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NUTRITIONAL AND SENSORY QUALITY OF LABORATORY CANNED SARDINES

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In Pakistan significant resources of small fish are available which can potentially be processed in the form of canned sardines. Technology for oil based canned sardines has been successfully developed and evaluated for its nutritive quality and consumer acceptability. Laboratory canned sardines compared well with similar commercial products both in nutritive and biological value and will provide 24g protein, 17g fat, 4.1g minerals and 249 k cal/100g. The colour of the canned product was silvery white, it had no off flavour and had a firm texture. When subjected to consumer evaluation, the product was liked and accepted by a large number of consumers.

Key words: Canned sardines, Quality assessment, Consumer acceptability.

Introduction

Exploitable populations of small pelagic fishes occur in Pakistan and approximately 50,000 metric tones of sardines locally known as Tarli are caught annually on Sindh and Baluchistan coasts. Karachi Fish Harbour and Korangi Creek are the two important landing centres [1].

Canning is an accepted method for small pelagics throughout the world. Japan the United States and certain European countries are the main producers of canned fish products. For most developing countries only a small portion, if any, of their fish catch is canned [2]. The bulk of their catch is sold in fresh or cured form. In Pakistan fish canning has been neglected significantly. Although shrimp is canned on a very limited scale by a few industrialists only 0.03% of the total catch is utilized [3]. Currently almost all the landings of small pelagic fishes in Pakistan are utilized for fish meal production. Canned sardines are an imported item, available only in super markets at high prices. A common man is not aware of its taste since this product is beyond their reach. Therefore, attempts were made to develop and standardize the technology of canning these fishes under local conditions to provide an additional nutritious food product at a reasonable price. The present study was undertaken to evaluate the nutritional and organoleptic quality of oil based laboratory canned sardines and to assess the consumer acceptability of the product.

Materials and Methods

Sardines. Fresh sardines were procured from Karachi Fish Harbour. These were comprised of Sindh sardines, locally known as Kichak (consisting of two morphologically similar species (*Sardinella sindensis* and *S. fimbriata*) and Indian oil sardines (*S. longiceps*) locally called chakoo. The size of fish ranged from 10 to 13 cm. The fish well surrounded with crushed ice was transported to the laboratory for processing. Sunflower oil and other ingredients were obtained from local market. Lacqured cans of 4 oz capacity were procured by a local manufacturer (Hashmi Can Company, Site Karachi).

Dressing, washing and salt sprinkling. Fish were washed in tap water and dressed manually by cutting off the heads and tails and by removing the guts. A mixture consisting of 4 parts of salt, 0.5 parts each of citric acid and sodium glutamate (100g) was sprinkled uniformly per 2 kg of dressed fish. The salted fish were maintained at 70-80° for 20 mins. This step facilated toughening of the skin, salting the fish, dehydration and removal of slime and blood.

Precooking, filling in cans and exhausting. Salted fish were placed in a steam chamber for 20 mins at atmospheric pressure to partially cook and further dehydrate the fish. The partially cooked fish along with hot oil (85:37 w/w) were placed into the cans. The cans were heated in an exhaust chamber to a can centre temperature of 85° for 15 mins in order to ensure a proper vacuum.

Sealing, processing and cooling of cans. The hot cans from the exhaust chamber were immediately sealed with the help of HINZ Elecromaschinen Und Apparatebu Braunschweing. The sealed cans were processed in an autoclave at 15 psig pressure for 60 mins. Finally, the cans were promptly cooled in ice chilled water and stored at room temperature. A schematic diagram of the canning process is shown in Fig. 1.

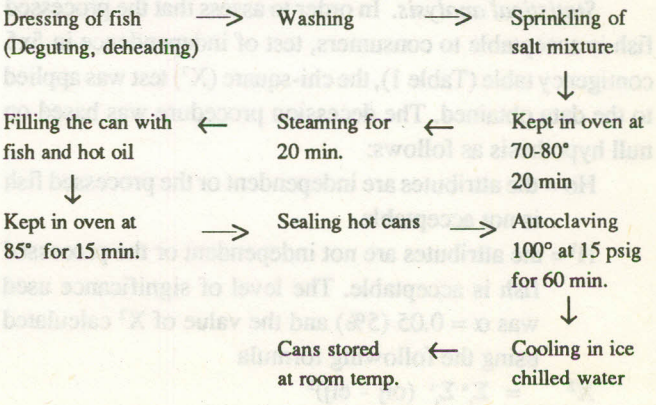

Fig. 1. Schematic diagram of laboratory canned sardines.

