DEVELOPMENT OF A COMPRESSED PRODUCT MADE WITH SARDINE[1]

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SUMMARY

The *per capita* consumption of marine products is very low in Mexico, averaging less than 4 g/day. This fact has been partially attributed to the costly techniques used in their preservation, which result in high market prices unaffordable for large segments of the population. Previous research lead to the development of pressed and salted patties based on lean fish species, the low cost and easy preservation of which would contribute to a higher fish consumption among the low socio-economic strata of the Mexican population.

The present work was directed to adapt the procedure to sardine, which is more abundant and less expensive than lean fish species. Since deffating the sardine lead to poor sensorial characteristics of the patties, measures were taken to protect the fat from oxydation, through the use of BHT and citric acid. The best results were obtained with descaled sardine, and with the addition of 8o/o NaCl, 10o/o corn flour and a condiment mixture. The resulting product had 32o/o of high-quality protein and a shelf life of at least six months under environmental conditions. Its cost per gram of protein was one-third lower than the price of fresh or canned sardine. Sensorial tests revealed an acceptability of 82o/o.

INTRODUCTION

In spite of the fact that the country has a great fishing potential, since it has over 10,000 km of sea shores plus 6,000 km^2 of inland waters, fish consumption in Mexico is low (1, 2).

This may be attributed to the fact that a great proportion of the Mexican population lives in the central plateau, separated from the coast

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by high mountain ranges. Therefore, fish products must be transported over long distances in order to reach the markets, generally preserved by freezing or low-temperature cooling, which result in high market prices of the product for the consumer. Currently, only the high economic strata in the great urban centers represent an attractive market for fish and fish products; there, the price is three to ten times higher than "at the beach".

If the country's fishing potential is to be fully utilized to improve the average Mexican diet, simple and inexpensive techniques must be found so as to develop low-cost products of a high nutritive value, and easy preservation.

One of such techniques was developed by Del Valle (3). Salting and pressing were combined to obtain dry patties at a low cost, but the acceptability of the product was poor, due to its high salt content (25 to 43o/o depending on the species utilized). Moreover, washing in boiling water was necessary to desalt the patty before preparation and consumption. This technique was later improved by Camacho *et al.* (4) through optimization of the effect of combined treatments, including heating and mixing with corn flour and spices. The improved product was highly nutritive, inexpensive, and more acceptable, since its salt content was much lower (10o/o) and washing was not necessary. The addition of cereals and spices further improved its sensory characteristics. For the development of this product, a lean species *(Scombermourus maculatus)* was utilized. Since other species such as the Monterrey sardine *(Sardinops sagax)* (5) are cheaper and more abundant, its use could further reduce the price of the final product. Problems foreseen with the use of sardine and related species, are: first, their high fat content, which may be oxidized and thus give the patty an unpleasant flavor and aroma, and second, their small size, which gives a low yield of muscle tissue.

The general objective of this work, therefore, was to develop a low-cost sardine-patty with the same characteristics of nutritive value and long preservation as the lean-fish patties obtained by Camacho *et al.* (4).

MATERIALS AND METHODS

Study Design

The procedure described by Camacho *et al.* (4) for lean fish, represented in Figure 1, was also followed for sardine. The latter was prepared in different ways: 1) only descaled; 2) descaled, eliminating the tail; 3) descaled, eliminating both head and tail; 4) descaled, eliminating head, tail and viscera. The best presentation of the raw material, protein content, general appeareance and yield, determined following the first compression stage, were followed as selection criteria.

In a parallel fashion, different solvent systems (ether, alcohol and isopropanol) were tested for fat extraction from the sardine, selecting that one which showed the higher efficiency and the lower cost.

