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DEVELOPMENT OF INTERMEDIATE MOISTURE MARINATED FISH PRODUCT AND ITS STORAGE CHARACTERISTICS

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ABSTRACT

An attempt was made to prepare an intermediate moisture (around 44% moisture) marinated (pH around 4) fish product. Fillets from Sciaenid fish (each fish weighing 70-80 gm) were dipped in a solution containing 7% acetic acid, 20% common salt and 1% propionic acid for 2 hours. After soaking, the soaked fillets were partially dried to about 44% moisture. Three effective hurdles like low pH (by using 7% acetic acid and 1% propionic acid), low water activity (by using 20% salt and partially drying the fillets) and preservative (1% propionic acid), were used to prepare a shelf-stable product at room temperature. The dried product was sprayed with 0.05% BHA in 50% alcohol and further dried for 10 minutes to remove added water and alcohol, thereby another hurdle (preservative) against fat oxidation. The product was packed in 300 gauge polythene bags and stored in transparent screw cap plastic jars. Fortnightly samples were drawn and subjected to biochemical, bacteriological and organoleptic evaluation to study its storage characteristics. The product was in good acceptable form up to 4 months at ambient temperature. The product needed one hour soaking in water with two changes of water in between to make it free from excess salt and acid smell.

Key words: Intermediate moisture, fish product, marinated fish product, storage life, hurdle technology.

INTRODUCTION

India is on the threshold of blue revolution as a consequence of steady growth of the fishery sector during the last several years. The fishery sector is bound to progress further with plans for collaborative ventures for deep sea fishing and fish processing. In terms of consumer preference, a significant proportion of total available fish constitutes commercially unimportant and hence considered under-utilized species, most of which are landed as by-catch.

The need for better utilization of total fish catch arises from several reasons, which included recognition of depletion of the commercially important fish stocks throughout the world, nutritional importance of fish as human food, and environmental significance. Efforts must be directed towards increase in the production. Proper processing and preservation methods should be adopted to minimize wastage and develop value added

products so that they can be properly distributed throughout the country and per capita consumption of fish may be increased. Intermediate Moisture Foods (IMF) normally ranges in water activity (a_w) from 0.7 to 0.9 and in water content from 20 to 50% (Karel, 1973). The aim of IMF technology is to reduce water-activity of a food to a range in which most bacteria in foods will no longer grow. Bacteria, other than halophiles, will not grow at 0.83 a_w or below and most are inhibited markedly at 0.90 or less. Because of many moulds proliferate at a_w levels $\leqslant$ 0.83, antimycotic agents such as sorbic or benzoic acids are often added to IMF (Troller and Christian, 1978). The bound water need to be retained within the food so that structural changes affecting texture will be minimized and the addition of humectants permits retention of relatively high moisture levels thus providing better texture. Oxidation can be effectively controlled in most systems through the use of conventional antioxidants (BHA and BHT) or by inert gas packaging (Labuza, 1972).

Generally, intermediate moisture foods are packed in moisture-proof materials and are not affected by the frequently changing relative humidity conditions of the external environment (Torres, 1987).

Marinating is a method of preserving fish using common salt and acetic acid along with spices and condiments. The salt and acetic acid guard the fish products against infection and development of microorganisms. Study said that the pH 4-4.5, make the tissue cathepsins much more active, thereby, causing degradation of muscle protein into peptides and amino acids which gives marinade proper texture and flavour (Sikorskii, 1990). Leister and Rodel (1976) found that the inhibition of microorganisms in intermediate moisture foods depends on a_w, pH, Eh, temperature, preservatives and the competitive microflora and their numbers. Hence, studies have been made to develop an intermediate moisture marinated fish product and its storage characteristics at room temperature.

MATERIALS AND METHODS

Dhoma (*Otolithus argenteus*) fish ranging from 140 to 210 mm long were used in this study were collected from Versova landing centre of Mumbai in post rigor conditions and were taken to the laboratory in iced condition within half an hour. The fish were washed in potable water to remove blood, slime, dirt, etc. Filleting was done manually, using sharp knife and filleting board. Fillets were washed in fresh water so as to remove blood, slime, dirt, etc. The fillets were then kept in perforated wire mesh baskets so as to drain the excess water for 15 to 30 minutes. The fillets were removed from the wire mesh basket and were given a dip treatment in solution containing different concentration of salt (10%, 15%, 20%), acetic acid (6%, 7%) and 1% propionic acid for different interval of time. The ratio of fish muscle to brine was 2: 1 (fillet: brine). All the samples were then placed into the drying racks of the mechanical drier (Tory Kiln). Fillets were dried at a temperature of 43 ± 2^{0} C with an air velocity of 200 to 250 ft/min, for 4 hours to moisture content around 42-44%. Fillets were then sprayed with fine spray in single layer with 0.05% BHA in 50% alcohol and further dried for 10 minutes to remove added water and alcohol. All fillets were made into a number of

lots in such a way that approximately 70 gm of the fillets were there in each lot. Fillets were packed in 300 gauge polythene bags and heat sealed. The packets were stored in transparent screw cap PET jar.

