

Shelf Life of Brine Refrigerated Anchovies (*Engraulis anchoita*) for Canning

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ABSTRACT

The possibility of keeping anchovies in brine at 0°C was studied. The storage life of anchovies under these conditions was about 85 hr. The concentration of brine seems to have little effect on the quality loss at the concentrations used in this study. An acceptability level for the raw material based on sensory attributes cannot be established with any degree of accuracy since the latter deteriorate slowly. Thiobarbituric acid number increased slightly over the initial value throughout this study. Total volatile base increased abruptly after 85 hr of storage.

INTRODUCTION

OVER 11,000 TONS of anchovies (*Engraulis anchoita*) were landed at the port of Mar del Plata in 1981. Small fish are used in the production of fish meal, while large fish are either salted and marinated or canned. This species is particularly suited to the canning industry because of the small size of the fish, its fat content and the abundant catches over relatively short periods. Under the food regulations of Argentina (Código Alimentario Argentino, 1978) anchovies that are canned as sardines can be labelled Argentine Sardines. Traditional production procedures for sardine and sardine-like canned products have been described (Huntley, 1953; Stansby, 1967; López, 1975; Burgess, 1965; Soulé et al., 1980; Yeannes et al., 1976).

Most recent technological research has been aimed at increasing production rates and exercising better quality control of the product. However, a stage of the process that has received little attention has been the storage and conditioning of the raw material from the time it is caught until it is processed. Anchovies are caught near Mar del Plata from September or October to November or December and again in May or June. The length of the fishing seasons depends on weather conditions. The largest catches correspond to the spawning period (September-December) when the ambient temperatures are in the range 10–25°C. These temperatures cause rapid spoilage if the fish are not handled promptly.

Fishing is done mostly by coastal boats with limited holding capacity and the anchovies are landed a few hours after being caught. Even if no conditioning of the fish were done on board, spoilage resulting over such short periods would not be very sizeable. However, delays of up to 2 days may occur at the canning plants due to saturation of the processing lines. Immersing the fish in brine at 0°C will effectively increase storage life at the cannery (Connell, 1975). Information on the influence of such factors as temperature, brine concentration, brine-to-fish ratio, etc., on the quality of fish is scarce. Hansen (1976) reported that mechanical circulation of the brine is not advisable for sprat and other small fishes because it may result in excessive salt uptake and in softening of the flesh. The brine-to-

fish ratio in static systems should be small to avoid excessive salt penetration. McLay (1970) recommended that this ratio should not exceed four parts of herring to one part of water and that the salt concentration should be below 8%.

The purpose of this study was to establish the possibility of using brine refrigeration for anchovies (*Engraulis anchoita*) and to determine the storage life for different brine concentrations.

MATERIALS & METHODS

Samples

Pre-spawning anchovies were obtained from the local fishing port (mid-September) 2 hr after capture. The fish did not receive any special treatment during this period as is the case for commercial handling of anchovies used by the canning industry. Upon reception at our laboratory, half an hour later, samples were separated for chemical and sensory analysis. Three lots, each of 40 kg fish, were placed in plastic containers (length 60 cm, width 40 cm and depth 30 cm) with 13.33 kg brine in each. Fish-to-brine ratio was expressed by weight to conform with commercial practice.

Preparation of brines

The brines were prepared beforehand by adding sodium chloride and ice to tap water. The concentrations of these brines were 4, 7 and 10% by weight. The containers were placed in a chamber at 0°C where they remained throughout the experiment.

Sampling

Samples were removed two to four times a day during the first 8 days of storage, and then once again on the 11th day. Sufficient brine was removed to keep the brine to fish ratio constant. To make up each sample, anchovies were taken from different locations in the containers.

Sensory evaluation

The sensory evaluation was done by four trained experts who examined three fish from each container at each sampling. Scores were assigned according to the table proposed by Darlan et al. (1981) for the evaluation of fresh anchovies (*Engraulis anchoita*). This table takes into consideration the changes in the external appearance of the skin, the presence of blood clots in the head, the odor of the gills, and the characteristics of the flesh, peritoneum and viscera. Scores from 90–100 correspond to optimum quality, from 70–80 very good quality, from 50–60 good quality, from 30–40 regular quality and less than 30 poor quality. Other indexes such as color and sinking of the eyes, color of gills, adherence of backbone to flesh, etc., were also recorded. Belly burst was evaluated as a percentage of exposed abdominal area.

Chemical analysis

Anchovies removed for chemical analysis were washed under tap water, headed and gutted and passed twice through a manual grinding machine. All chemical tests were done in duplicate and when the difference between the two values exceeded 10% they were discarded. Total Volatile Base (TVB-N) was determined by a modification of the direct distillation method (Giannini et al., 1979). Rancidity was measured by the thiobarbituric acid test (TBA) on trichloroacetic acid extracts (Vyncke, 1975). Determination of salt contents was performed according to the AOAC (1960) method based on titration with silver nitrate. Fat and oil concentrations were determined using a Soxhlet extraction apparatus with a mixture of petroleum and ethyl ethers (Lees, 1969).