Three types of patties were thus prepared and tested in order to determine whether it was necessary to extract the fat from the sardine, or just to protect it from oxidation: 1) one, where fat was extracted using the

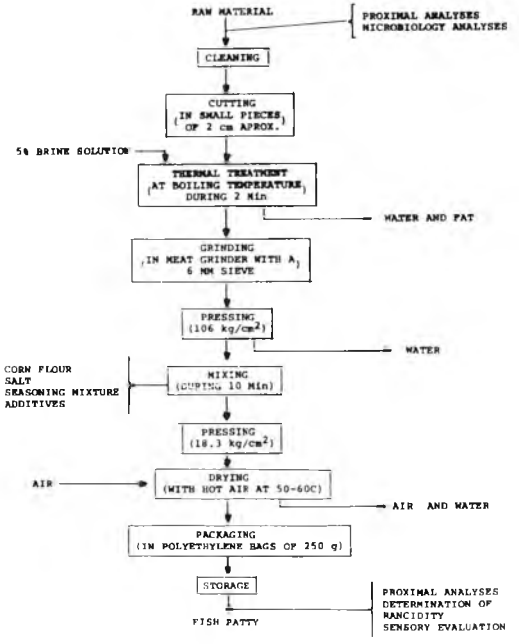

FIGURE 1

Flow chart for the elaboration of fish patties

solvent system previously selected; 2) a second one where fat was not extracted but, butil-hydroxytoluene (BHT) was added in the proportion of 20 mg/100 g of fat; and 3) a third one where fat was neither extracted nor protected. The sensory characteristics of the product and the suitability of the process were then evaluated in the three types of samples

Once the best conditions were selected, the amount of spices and whole, white or yellow corn flours to be added, in order to obtain better sensory properties, was determined.

Methods of Analyses

Proximal analyses:

These included determination of moisture content using the thermo balance method (6); ash, by calcination (7); ether extract, by continuous extraction (8); crude protein, by the Kjeldahl-Gunning procedure (9); rancidity, by the peroxide index method (10), and pH by a Beckman Potentiometer (11).

Bacteriological tests:

Bacterial estimates were done by the standard plate count method

(12), presumptive in sulfate triptose broth, and confirmative in brilliant green bile, 2o/o (13). Molds and yeasts were determined in potato-dextrose agar, acidified with tartaric acid solution, and incubated at 21oC for 50 days, and at 35oC for two days, respectively (12).

Protein quality:

The amino acid content of the protein was measured in a Beckman Amino Acid Analyzer, Model 116 by column chromatography (14). The results were used to calculate the chemical score with the FAO/WHO provisional pattern (15) as standard of comparison; tryptophan was determined by the Spies and Chambers technique (16). To establish the protein efficiency ratio (PER) and the net protein utilization (NPU) the methods of Campbell (17), and Miller (18), respectively, were used.

Sensory evaluation:

A preference test for aroma and flavor was done by the ranking method with a group of 20 untrained panelists (19). To evaluate the grade of acceptation of the dishes prepared with the final product, a monadic test was utilized.

RESULTS

The proximal composition of the main raw materials utilized in our study, is presented in Table 1. As shown, sardine had a relatively high fat content, but was low in ash, even considering the whole sardine. The ash content, therefore, should not constitute a problem for human consumption.

TABLE 1

PROXIMAL ANALYSES OF THE "MONTERREY" SARDINE AND CORN FLOUR (g/100 g of product)

Determination	Sardine	Corn flour
Crude protein (N x 6.25)	20.2	8.9
Ether extract	8.7	5.1
Ash	2.3	1.2
Crude fiber	0.0	2.8
Moisture	65.6	10.3
Carbohydrates (by difference)	3.2	71.7

Table 2 shows the protein content of compressed sardine and the yield of different ways of preparing the raw material; as may be observed, simple descaling gave the highest yield. Elimination of head, tail and viscera resulted only in a small increase in protein content, but in a consid-

TABLE 2

PROTEIN CONTENT OF THE COMPRESSED SARDINE, AND YIELD OF DIFFERENT PREPARATIONS OF THE RAW MATERIAL

Type of raw material	Protein content of compressed sardine (g/100 g)	Yield (g prod/100 g of sardine)
Descaled sardine	32.3	68–70
Descaled sardine without tail	32.6	62
Descaled sardine without tail or head	33.5	62
Same as the former, eviscerated	35.0	47

erable decrease in yield. From these results, it may be concluded that descaling alone was by far the best alternative; furthermore, the processing costs would obviously be lower in this case.