Quality of fillets was analyzed as soon as the packet was opened. Quality was determined by analyzing moisture (FAO, 1983), ash (AOAC, 1995), protein (Kjeldahl's method, AOAC, 1995), total volatile base nitrogen (TVBN) (Conway and Byrene, 1933), NaCl (FAO, 1981), free fatty acid (FFA)(IS: 5734,1970), peroxide value (Santosh *et al.*, 1981), fat (Soxhlet method), alpha amino nitrogen (Pope and Steven, 1939), total plate count (Spread plate method), water activity (Wert Messer), pH (digital pH meter, No. pH 5652 using a paste of muscle prepared by mixing five times the volume of water).

Polyethylene packed samples, for storage life studies were stored in insect proof empty plastic container, at room temperature. Biochemical and bacteriological analysis were carried out at fortnightly interval for four months. The sensory evaluations were carried out for the product by a panel of five assessors drawn from the laboratory staff. Samples were soaked for one hour in water (Product: Water = 1:5) with two changes of water in between. The soaked product was boiled in water containing 2.5% salt and served for organoleptic assessment. The sequence of observation was as follows.

1. General appearance (discolouration if any)
2. The texture of raw product
3. The odour of raw product
4. The odour of cooked product
5. The texture of cooked product
6. The flavour of cooked product

Organoleptic evaluation and overall acceptability rating of the product was done on a 9-point hedonic scale. The pattern of scoring is given below.

9. Extremely good, 8. Very good, 7. Moderately good, 6. Slightly good, 5. Neither good nor poor, 4. Slightly poor, 3. Moderately poor, 2. Very poor, 1. Extremely poor.

RESULTS AND DISCUSSION

Several trials were made by dipping the fillets of Sciaenids in solution having different compositions. It was intended to get a product having pH less than 4, so that the product with moisture content above 40% can be stored at room temperature without spoilage. Sodium chloride is known to be an agent having high water activity reducing property. So acetic acid was tried in two different concentrations (i.e. 6% and 7%) and salt was tried in three different concentrations (i.e. 10%, 15% and 20%) (Table 1, 2, 3).

Table 1. Dip treatment in different solutions

Product no.	Salt (gm/100ml brine)	Acetic acid (%)	Propionic acid (%)	pH of product	Water activity of product	Moisture (%) after drying
1	10	7	1	4.01	0.908	26.44
11	15	7	1	3.93	0.878	26.01
111	20	7	1	3.83	0.850	26.92

Table 2. Dip treatment in different solutions

Product no.	Salt (gm/100ml brine)	Acetic acid (%)	Propionic acid (%)	pH of product	Water activity of product	Moisture (%) after drying
1	15	7	1	3.92	0.885	38.59
11	15	6	1	4.01	0.895	38.12
111	20	6	1	3.90	0.880	39.54

Table 3. Dip treatment in different solutions

Product no.	Salt (gm/100ml brine)	Acetic acid (%)	Propionic acid (%)	pH of product	Water activity of product	Moisture (%) after drying
1	15	6	1	3.94	0.900	39.92
11	15	7	1	3.90	0.880	39.84
111	20	7	1	3.82	0.855	39.64

It was found that 7% acetic acid along with 1% propionic acid gave desirable low pH of 3.82/ 3.83. Rao and Valson (1962) have shown that a dip treatment of dressed Indian mackerel in 4% acetic acid for 10 minutes before salting and pickling in saturated brine containing 0.5% to 1% propionic acid could prolong their shelf life. Strom, *et al.* (1991) suggested that the fish viscera treated with propionic acid at pH 4.3 remained sterile for months at room temperature. The growth of moulds was not detected. Propionic acid inhibited growth of the fungus *Aeromonas flavus* at 0.2% (W/V) or more at pH 4.5. The product was dried to around 26% moisture and organoleptic evaluation revealed that the product had tough rubbery texture (Table 1). So, it was decided to dry the product after soaking in solution to moisture content above 40%. Basu *et al*. (1989) developed an intermediate moisture fish cake with 1% Ethylene Glycol, 0.5% sorbitol, 2% glycerol and 3% NaCl and reported that the product with about 50% moisture and a_w around 0.85 was the most acceptable. No humectant flavour was detected in the product.

