Asian Fisheries Science 4(1991): 147-154.
Asian Fisheries Society, Manila,
Philippines

https://doi.org/10.33997/j.afs.1991.4.2.003

Studies on the Canning of White Sardine, *Escualosa thoracata*

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Abstract

The suitability for canning of an underutilized, small, low-fat, high-protein pelagic marine fish of the species *Escualosa thoracata* (Valenciennes, 1847) commonly known as the white sardine, was studied. Physical and chemical characteristics of the fish were examined and a suitable procedure for canning of 'natural' and 'oil-packed' products was developed. The canned products were highly acceptable in quality, being rated as good or excellent with respect to all the organoleptic attributes studied.

Introduction

Three species of lesser sardines have been investigated for canning in the past (Srinivasan et al. 1966); while the oil sardine (*Sardinella longiceps*) was canned in its own juice as 'natural' (Nair et al. 1974) or smoked (Nair et al. 1977). The present work investigates a canning method suitable for the white sardine, *Escualosa thoracata* (Valenciennes, 1847), locally called Bolingir.

Materials and Methods

Fish

The white sardines were obtained from commercial catches off the Mangalore coast and total length, standard length, total weight, dressed

weight and canning yield were measured, using four random samples of 10 fish. Moisture, crude protein (N x 6.25), salt (NaCl), total ash contents (AOAC 1975) and total lipids (Bligh and Dyer 1959) were expressed as percentage of fish muscle (w/w) on wet-weight basis.

Preprocess Operations in Canning

The fish were dressed by removing the scales, cutting off the head, pulling out the entrails without slitting the belly and finally cutting the caudal fin to obtain a single 54-mm piece from each fish. Brining was standardized by dipping the dressed and washed fish in a saturated salt solution at room temperature (29°C) for 4, 6, 8 or 10 minutes, and analyzing for salt content. The fish were packed vertically in cans (301 x 203, sulfur-resistant lacquer), adjusting the fish weight to give a final drained weight of solids around 65-70% in the canned product. To obtain optimum conditions, precooking trials were conducted for 15, 30, 45 and 60 minutes in steam at 100°C, observing the exudate in the oil-packed product.

Processing by Retorting

Retorting was standardized for three different packs: the natural pack (no precooking and no additional filling medium), brine pack (with fish precooked, drained and filled with 2% table salt solution) and oil pack (with the cook dip replaced by refined groundnut oil). Each can had a net content of 175-190 g. The three lots were subjected to heat penetration tests while autoclaving at 115.6°C (240°F) using thermocouples and a self-compensated digital thermometer (accuracy 0.1 °C, M/s Ellab Instruments, Copenhagen, Denmark). Can center temperatures were recorded at 5-minute intervals. From these data the rates of heat penetration (f_h) and sterilization ($F_{121.1}$ or F_{250}) values were determined (Patashnik 1953).

Product Preparation

The natural and oil packs of canned white sardines were selected for quality evaluation and were prepared in sufficient number, following the described procedure and adjusting the retorting to get $F_{121.1}$ values equivalent to 12-17 minutes at can center.

Evaluation of Product Quality

The quality of the finished product was evaluated through 'sample cutting tests. Organoleptic attributes, like appearance, color, odor, taste and texture, were judged by a trained panel of 8-10 experienced persons and rated on a scale of excellent (E), good (G), fair (F), poor (P) and very poor (VP), with equivalent scores, E: 9-10, G: 7-8, F: 5-6, P: 3-4 and VP: 2 and less than 2, respectively. Proximate composition of the canned fish was determined as for raw fish, taking only muscle portion.

Results and Discussion

Fish Characteristics

White sardines are very small compared to the oil sardine or the lesser sardines, weighing 10-12 g per individual, but represent commercial catches (Nair 1951). The proximate composition (Table 1) agrees with that of Ramaiyan and Paul Pandyan (1976) showing it is a low-fat, high-protein fish. The dressing and overall canning yields of 71 and 70% of the round fish weight are much higher than that of other marine fishes such as the oil sardine, mackerel, tuna, seer and pomfrets (Saralaya and Parashuram 1971).