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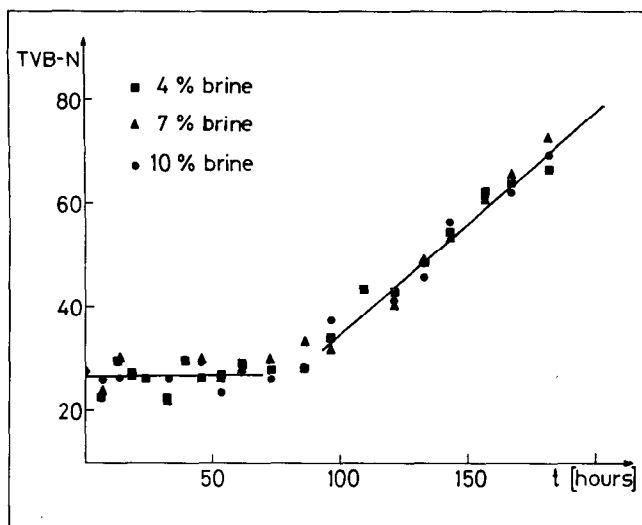


Fig. 1—Influence of storage time and brine concentration on the content of total volatile base (TVB-N, as mg N/100g muscle).

Water content was determined by the weight lost in 24 hr at $100 \pm 1^\circ\text{C}$ (Boeri et al., 1978) and ashes by ashing of the sample at $500 \pm 10^\circ\text{C}$ (Pearson, 1976).

The specific gravity of the fish was calculated from the weight-to-volume ratio and the specific gravity of the solutions was also determined.

RESULTS & DISCUSSION

THE AVERAGE WEIGHT of the anchovies was 29.86 g/fish ($\sigma = 2.87$). Water, fat and ash content were determined throughout the experiment and no changes due to the storing conditions were detected. Water content remained, for all samples, at $76.99 \pm 0.43\%$ (95% confidence interval); fat, as a percentage of total weight, was $3.55 \pm 0.26\%$ and ash, also as a percentage of total weight, was $3.08 \pm 0.23\%$.

The determination of total volatile base is one of the most widely used methods for evaluating the quality of fish (Pantaleon, 1969). Fig. 1 shows little or no increase in TVB-N in the first 85 hr of storage, indicating very little spoilage. These results were independent of the brine concentration. The rate of increase in TVB-N after 85 hr of storage was similar for the three brine concentrations.

The sensory scores (Fig. 2) show a gradual deterioration of the sensory attributes of the fish. Straight lines fitted to the data by the method of least squares indicate that the spoilage rates of fish kept at the three brine concentrations were different. Nevertheless the differences between individual slopes tested by the F test were not statistically significant at a 95% confidence level.

The sensory quality of the fish was still very good after 85 hr of storage. Working with Maine sardines (*Clupea harengus*) kept in brine, Slabyj and True (1978) reported difficulties in establishing the acceptability limit for sensory scores of the raw material that would insure acceptability of the canned product. The amount of exposed abdominal area due to belly burst (Fig. 3) became important at the same time the level of TVB-N started to increase. Enzymes and bacteria liberated from the digestive tract in belly burst might be responsible for the formation of dimethylamine and trimethylamine from trimethylamine oxide in the muscle (Yamada, 1968). Unfortunately belly burst depends heavily on the way the fish is caught and handled before it reaches the processing plant (Hansen et al., 1977).

The initial TBA value for anchovies in the present study ($0.22 \text{ mg malonaldehyde/kg sample}$) is very similar to the value reported for sardines by Slabyj and True (1978). The

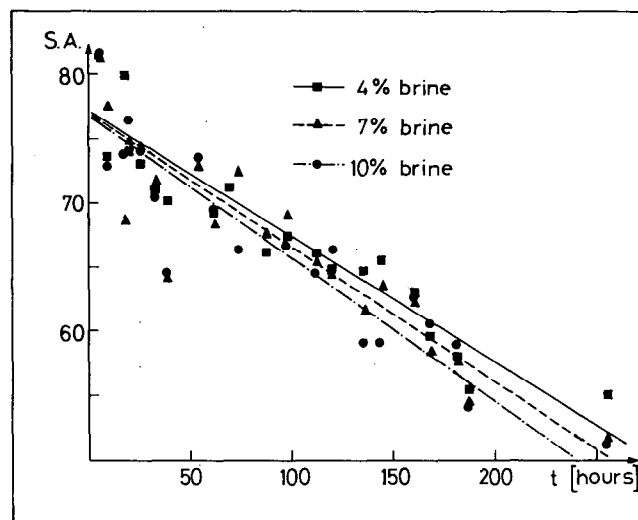


Fig. 2—Influence of storage time and brine concentration on sensory assessment scores (S.A.).

