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An objective index for the evaluation of the ripening of salted anchovy

B. FILSINGER, C. A. BARASSI, H. M. LUPIN* AND R. E. TRUCCO

Summary

Salted anchovies were conditioned in order to allow ripening in brine. A sensory panel procedure was developed to systematically follow the process.

This sensory evaluation was carried out for up to 328 days, and the results indicated 10 months as the minimum time required to obtain an adequately cured product.

Total ester index was determined at the successive stages of anchovy ripening. There was a close correlation between total ester index and sensory score between 100 days and 328 days of ripening. This relationship to storage time and to sensory assessment supports the use of total ester index as an objective method to follow and assess the later stages of this little known process.

Introduction

Salting and curing of anchovies is a traditional process used by Mediterranean fishermen to obtain a product with a tender consistency and specific pleasant aroma and taste as a result of enzymic activity on the fish flesh.

The reproduction of *Engraulis anchoíta* takes place all year round, but there are two principal periods of spawning, the main one taking place during October–November and the second during May–June (Bellisio, López & Torno, 1979).

From experience it has been observed that the desired ripening reaction takes place only in *E. anchoíta* caught during the October-November period and this fish is suitable as raw material for semi-preserves.

Authors' address: Instituto Nacional de Tecnología Industrial, CITEP, 12 de Octubre 4728, 7600 Mar del Plata, Argentina.

*Present address: FAO, Via delle Terme di Caracalla, 00100 Roma, Italia.

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In spite of the antiquity of the process, there is a marked lack of reports on the curing of anchovies and most of the knowledge about the process is empirical (Cheftel, 1965).

The minimum time described for the ending of maturation is 6 months for anchovies in Spain (Kemp, 1973), and 8 months for *E. anchoíta* (Mattos *et al.*, 1977). After these periods of time, an adequately cured product is suitable for the preparation of several subproducts, such as pickled fish, salted fish, fish sauce, or anchovy paste, all of them with the same characteristics as those obtained using European anchovies.

In spite of the importance of the ripening process, visual inspection and tasting are still the usual methods of following the process (Thackaberry, 1979).

Chemical changes have been described during the salting and ripening of Atlantic herring (Plorina & Leonova, 1970) Baltic herring (Podeszewski, Stodolnik & Otto, 1975) Caspian herring (Konnova, 1966) Siberian cisco fish (Sedova & Emel'yanova, 1976) and anchovies (Baldrati *et al.*, 1977; Establier & Gutierrez, 1972; Lee & Choe, 1974). Some of those changes could be used as maturation indices (Sedova & Emel'yanova, 1976; Mattos *et al.*, 1977). However, a systematic attempt to find a reliable and objective parameter to follow and assess the different stages of fish ripening in brine has not been made. The objective of this work was to undertake an investigation on the applicability of the total ester determination as an objective method of following the anchovy maturation process, compared with the sensory assessment. A systematic arrangement of sensory scores based on flavour, colour, odour, flesh consistency and flesh adherence to backbone was also developed in order to follow the ripening of salted anchovy.

Materials and methods

Anchovy salting, packing and ripening in brine

Anchovies (*E. anchoíta*) were caught on the Argentinian platform in the south-eastern Atlantic Ocean from *ca.* 37.4°S to *ca.* 38.8°S during spring, when they arrived at the coast for spawning. Fish samples were obtained from commercial vessels and were immediately immersed at *rigor mortis* stage in saturated brine in plastic boxes after their arrival at the laboratory. After 24 hr of brining, the fish were manually beheaded and partially gutted in the same operation, and then returned to strong salt solution in order to wash them thoroughly. The washed anchovies were packed in 10-kg tins, in layers with two fish in each layer being at right angles to each other. There was close contact between the different layers of fish, and dry salt was not added, except at the bottom and the top of packed fish. The average fish content was 7.3 kg. One hundred and twenty grams of dry salt was put into the bottom of each can and a further 120 g was also scattered, when packing was completed, on top of the last layer of fish.

A round piece of wood was placed on the top layer of salt and pressed to a maximum of 80 g/cm^2 by means of heavy weights on top of the wooden disk. Due to the applied pressure and to the osmotic effect of the salt, extruded liquid containing biological material in brine was produced, which completely covered the fish.

The cans were stored for ripening in a cellar at 18–22°C under the above mentioned pressure for a period up to 400 days.

Sensory assessments

At regular intervals, anchovies were taken from different cans in order to obtain representative samples. The anchovies were washed with running water to remove extruded liquid and then were organoleptically evaluated by a panel of at least three people experienced in judging fish quality. The assessors were previously trained in the fish processing industry according to the current methods used to assess the degree of ripening of salted anchovy. Based upon personal communications with fish processors, a scoring method to follow the anchovy ripening process was developed. This is shown in Table 1. A scale of

Table 1. Organoleptic panel.