Table 1. Physical and chemical characteristics of white sardine (*Escualosa thoracata*).

Characteristics	Values			Remarks
	Max.	Min.	Average	
Total length of fish (mm)	108	98	103	Average of 4 samples of 10 fish each
Standard length (mm)	87	78	82	
Total weight (g)	13.0	10.0	11.4	
Dressing yield			71.43	As percentage of total fish weight
Overall canning yield			70.00	
Moisture content			74.49	
Fat			0.73	As percentage (w/w) on wet weight basis in fish muscle
Crude protein			23.19	
Total ash			1.36	
Salt			0.26	

Salt Intake During Brining

It is usual to brine the fish before canning by dipping the dressed fish in a saturated salt solution at room temperature to give the final canned product a desirable salty taste. The salt intake by fish during brining depends on several factors (Rowan 1954) such as concentration and temperature of brine, duration, brine-to-fish ratio, freshness and fat content of fish. Since part of the absorbed salt is lost during precooking and sterilization, a slightly higher salt content than the desired 1.5-2.5% in the final product was obtained by treating for 6 minutes at room temperature (Table 2).

Table 2. Effect of brining time on salt intake in white sardine.

Brining time (min.)	Percent NaCl (w/w) on wet-weight basis		
	Brined fish	Precooked fish	Canned fish
4	2.09	1.74	1.65
6	2.78	2.61	2.35
8	3.27	3.04	2.66
10	3.48	3.16	2.69

Packing

Fish packed vertically in round cans must be cut to a length suitable for the can height, allowing for shrinkage during later heat treatments. A maximum yield of 70% of whole white sardines weight could be obtained by cutting to 54 mm and packing in 301 x 203 cans, minimizing dressing and trimming losses.

Precooking

Precooking and removal of excess moisture from fish tissue improves the quality and enhances shelflife of canned fish. It is common practice except when fish are canned as 'natural'. Studies on European sardines (Meesemecker and Sohier 1955), Indian oil sardines and mackerels (Varma et al. 1970; Joshi 1978) showed respectively, that the most convenient method of precooking was to autoclave the filled cans at 100°C, judging cooking time by the amount of exudate remaining in the

oil-packed product; that when properly precooked, the exudate in canned sardines was reduced to below 25% of the total drained liquid in the can, and the rancidity and off flavor in the fish were significantly reduced, with low peroxide value and free fatty acids; and that lean fish required more severe precooking than fatty ones. In the present experiment, for similar precooks, the white sardines showed less weight loss and more exudate than either the European sardines or the Indian oil sardine. Temperatures above 100°C and longer cooking tended to break the fish meat away from the backbone, giving the product an attractive appearance. As this fish is very low in natural fat, mixing of fish lipids with filling oil did not result in any serious defect. Thus, precooking for 45-60 minutes at 100°C was considered adequate. The final oil-packed product showed less than 25% exudate and the fish suffered no adverse effect in quality (Table 3).

Table 3. Effect of varying precooking times (at 100°C) on weight loss and 'exudate' in oil-packed white sardine.

Pre-cooking time (min.)	Weight loss (percent of raw fish weight)	Exudate in oil pack (percent of total liquid in can, v/v)
15	6.40	42.98
30	9.87	30.11
45	11.20	27.97
60	11.40	25.38

Measurement of Exudate

After precooking, the fish material was drained and the cans filled with refined hot groundnut oil and finally seamed and retorted. After retorting, the cans were cut open and the quantities of exudate in the canned products were measured after draining in the measuring cylinders and then expressed as percentage of total drained liquids (v/v).