Chemical, microbiological and sensory analysis. Random samples of canned fish were drawn after 24 hrs and subjected to analysis in order to ensure that the cans had received sufficient heat, had been adequately processed and were properly sealed. The representative cans were incubated both at 55° and 37° for 10 days and carefully examined for their physical appearance (such as swelling of the cans) and were tested chemically and organoleptically. For the assessment of nutritive value the oil was drained off and solids were used for the analysis.

Chemical analysis. Moisture, crude protein, ash and lipid were determined by the method 18.023, 2.057, 31.013, 18.046 of the AOAC [4], respectively. Solids were homogenized 1:10 (w/v) in distilled water and the pH was determined using a Digital VWR Mini-pH meter (Scientific Inc.) iron and calcium were determined by the volumetric methods recommended by Winton [5] and the Phosphorous was estimated spectrophotometrically using the method described by PSI [6]. Vitamin A was analyzed by the ultraviolet absorption methods [7].

Consumer evaluation. In order to assess the inherent properties of the product and consumers acceptability, pilot consumer product testing recommended by Jean. F. Caul [8] were carried out by scoring method. Responses from 100 consumers were gathered within a week of distribution of the ready to serve oil based canned sardines. The attributes of the product evaluated were colour, taste, flavour, texture and overall acceptability. A 5 point scale was used to determine the degree of like or dislike. The scale was Excellent, Very Good, Good, Fair and Poor. The ratings were converted to numerical scores of 1,2,3,4 and 5 respectively. Samples were hand delivered along with a questionnaire and the efficacy of the product was explained to the consumers. The pannel of consumers consisted the technical and non technical staff members of the laboratories and their family members. This enabled us to get the verdict of the whole family including women and children.

Statistical analysis. In order to assess that the processed fish is acceptable to consumers, test of independence in 5x5 contigency table (Table 1), the chi-square (X^2) test was applied to the data obtained. The decession procedure was based on null hypothesis as follows:

Ho = the attributes are independent or the processed fish is not acceptable

H^1 = the attributes are not independent or the processed fish is acceptable. The level of significance used was $\alpha = 0.05$ (5%) and the value of X^2 calculated using the following formula

$$X^2 = \Sigma_i^s \Sigma_j^t \frac{(oij - eij)^2}{eij}$$

where oij = observed frequencies., eij = expected frequencies and df = (s-1) (t-1)

where s = rows., t = column

Results and Discussion

The present studies have recorded a total loss of 60% of fresh fish weight during the entire canning process. Approximately 40% of the fish weight loss was observed in the heading and gutting operation. A further loss occured in salting and precooking the fish in the steam chamber at 100°. Both these operations served to dehydrate the partially cooked fish and exudate the liquid from the fish quite rapidly resulting in about 20% loss. In different trails around 40% partially cooked, ready to can fish was obtained from the raw whole fish. These values are in agreement with those of Edward *et al.* [2], who stated that 59% of the fish weight was lost in heading, gutting and as exuded water after cooking.

The nutritive value of laboratory canned sardines is depicted in Table 2. Drained sardines (as they are eaten) contain 59% moisture, have a protein value of 24.0%, lipid 17.0% and an average energy value of 249 (Px4 and Fx9) calories per 100gm, with a mineral content of 4.1%. One pack of 40z canned sardines may provide around 53% of the adult requirement for protein and about 10% food energy as recommended by the U.S. RDA (Table 1). Per capita consumption of fish in Pakistan is only 2.5 kg per person per year, far below the world standard of 13kg/per person/year [9]. Therefore, wide availability of canned fish in Pakistan, especially in the interior areas, may help to expand the fish consumption and hence increase the intake of good quality protein. Newly developed canned sardines are an excellent source of calcium and phosphorous, providing 386 and 476 mg/100gm respectively and contributing some 38% and 47% of the U.S. RDA for these nutrients. However, during processing a slight decrease in mineral composition was observed. The calcium and phosphorous in raw sardines was found to be 610 mg and 511 mg/100gm respectively. This loss may be attributed to leaching while precooking and salting of fish. Vitamin A content of the canned fish was estimated at 200 iu/100gm. It has been reported that 70-98% of vitamin A is retained in canned foods

TABLE 1. OBSERVED FREQUENCIES (oij) OF CONSUMER DATA FOR 100 SAMPLES.

character-istic of fish	Scores					Total
	Poor	Fair	Good	V.good	Excellent	
Colour	9	36	38	7	10	100
Taste	5	25	34	27	9	100
Flavour	9	34	25	21	11	100
Consistancy	0	38	40	17	5	100
Acceptability	5	25	43	20	7	100
Total	28	158	180	92	42	500