	Sensory score				
Factor	0	2	4	6	8
Flavour (disregarding salt)	Raw fish	Neutral	Slightly ham-like	Ham-like cured meat	Rancid off-flavours
Flesh colour	Natural fresh fish	Natural around borders, deep red in the middle, pink in between	Light pinkish meat, deep red or pink in the middle	Uniformity in the pink tone distribution	Dark red, black, red blots and/or black dots
Odour	Fresh fish	Neutral (smells like brine)	Smooth agreeable odour to volatile esters	Smells of agreeable volatile esters. 'Characteristic anchovy odour'	Rancid, acid, ammoniacal or sulphurous off-odours
Flesh consistency	High elasticity, damp	Less elasticity, less damp	Slight elasticity, more compact, does not feel damp	No elasticity, firm and resistant to finger pressure	Flimsy
Flesh adherence to backbone	Very adherent, does not separate	Very adherent, does not separate easily	Adherent, it separates (incomplete filleting)	Very little adherence, it separates neatly (adequate filleting)	Flesh gets torn in the filleting process

points from 0 to 8 is proposed to replace the ambiguous 'unripe' or 'green', 'ripe' and 'over-ripe' terms which are traditionally used by the expert tasters of the fish processing industry. The odd numbers were reserved to intermediate stages. Number 8 corresponds to deteriorated or over-ripe anchovy. A fish is assigned a score for each factor according to the descriptions in the Table. The average of the five considered factors was taken as the score for the fish. The final score given to the sample was the average of at least eighteen specimens, evaluated in groups of six, by three or more assessors.

Total ester index

The method used was a modification of that given in the Official Methods of Analysis of the AOAC (1970, method No. 9.125). Ten grams of anchovy paste obtained from fillets were ground in cooled, distilled water in a Virtiss homogenizer and made up to 100 ml. Aliquots of 20 ml were taken after adjustment to volume for the determination of ester indices. Since the measurements were done in aqueous homogenates instead of purified lipid extracts, the values obtained are representative of total ester indices, including the saponification indices. Results were expressed in gKOH on a dry weight (CDW) basis. Dry weight was obtained after dessication of 20 g of anchovy paste in a oven at 100±5°C up to a constant weight. The residues were ground in a mortar to a fine meal and representative 2 g samples were quickly taken and transferred to beakers. Approximately 150 ml of distilled water were added to each beaker and the solution boiled for 5 min. After cooling, the suspension was filtered through glass wool to a 250 ml volumetric flask. Aliquots of 10 ml were taken for NaCl determinations according to Mohr's method as given in the Official Methods of Analysis of the AOAC (1970, method No. 50.028). Corrected dry weight was calculated by subtracting the salt content from the weight obtained by drying.

Statistical analysis

The experimental curves were mathematically expressed as empirical models. The functional form

$$\tan[(y-a)\,z] = mx+b$$

was chosen for the sensory assessments *vs* days and for the total ester index *vs* days curves. Parameters a and z were chosen by a trial and error method. Parameters m and b were estimated by the regression analysis procedure from least squares estimates (Himmelblau, 1970).

Statistical analysis carried out by a model such as $y = A+Be^{-kx}$ had no special advantages on the tangent transform system (data not shown). Moreover, the proposed functional form can be used to analyse data by means of a small personal programmable calculator instead of requiring a computer when an exponential model is used.

Results and discussion

Visual inspection and tasting are still the usual methods of following anchovy-ripening in brine (Thackaberry, 1979). However, there are no references on the use of a sensory panel to follow the maturation of salted anchovy. Assessment of the changes in the sensory characteristics of anchovies during ripening in brine was made using the scoring system described in Table 1. This procedure, based on the evaluation characteristics empirically used by the producers, allows for the systematic assessment of the ripening process.

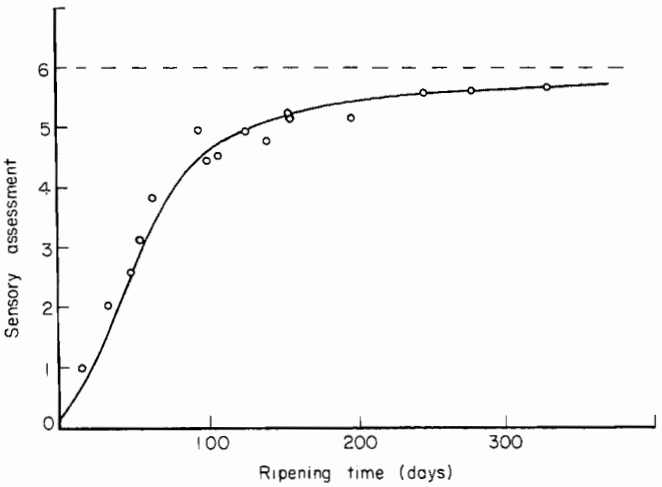

Figure 1. Sensory assessment during ripening time of anchovy. Each point is representative of at least eighteen samples, and is the average of the sensory characteristics evaluated according to Table 1. Results are representative of experiments performed during 1979 and 1980.