Retorting for Sterilization

Thermal processes applied to canned products depend on the rate of heat penetration, quicker heating products requiring shorter retorting time than slower heating ones, at the same temperature. In the present experiment, it is seen that white sardines canned as 'natural' and in

brine, are almost equal in the rate of heat penetration (f_h = 24 and 23.5 minutes, respectively) and much faster than the oil pack (f_h = 31 minutes) in the same container. Sterilization values derived from heating - cooling data expressed as $F_{121.1}$ values, showed that retorting for 75 minutes at 115.6°C (240°F) resulted in processes equivalent to 14.1, 16.8 and 12.3 minutes at can center for the three packs mentioned, respectively. Based on the heat resistance of *Clostridium botulinum* spores, usually, F values equal to 2.5 minutes are considered minimal for low acid foods like fish from the public health point of view, but processes with 6-7 times this value ($F_{121.1}$ = 15-18 minutes) may be necessary when spoilage organisms of greater heat resistance are likely to be encountered (Hersom and Hulland 1980) or when bone softness in the canned fish is the required criterion. In the present case, 75 minutes retorting at 115.6°C was found to achieve both complete sterility and desired bone softness (Table 4).

Table 4. Results of heat penetration test on canned white sardines in 301 x 203 cans (net weight 175-190 g).

Particulars	White sardine natural pack	White sardine in brine	White sardine in groundnut oil
Initial temperature at can center (°C)	27.8	51.9	46.8
f_h value (slope of the semilog heating curve in min.)	24	23.5	31
$F_{121.1}$ value of process for retorting at 115.6°C for			
30 min.	2.5	4.9	1.6
45 min.	6.1	8.8	4.6
60 min.	9.9	12.8	8.3
75 min.	14.1	16.8	12.3

Quality of Canned White Sardines

The more important quality characteristics of white sardines in natural form and in oil are summarized in Table 5. It can be seen that general characteristics are all satisfactory with net weights, drained weight of solids, head space, vacuum and pH values being in the

Table 5. Quality characteristics of white sardines canned as 'natural pack' and in groundnut oil.

Particulars	Natural pack	Oil pack	Remarks
A. General characteristics			
Net weight (g)	176	190	
Drained weight of solids (g)	126	125	
As percent net weight	71.6	65.8	Average of 6
Vacuum (mm of Hg at 28°C)	158	180	Determination based on can opening test
Gross head space (mm)	7.0	5.0	
Number of pieces per can	22	21	
Turbidity of liquid	slight	Nil	
Meat adhesion to can	+	-	
pH of fish	6.5	6.5	
Exudate (percent of total liquid	-	24.3	
B. Organoleptic attributes			
Appearance	G	E	G=good; E=excellent
Color	G	E	Quality grading
Odor	G	G	for each attribute
Taste	G	G	was based on the
Texture	G	G	average panel
Overall acceptability	G	G	score for each
C. Chemical characteristics			
Moisture content in fish	73.52	72.15	Average of
Fat	0.92	2.67	duplicate estima-
Crude protein	22.77	22.11	tion on 4 samples
Total ash	2.83	3.93	each, expressed
Salt as NaCl			as percentage (w/w) of canned fish meat

desirable range. Only the oil pack had slightly higher exudate than similar packs of other marine fishes. The sensory evaluation (based on average panel scores) showed that the products were rated either as good or excellent with respect to the attributes tested. Oil-packed fish scored higher than the natural pack for appearance and color. Proximate composition of the products was also satisfactory, proving them to be high-protein foods. Thus it is evident that highly acceptable products can be obtained from the inexpensive fish by following the procedure suggested.

Acknowledgments

The authors are grateful to Prof. H.P.C. Shetty, Director of Instruction, College of Fisheries, Mangalore, for his encouragement. Thanks are also due to the Indian Council of Agricultural Research, New Delhi, for the award of the Junior Fellowship to the first author during the tenure of this work.

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Manuscript received 27 October 1989; revised ms received 28 May 1990; accepted 19 June 1990.