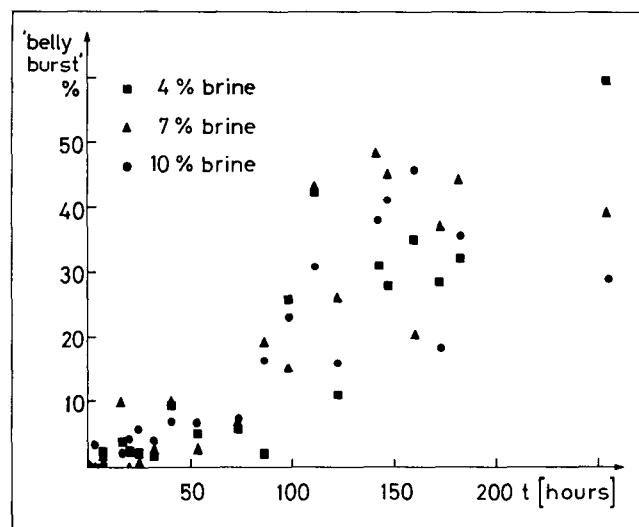


Fig. 3—Influence of storage time and brine concentration on belly burst (% of exposed abdominal area).

TBA values, determined during 8 days of storage, on anchovies refrigerated in 10% brine were 0.321 ± 0.125 (95% confidence interval). They were 0.279 ± 0.131 for fish in 7% brine and 0.251 ± 0.142 for fish in 4% brine. These results show the influence of the brine concentrations. Castell et al. (1965) and Damodaram Nambudiry (1980) reported that salt may lead to rancidity in fatty fish. A definite trend for the evolution of TBA value could not be established in this study, nevertheless the TBA values after 8 days of storage were much lower than the values reported by Slabyj and True (1978) after 3 days of storage. This difference may be due to the different species used (anchovies have lower fat contents than *Clupea harengus*) and the sardines being salted after catch.

The initial salt content (0.44%) of the fish was similar to values reported by Filsinger et al. (1978) for the same species. Salt uptake was highly dependent on brine concentration (Fig. 4). Considering the salt contents after 100 hr of storage to be representative of an equilibrium condition, and the dilution of the brines due to the migration of salt into the fish, an equilibrium constant can be calculated by the method proposed by Zugarramurdi and Lupin (1980). Calculated values are in the range 0.8–0.9 (moles of

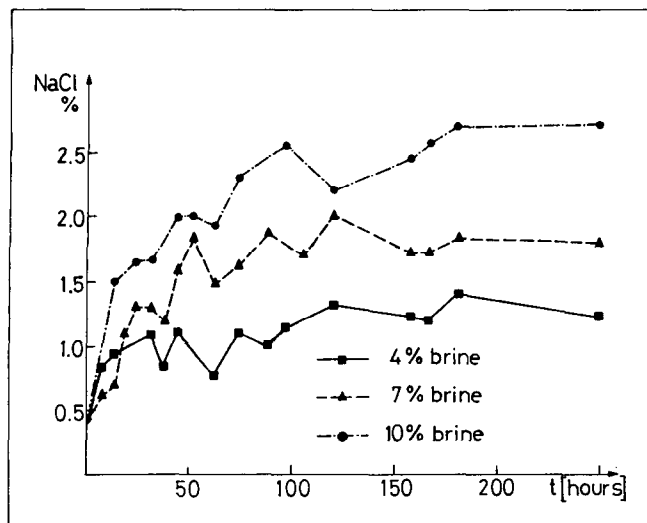


Fig. 4—Influence of storage time and brine concentration on salt content (g NaCl/100g muscle).

NaCl/liters of H₂O, in fish)/(moles of NaCl/liters of H₂O, in brine). These authors reported an equilibrium constant of 0.6 for whole anchovies (*Engraulis anchoita*) and 1.0 for anchovies with cuts. Although whole anchovies were used in this research, flesh fissures and ventral bursting due to deterioration could explain an equilibrium constant close to unity. Excessive salt uptake during brine storage may be undesirable for canning. Chafel (1965) and Roman (1954) recommended that salt content in canned sardines not exceed 1.5%. This is an important fact to take into account in the design of brine refrigerated systems.

Specific gravity of the anchovies was 1.080 ($\sigma = 0.004$) for all samples. After the first 24 hr, specific gravities of the liquid phase in the three containers were 1.029 ($\sigma = 0.004$), 1.038 ($\sigma = 0.003$) and 1.044 ($\sigma = 0.003$). These results are in agreement with the visual observation that, under the conditions tested in this research, the fish pile up on the bottom of the containers. The nonbuoyancy of anchovies should be taken into account in the design of a device to remove them from the containers.

In conclusion, anchovies can be held in refrigerated brine at 0°C up to 85 hr. As the concentrations of the brine appeared to have only minor effects on the quality loss, the concentration must be chosen considering other factors such as salt uptake.

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