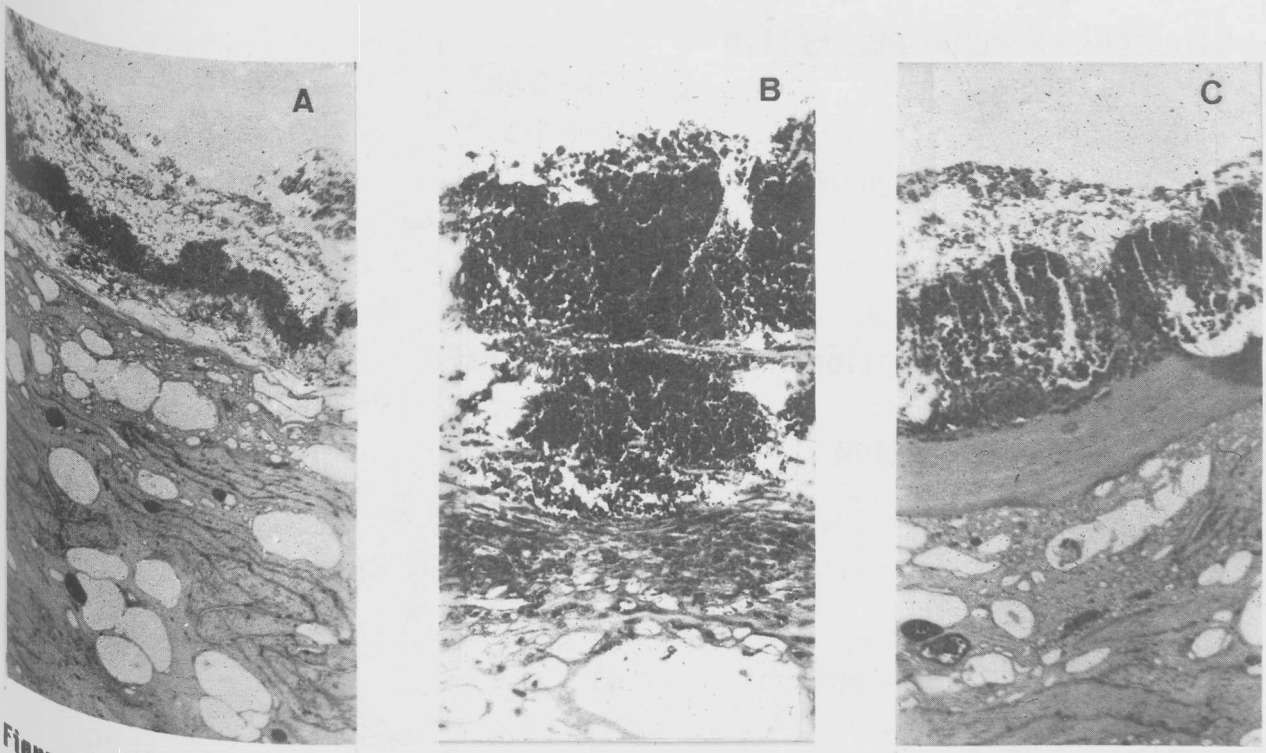

Figure 5.- Light micrographs of 5 µm thick cross sections (outer zone) of «fuet» sausages ripened for 30 days, stuffed in either (A) natural pork casing x 100, (B) natural pork casing x 250 and (C) artificial fibrous collagen casing x 100.

With a view to understand the close relationship established between mould mycelia and sausage casing, micrographs of sausage cuts were obtained, as are shown in Figure 5. Thinner natural skin (A) seems to disappear as it is totally colonized by mould mycelia. Further magnification of another section of the same cut (B) shows how mycelia penetrate and disintegrate casing natural tissue. Thicker artificial casing (fibrous collagen) (C) appears to be not colonized by mycelia, although it is also supposed to constitute no barrier for mycelia growth across skin

Table 2.- Sensory panel scores on a 9-point scale for sausages stuffed into either natural or artifical casing ripened for 30 days; 9 denoted highest value for each parameter evaluated and 1 denoted lowest value.

Sensory parameters	Natural casing	Artificial casing
Whole sausage external perception		
Visual appearance	$6.17 \pm 1.03^{a*}$	6.37 ± 1.50^{a}
Mould cover	6.30 ± 1.41^{a}	8.22 ± 0.73^{a}
Resistance to pressure	8.00 ± 0.71^{a}	8.19 ± 0.51^{a}
External smell: - Intensity	6.09 ± 0.82^{a}	2.53 ± 0.93^{c}
- Quality	6.83 ± 0.96^{a}	5.15 ± 1.33^{c}
Overall external perception	**6.28 ± 1.05^{a}**	**6.10 ± 1.06^{a}**
Slice cut external perception		
Visual appearance	7.33 ± 0.98^{a}	6.90 ± 1.09^{a}
Total fat	5.03 ± 1.35^{a}	4.75 ± 1.39^{a}
Easiness of casing removing	2.87 ± 1.26^{a}	8.40 ± 0.74^{c}
Smell: - Intensity	6.75 ± 1.17^{a}	5.89 ± 1.33^{b}
- Quality	7.33 ± 0.72^{a}	6.83 ± 1.19^{a}
Colour	7.20 ± 0.65^{a}	6.37 ± 0.97^{c}
Overall cut perception	**7.03 ± 0.74^{a}**	**7.10 ± 0.87^{a}**
Slice mouth perception		
Flavour: - Intensity	7.47 ± 0.66^{a}	7.10 ± 0.87^{c}
- Quality	7.53 ± 0.66^{a}	5.97 ± 1.04^{c}
Toughness	6.78 ± 0.70^{a}	6.28 ± 1.11^{a}
Juiciness	6.87 ± 1.01^{a}	6.40 ± 0.81^{a}
Overall mouth perception	**7.41 ± 0.45^{a}**	**6.17 ± 0.94^{c}**
Overall acceptability	**7.50 ± 0.68^{a}**	**6.31 ± 0.79^{c}**

*Means within the same row not followed by the same letter are significantly different (b: $p < 0.10$, c: $p < 0.01$).

material into sausage filling.

Nevertheless, the closer relationship existing among mould, natural casing and sausage is evident, which appears to be consistent with the higher pH reached in this sausage according to Grazia et al. (1986).

Table 2 shows results obtained in the sensory evaluation of both types of sausage. First to point out is the fact that «fuet» stuffed in natural casing is rated at least similar but in most cases with a higher quality scoring than that stuffed in artificial skin, with the sole exception of easiness of casing removing ("peeling"), which is significantly higher in the latter. It must be emphasized that intensity and quality of smell and flavour are always significantly higher in natural «fuet», as well as the overall mouth perception and overall acceptability scores.

As discussed before, this superior sensory quality of «fuet» sausage stuffed in natural casing is to be referred to a higher pH after the fermentation phase reached along ripening, due most likely to the effect of a larger colonization of natural casing by superficial moulds. A negative effect of high yeasts counts could also be taken into consideration.

CONCLUSIONS

Dry fermented sausage «fuet» possesses a superior sensory quality when stuffed into natural casing as opposed to artificial fibrous collagen casing. This fact appears to be related to a higher pH of the former along ripening, most probably due to a larger colonization of natural casing tissue by superficial moulds.

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