Table 3 depicts the fat extraction efficiency values obtained with different solvents. The treatment with isopropanol gave the bests results, leaving a residual fat content of only 4.7 g/100 g of dry product from 24.8 g (dry basis) originally present.

TABLE 3

RESIDUAL ETHER EXTRACT OF PATTIES DEFATTED WITH VARIOUS SOLVENTS*
(g/100 g dry basis)

Extraction with	Ether extract
Isopropanol	4.7
Ether	7.6
Ethanol	10.4

* The original fat content on dry basis was 24.8 g/100 g of sardine.

Once it was decided that simple descaling was the best procedure, and that isopropanol gave the best fat extraction values, three types of patties were prepared according to the study design: defatted, non-defatted, and non-defatted plus antioxidant.

Defatting produced a material which due to its crumbliness was inadequate for conformation of the patty; therefore, this alternative was eliminated at this point.

The non-defatted patty without antioxidant was notably rancid after ten days. On the other hand, the non-defatted patty with 0.02% BHT, maintained acceptable properties during the same period. Consequently, the best alternative was not to extract the fat, but to add BHT to prevent oxidation.

The adjustments on the patty's formulation were done on simply descaled sardine by adding different amounts of corn flour (10, 15 and 20 g for 100 g of patty) and different amounts of sodium chloride (3, 5 and 8o/o).

Patties prepared with 15 and 20o/o corn flour did not have sufficient cohesiveness; excellent consistency and cohesiveness, however, were obtained with 10o/o corn flour. A panel test revealed similar acceptability for patties containing 3, 5 or 8o/o NaCl. Nevertheless, better results in regard to appearance (color) and in the control of mold growth at the surface were obtained with 8o/o NaCl.

Table 4 presents the final formulation of the patty, and Table 5 provides details of the seasoning mixture utilized. It is worth while noticing that pepper and cummin had to be treated by autoclaving for five minutes, at a steam pressure of 1 kg/cm^2, to eliminate coliform contamination.

The proximal analysis of the patty is given in Table 6. As the data reveal, the product had a low moisture content (5.2o/o) and a protein content of 32 g/100 g.

TABLE 4

FORMULATION OF THE SARDINE PATTY
(g/100 g of product)

Ingredients	o/o
Sardines without scales	7.0
Corn flour	10.0
Salt	8.0
Seasonings	4.0
Citric acid	1.0

BHT 0.02o/o of the total content of fat.

TABLE 5

FORMULATION OF THE MIXTURE OF SEASONINGS USED FOR ELABORATION OF THE PATTY

Seasoning	Grams
Mixture of "chiles" (Guajillo[1] and Piquin[2])	78.81
Onion	8.22
Pepper	4.77
Garlic	3.55
Cummin	2.06
Clove	1.59

1 *Capsicum annuum* var. *longum*. Redpepper, Long.
2 *Capsicum frutescens* L. var. *baccalum*. Redpepper, Bush.

TABLE 6

PROXIMAL ANALYSIS OF THE PATTY
(g/100 g of product)

Determination	Content
Crude protein (N x 6.25)	32.2
Ether extract	17.6
Ash	24.7
Moisture	5.2
Carbohydrates (by difference)	20.2

The amino acid composition of the protein is depicted in Table 7. Except for tryptophan, the essential amino acid contents of whole fresh sardine and of the sardine patty were similar and, in some cases, higher in relation to the FAO/WHO 1973 provisional pattern (15), with a chemical score of 94. On the other hand, the patty was rich in lysine and in sulfur amino acids.

The PER and NPU of the patty are shown in Table 8. According to the data, both indexes were similar to those of the casein control, and confirmed the good quality of the protein.