Figure 1 shows the sensory scores obtained during ripening of anchovy in brine. The line

$$\tan [24(y-2.25)] = 0.027x-1.191 \qquad (r = 0.982) \qquad (1)$$

where y is the sensory score and x is the ripening time (days), fits the experimental data presented in Fig. 1. Although the most pronounced sensory changes took place within the first 100 days of ripening, the anchovy were not yet ripe. It can be observed that the curve tends toward an asymptotic value after 10 months, which can be considered to be the time normally required to obtain a fully maturated anchovy. A maturation period of approximately 8 months has been reported for *E. anchoíta* (Mattos *et al.*, 1977). The differences from the results presented here could be due to the wide temperature range (11-30°C) described by these authors, the biological condition of the anchovies used or to differences in the technological process used, such as the salt content, pressure employed, and others.

The total ester indices obtained during the ripening of anchovy are presented in Fig. 2. Starting from 90 days of anchovy ripening, the total ester index determinations plotted against time showed a hyperbolic shape (Fig. 2) which had similar asymptotic characteristics to that of the organoleptic assessments *vs.* time (Fig. 1). The line

$$\tan [22.5(y-5.85)] = 0.008x-1.396 \qquad (r = 0.914) \tag{2}$$

where y is the total ester index determination (gKOH/100 gCDW) and x is the ripening time (days), fits the experimental data presented in Fig. 2. Despite the good correlation obtained for the data shown in Fig. 2, results obtained during the first 90 days of ripening varied between 3.19 and 9.30 gKOH/100 gCDW. This wide variation rules out the use of the total ester index determination as a method to follow the first stages of the anchovy ripening process. However, it is necessary to wait a further 200 days in order to obtain a fully ripe anchovy despite the fact that the sensory score during that period changed more slowly than during the first 100 days of ripening (Fig. 1). In contrast, the total ester index showed a systematic change after only 90 days of anchovy ripening and in such a way, could be used to follow both of the later third stages of the process (Fig. 2).

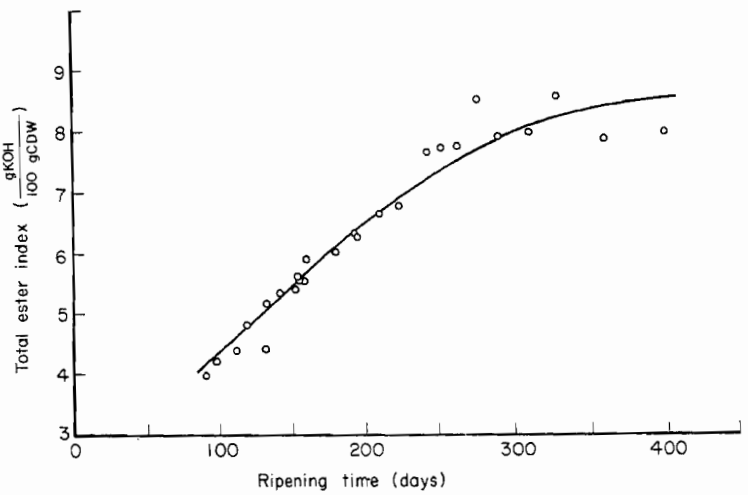

Figure 2. Total ester index during ripening time of anchovy. The points presented are the average of at least three individual determinations and results are representative of experiments performed during 1977, 78, 79 and 80.

Figure 3 shows the relationship between the total ester index plotted on a logarithm scale and the sensory score during anchovy ripening. In the same figure the points calculated from equations (1) and (2), and the experimentally obtained values are plotted respectively. A linear correlation can be observed,

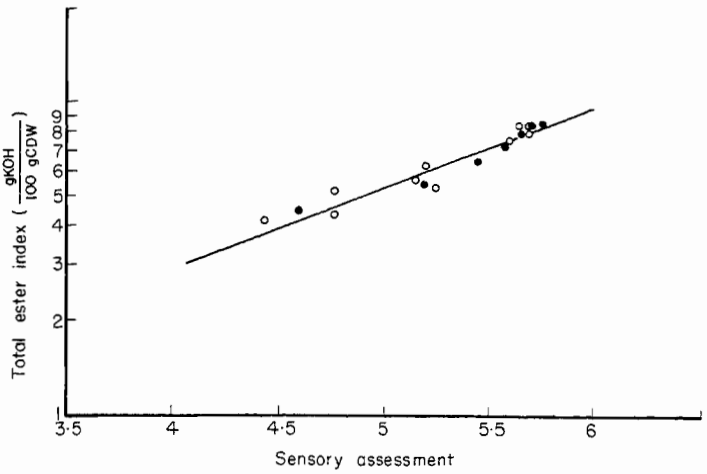

Figure 3. Total ester index *vs* sensory assessment. ●, calculated from equations (1) and (2) given in the text; O, experimental results obtained during 1979 and 1980.

and as much as the resulting equation and the correlation coefficient are the same in both circumstances:

$$y = 0.3136.\ e^{0.5706x} \qquad (r = 0.968)$$

where y is the total ester index determination (gKOH/100 gCDW) and x the organoleptic score.

These data support the total ester index determination as a valid proposition of an objective method to follow and assess the process of anchovy ripening in brine.

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