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Increase on free fatty acids during ripening of anchovies (*Engraulis anchoíta*)

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Summary

The changes of free fatty acids (FFA) during the ripening of salted anchovy was studied. In the course of the curing process, the content of free fatty acids (FFA) in the muscle increased fifteen-fold, mostly in the first 100 days of the process. Each sample was subjected to sensory evaluations. A high correlation between FFA contents and sensory scores was found. Therefore the determination of FFA is proposed as an objective index to assess the ripening of salted anchovies.

Introduction

The need of a non-sensory index to evaluate the ripening of cured fish instead of sensory assessments, such as that proposed by Thackaberry (1979), is widely accepted.

Several methods based on the chemical changes which take place during the salting and ripening of fatty fish have been reported for different species: Atlantic herring (Plorina & Leonova, 1970); Baltic herring (Podeszewski, Stodolnik & Otto, 1975); Caspian herring (Konnova, 1966); Siberian cisco fish (Sedova & Emel'yanova, 1976); and anchovies (Baldratti *et al.*, 1977; Establier & Gutiérrez, 1972; Lee & Choe, 1974).

The total ester index has been proposed by Filsinger *et al.* (1982), as a chemical index to assess the ripening of anchovies starting at about 100 days of curing. The possibility of using the determination of total volatile basic nitrogen has also been studied (Filsinger, Barassi & Lupin, 1984).

The purposes of this work were to determine the evolution of FFA during the ripening of anchovies, and to study the possibility of using the quantitative determination of FFA content to evaluate the curing of fish throughout the process.

Materials and methods

Anchovy salting, packing and ripening in brine

Fresh anchovies caught on the sea platform during spring, were salt cured during each one of 3 consecutive years. Fresh fish were put in saturated brine, and after 24 hr, fish were beheaded, gutted and washed. Washed anchovies were packed in 10 kg tins, with a total of 240 g salt scattered in the bottom and top of the fish pack. The final fish to salt ratio was approximately 30.

A maximum pressure of 80 g/cm^2 was applied to salted fish, which were stored in a basement at 18–22°C for up to 300 days. During that period an extruded brine

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containing biological material completely covered the fish. This general procedure has already been detailed (Filsinger *et al.*, 1982). At lest twenty-four batches of salted fish were prepared each year.

Sensory assessment

Fish samples were taken at different curing times. Eighteen anchovies were taken from different cans to obtain representative samples. Each anchovy was organoleptically evaluated and scored by a panel of at least three experts. The scoring method has been reported by Filsinger *et al.* (1982). The scale ran from 0 for fresh, unprocessed fish to 8 for overripe anchovies with 6 corresponding to optimally ripe anchovies. The mean panel scores were used.

Determination of free fatty acids

Uniform muscle paste was prepared with fillets taken from the same cans used for sensory assessments. Twenty g of muscle paste were homogenized with 100 ml ethanol in a Braun MRA homogenizer. Homogenates were filtered through Whatman No. 1 paper; and 0.1 aliquots of the filtrate were used to measure FFA according to the method described by Smith (1975). Calibration curves were obtained for each analysis set, by using palmitic acid (16:0) as the standard. FFA determinations were done by quadruplicates. Results were expressed as milliequivalents of palmitic acid per 100 g wet tissue. Data points in Figs 2 and 3 are mean values.

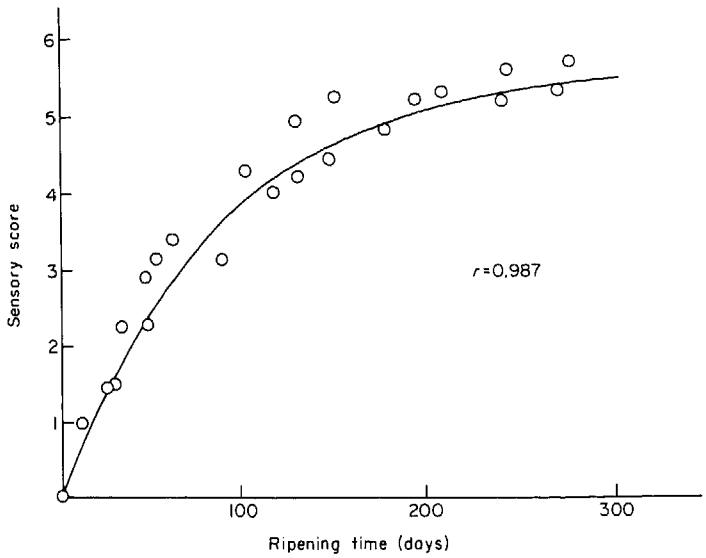

Figure 1. Sensory scores *versus* ripening time of anchovy. Each point is the panel mean score of the sensory characteristics evaluated.

Statistical analysis

Data shown in Figs 1 and 2 were fitted to pseudo first order kinetics models of the form $y = a + b\ e^{-kt}$. To fit the data, Stevens' (1951) maximum likelihood iterative method was used.