The final product had 15,000 col/g, with neither coliform organisms nor pathogens presented. After a slight increase during the first weeks of storage at room temperature, the count decreased to 7,500 col/g at six weeks. Samples stored at 40°C, rapidly decreased to 2,500 col/g probably attributable to a further loss of moisture.

The proxide index of the patties stored at 40°C and at room temperature was determined every two weeks during a two-month period. The

TABLE 7

ESSENTIAL AMINO ACIDS CONTENT OF THE SARDINE PATTY AND OF THE WHOLE SARDINE
(g/100 g of protein)

Amino acids	Whole sardine	Sardine patty	FAO/WHO Provisional Pattern 1973
Valine	6.03	5.82	5.0
Isoleucine	4.91	5.37	4.0
Threonine	4.37	4.29	4.0
Tryptophan	0.97	0.94	1.0
Phenylalanine + tyrosine	5.64	5.99	6.0
Leucine	8.15	8.45	7.0
Lysine	6.16	7.08	5.5
Methionine + cystine	3.45	3.53	3.5

TABLE 8

PROTEIN EFFICIENCY RATIO (PER) AND NET PROTEIN UTILIZATION (NPU) OF THE SARDINE PATTY, AS COMPARED WITH CASEIN

Source of protein in the diet	PER	Per as o/o of casein's	NPU	NPU as o/o of casein's
Casein	2.5 ± 0.09	100.0	60.0± 1.79	100.0
Sardine patty	2.37± 0.16	94.8	58.8± 1.44	98.0

The values were adjusted for a casein's PER of 2.5 and NPU of 60o/o.

index slightly increased with time, but the patties were considered sensorially acceptable in all cases.

Sensory evaluation of the products was done by making different preparations in which the patties were included together with "nopales" (*Opuntia* sp), stuffed peppers and soup. The panel was asked to grade the patties by using a monadic test, and to compare them with similar preparations with lean fish patties; 82o/o of the panelists preferred the sardine patties.

Taking into consideration salaries, raw materials and energy, the cost of these patties was approximately US$1.20 per kg. The cost per gram of protein per patty represents only 30o/o of the price of protein in fresh or canned fish, or in milk, available at the market in Mexico City.

RESUMEN

DESARROLLO DE UN PRODUCTO A BASE DE SARDINA, MEDIANTE EL PROCESO DE PRENSADO

En México, el consumo de productos marinos representa menos de 4 g por persona, por día. En parte, este bajo consumo ha sido atribuido a que tales productos exigen métodos costosos de conservación, que se traduce en precios de mercado altos que la población no puede pagar. Así, con base en trabajos anteriores sobre especies magras para la producción de tortas prensadas y saladas, se juzgó conveniente utilizar la sardina, que es mucho más abundante y barata, previéndose como única dificultad su alto contenido de lípidos.

Para el caso, se utilizó la sardina desgrasada y sin desgrasar, con eliminación previa de aletas, escamas, cabeza, porción caudal y vísceras, así como diferentes concentraciones de cloruro de sodio (sal común) y harina de maíz. Las tortas preparadas con cada una de las diferentes presentaciones de materia prima se sometieron a las determinaciones químicas y pruebas sensoriales pertinentes. Los resultados revelaron que no es necesario desgrasar, pero sí eliminar las escamas. La mejor formulación se obtuvo agregando 10o/o de harina de maíz, 8o/o de sal, y una mezcla de condimentos. Se utilizó un antioxidantes (BHT) y ácido cítrico para proteger la grasa. El producto resultante contiene 32 g de proteína de alta calidad. En cuanto a la calidad sensorial, se obtuvo una aceptación del 82o/o con respecto a un 100o/o teórico, y se estimó una

vida de anaquel de por lo menos seis meses a temperatura ambiente (25oC). El costo por gramo de proteína resultó ser un tercio del precio de la sardina fresca o enlatada.

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