[10] because of its insolubility in water, the leaching losses are mineral during washing, steaming or processing. A little loss may however, occur during thermal processing because of the low concentration of oxygen in the cans. Although the vitamin was not estimated in the raw fish it is reasonable to assume that slightly over 200 iu of vitamin A/100 gm would have been present. During canning where the raw fish flesh is changed to a nutritious food, various changes in the nutritive value occur during the process. The fat in the raw fish (6.0%) ends to 17.0% in the canned sardines. This is because of the removal of moisture during processing and absorption of the lipid of oil used. The increase in the ash (total minerals) from an initial value of 3.9% in raw to 4.1% in canned sardines is very slight. Looking into the loss of moisture during processing more increase may be expected. It is likely that minerals are leached out during the canning process. When calculated from the analysis of the raw fish and the cooked fish, the fish lost 7% of its proteins and 5.3% of its mineral content during precooking in steam. It has been reported that Scandinavian sardines under similar treatment lost 8% of its nitrogenous matter and about 10% of its mineral contents [11].

TABLE 2. FOOD VALUE OF RAW AND LAB. CANNED SARDINES.

	Raw sardines (100g)	Lab. canned sardines drained solids (100g)	U.S. RDA* for adults	% of U.S. RDA
Moisture g	73.0	55	–	–
Protein (NX6.25)	16.4	24.0	45.0	53
Fat g (Ether extract)	6.0	17.0	–	–
Ash g (at 600°)	3.9	4.1	–	–
Food energy K. cals	120	249	2400	10
Calcium mg.	610	386	1000	38.6
Iron mg	2.0	2.6	18	14.4
Phosphorus mg	511	476	1000	47.6
Vit. A. i.u.	–	200	5000	4.0
*Biological Evaluation of Canned Sardines***				
Biological value	71.8	73.4		
True digestibility coefficient	95.4	91.0		
Coefficient of protein net utilization	68.6	66.5		

*Recommended daily allowance values adopted from Fundamental of Food Canning Technology[10] – Values not determined. ** Source: Values adapted from fish in nutrition [12].

It may be noted that protein rich canned sardines provide protein of high biological value [12] (Table 2). In this study, changes that may take place in the nutritional and biological value of canned sardines during long storage at different temperatures were not monitored. No changes were found during storage at ambient temperatures (25°-30°) for upto one month. However, changes in the biological value of canned sardines in oil during prolonged storage have been reported [13], with a decrease from 70;34 to 64.54 during 24 months of storage at 2-6°.

Table 3 reports a comparative nutritive value data of laboratory canned sardines and other canned protein foods. The newly developed product compares well with the similar commercial products. Canned sardines can be placed among the foods which are considered rich sources of animal protein including canned fishery products such as different species of sardines, tuna, salmon, shrimp and other canned protein foods such as beef and poultry (17-24% protein). No appreciable loss of protein during the canning process of sardines was noted. However, thermal processing has been reported to effect the availability of certain amino acids insignificantly [10].

After the incubation period of 10 days no swelling or bulging of cans stored at 37° or 55° was observed (Table 3). This indicated absence of both mesophilic (37°) and thermophilic (55°) organisms. Underprocessed cans permit the growth

TABLE 3. COMPARATIVE STUDY OF NUTRITIVE VALUE OF LAB. CANNED SARDINES WITH OTHER CANNED PROTEIN FOODS.*

	Units 30 oz (gm)	Food energy (cals)	Protein (gm)	Fat (gm)	Carbohydrates (gm)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Lab. canned sardines drained solids	85	212	20.4	14.5	0	328	405	2.2
Sardines, Atlantic in oil drained soilds	85	175	20	9	0	372	424	2.5
Tuna in oil drained solid	85	170	24	7	0	7	199	1.6
Salmon, pink, solids & liquid	85	120	17	5	0	167	243	0.7
Shrimp meat	85	100	21	1	1	98	224	2.6
Corned beef	85	185	22	10	0	17	90	3.7
Chicken, boneless	85	170	18	10	0	18	210	1.3

* Source: Value adapted from Fundamentals of Food Canning Technology[10].

of microorganisms which may produce gas and acid or acid alone. There was no measureable difference in pH values of cans incubated at 37 and 55° as compared with room temperature cans (Table 3). The pH value of 5.7 to 5.8 eleminates the possible presence of flat sour type of organisms such as *Bacillus coagulans* and *B.circulans* (reported in under processed cans) that produce acid which would result in fall in the pH.