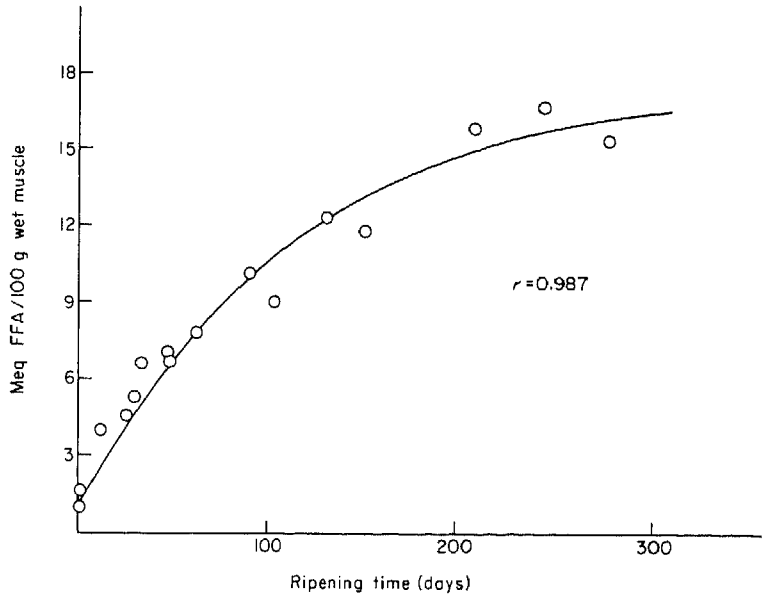

Figure 2. Changes in FFA content *versus* ripening time of the anchovies.

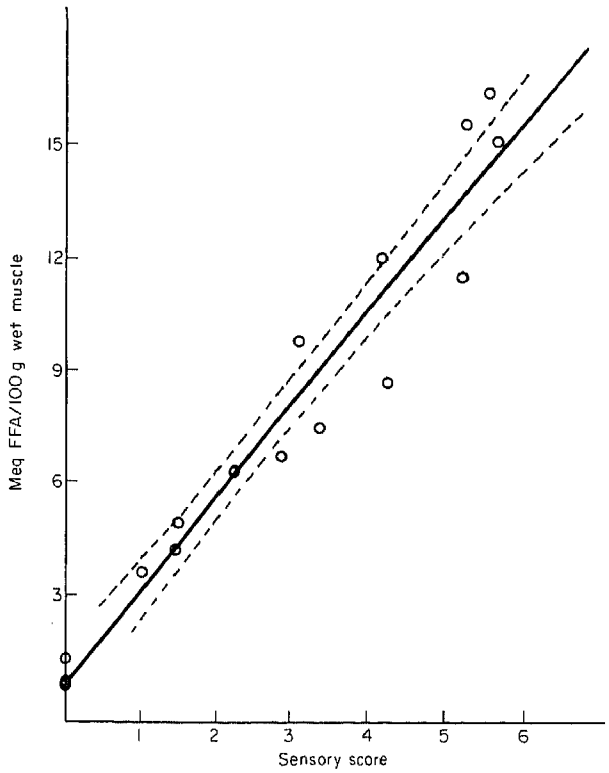

Figure 3. FFA content *versus* sensory scores for the curing of salted anchovies. The area between the dashed lines is the 95% confidence limits of the regression estimate.

Results and discussion

Figure 1 shows the increase in sensory score for three batches of anchovies caught and subsequently salted in 3 consecutive years. Over 70% of the ripening takes place in the first 100 days of the process. However, at this time, the odour and flavour of the fish are not those characteristic of the fully cured anchovy and the colour is not uniform. Actually, sensory scores reached almost constant values, indicative of complete maturity, after 200 days of curing.

Information on changes in lipids during maturation of salted fish is scarce and, in case of *Engraulis anchoíta* it is non-existent. Sedova & Emel'yanova (1976), have pointed out the importance of the characteristic aroma of cured fish. Poideszewski & Stodolnik (1976) have claimed that FFA level has a strong influence on the flavour of salted and maturated fish.

The assessment of changes in FFA could provide an objective method for measuring the maturation of salted fish. Figure 2 depicts FFA production in anchovy muscle *versus* time, for the three batches of anchovies used in sensory evaluation. A fifteen-fold increase in FFA occurred over the maturation process. Again, over 65% of this increase took place in the first 100 days period. A maximum value of about 15 mEq of FFA per 100 g wet muscle was reached after 200 days of the curing process.

Since Smith's method (1975) measures fatty acids having carbon chains over C8, the results presented here do not support a direct link between FFA production and flavour. However, a possible relationship between long chain FFA production and their subsequent degradation to shorter fatty acids cannot be totally excluded. On the other hand, the assessment of changes in FFA could provide a useful method for measuring the ripening of salted fish.

The parallel between the increase of the sensory scores and the increases in FFA, gives rise to the possibility of correlating these parameters. FFA contents are plotted against the sensory scores in Fig. 3. The high correlation coefficient obtained (0.971), would allow the estimation of curing of salted anchovies throughout the ripening process by the estimation of FFA. This would represent an advantage over the total ester index, which is not applicable for the first stages.

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