The quality parameters of the contents of cans incubated at 37° and 55° were compared with the freshly canned product (Table 4). No browning or H_2S discolouration was observed. The colour of the canned product was silvery white and no off flavour or perceptible odour was detected. The texture of the canned fish was firm and no undesirable softness was present. The authors did not find any difference in overall acceptability among the freshly canned cans and those stored at different temperatures when tested.

Bacteriological examination showed no microbial spoilage. Since the most resistant spores of clostridium botulinum have been reported to have a D value at 250° F of about 0.21 a 12D process is given by 2.52 mins at 250° F[14]. The cans were processed at 15 psi pressure (250°F) for 60 mins eliminating the chances of spores survival. It may therefore, be concluded that the cans were adequately processed and the heat treatment was enough to destroy the spores of *Clostridium botulinum* which is the minimum standard for heat processing low acid canned food. After six week of storage at room temperature the canned product was further examined for sensory quality, as the acceptability of the product is dependent on its organoleptic properties. This is important in view of the fact that canned fish is not freely available in this country and therefore, a common man is not aware of its taste. No noticeable difference was found in the appearance, texture or the taste of the canned product.

The quality and acceptability of the product is dependent on colour, taste, flavour and texture. The consumer grading of the canned sardines is presented in Fig. 2. It may be noted that the colour, taste, flavour and texture was rated Good, Very Good and Excellent by 55, 60, 57 and 62% of the consuming panel respectively. The corresponding Fair grading was 36, 25, 34 and 38% respectively and the Poor grading was obtained 9% for colour, 5% for taste, 11% for flavour and 0% for texture. The overall acceptability varied from 70% as Excellent, Very Good and Good to 25% as Fair and 5% as Poor. Thus the product was liked and accepted by a large number of consumers.

Statistical analysis. Table 1 presents observed frequencies (oij) of consumer test data for 100 samples of canned sardines. Since the calculated value of X^2 is greater than the tabulated value for 16 df i.e. 34.52>26.30, we reject H_o and

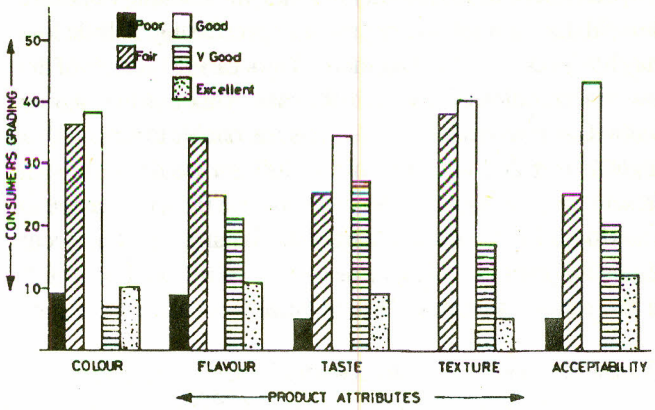

Fig. 2. Percent sensory grading of colour, flavour, taste, texture and acceptability of canned sardines.

TABLE 4. COMPARISION OF QUALITY PARAMETERS OF FRESHLY CANNED SARDINES WITH THOSE STORED FOR 10 DAYS AT 37° AND 55°.

	Room temp.	37°C	55°C
Swelling or bulging of the Cans	No sweling	No swelling	No Sweling
pH (drained solids)	5.7	5.8	5.8
Colour of the product	Silvery white	Silvery white	Silvery white
Flavour	Good	Good	Good
Texture	Firm	Firm	Firm
Taste	Good	Good	Good

accept H_1 i.e. the two attributes are not independent, in other words it may be concluded that this form of processed fish is acceptable to the consumers.

Conclusions

The present study reveals that the abundantly available sardines which at present are being utilized for making fish meal may be canned to value added acceptable product for human consmption. The technology of canning sardines has been standardized in the Laboratories and the product was liked and appreciated by consumers. There is a wide scope and termendous potential for the development of a fish canning industry in Pakistan. The resource is available for a relatively short season during the year. Therefore, it is advisible to consider an integrated approach i.e. to take account of the prospects of simultaneous canning of fish of other allied genera particularly those available abundantly when sardines are scare using the same plant. Alternative forms of processing and utilization of visera and other waste in canning for the production of fish silage should also be considered. The canned fish could be sent to interior places of the country where marine fish is unavailable due to inadequate refrigerated transport facilities. Once the domestic needs have been met, the product can potentially be exported. However, con-

certed efforts are needed to scale up the technology and to study the economic feasibility of mass production of the product.

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