Higher the salt concentration used, lower the water activity achieved. It was aimed at developing a product using several hurdles so that the product remained stable at room temperature for long period. In present study it was decided to dip the fish muscle in acetic acid solution containing sodium chloride, 1% propionic acid and then partially dried the product and sprayed with 0.05% BHA solution. Use of sodium chloride and partial drying will reduce the water activity considerably adding a strong hurdle to bacterial spoilage. Roberts and Smart (1976) stated that within a_w range 0.70-0.85 for IMF, *Clostridium botulinum* and *Cl. Perfringens* are unable to grow irrespective of pH and storage temperature. As it was decided to maintain moisture content above 40% to get soft juicy texture, there was a probability of mould growth. So, it was decided to use 1% propionic acid in the dip solution, which will prevent any mould growth when the product is stored at ambient temperature. To avoid development of rancidity 0.05% BHA spray in 50% alcohol was used. So, to develop a shelf-stable product at ambient temperature, three effective hurdles were used, they are low pH (using acetic acid and propionic acid), low water activity (using sodium chloride and partial drying) and preservative (using propionic acid and BHA).

As less than 4 pH was obtained using 7% acetic acid, it was decided to use 7% acetic acid in the soak solution. Higher salt concentration also reduced the pH to some extent besides reducing the water activity of the product. However, texture of the product should also be taken into consideration while optimising salt concentration.

Table 5 shows the effect of salt concentration on texture. Organoleptic evaluation of the product showed that the product developed by dipping in solution containing 20% sodium chloride had the best soft close meaty texture. Twenty percent salt also imparted the lowest water activity to the product. So, salt concentration was optimised at 20%.

Table 4. Effect of salt concentration

Product no.	Salt (gm/100ml brine)	Acetic acid (%)	Propionic acid (%)	Texture of the product
1	10	7	1	Little tough close texture
11	15	7	1	Soft close texture
111	20	7	1	Best soft close meaty texture

Finalizing dipping time

Fillets were dipped in a solution containing 7% acetic acid, 20% salt and 1% propionic acid for different intervals and then partially drying at 43±2^0 C to about 44% moisture content. Two hours dip treatment gave the best texture. So an Intermediate Moisture (44% moisture) Marinated Fish Product has been developed by dipping the fillets from Sciaenid (each fish weighing 70-80 gm) in a solution containing 20% salt, 7% acetic acid, 1% propionic acid for 2 hours and then partially drying at 43±2^0 C, and sprayed with 0.05% BHA solution and finally drying to 44% moisture content (Table 5).

The product was then packed in polythene bags (300 gauges) and sealed. The sealed bags were kept in screw cap transparent plastic jar at room temperature and its storage characteristics were studied.

Table 5. Finalizing dipping time

Product no.	Dipping time in hour	pH of the product	Texture of the product
1	1	4.14	Tough texture, rough surface
11	2	4.02	Soft texture, smooth surface
111	3	3.91	Smooth rubbery texture
1V	5	3.77	Smooth rubbery texture

Table 6. Proximate composition of Marinated Fish Product

Protein (%)	Fat (%)	Moisture (%)	Ash (%)
37.19	5.06	44.70	13.05

The proximate composition of the final product is presented in Table 6
.The product has a salt content of 11.94% and pH 4.10.The water activity of the product was 0.86 at 28^0 C.

Table 7. Storage characteristics of intermediate moisture marinated Sciaenid fillets

Period of storage (fortnight)	Total Plate Count/gm	TVBN (mg %)	Moisture (%)	Non-Protein Nitrogen (mg %)	£-Amino Nitrogen (mg %)	Free Fatty Acid (% of Oleic Acid)	Peroxide Value (mille-equivalent/kg of oil)	Overall acceptability
0	$8.5x10^2$	28.0	44.70	490	14.0	6.81	0	9.0
1	$5.5x10^2$	22.4	44.20	581	21.0	25.92	12.13	8.5±0.3
2	$4.5x10^2$	28.0	44.10	560	22.4	39.28	16.57	8.5±0.2
3	$1.1x10^3$	30.8	43.82	525	29.4	51.34	21.39	8.1±0.4
4	$1.3x10^3$	32.3	43.65	528	30.6	60.03	21.10	7.9±0.3
5	$2.9x10^3$	35.1	43.44	580	50.4	71.26	20.30	7.5±0.2
6	$3.7x10^3$	36.4	43.22	613	58.8	78.42	18.50	7.1±0.4
7	$6.5x10^3$	39.7	43.13	628	69.0	82.66	13.40	6.8±0.3
8	$1.45x10^4$	42.0	42.95	640	85.5	82.66	13.4	6.0±0.2

Table 7 presents the storage characteristics of the product. There was not much change in moisture value during storage period. TVBN content registered a gradual increase throughout the storage period. Total bacterial count was very low (8.5×10^2) at the beginning which increased slowly but steadily to 1.45×10^4 at the end of four months of storage. The hurdle of low pH and low water activity and the presence of preservative like propionic acid did not allow the microorganisms to grow at a faster rate. The value of TVBN, NPN and alpha-amino nitrogen which showed extent of bacterial degradation of protein, increased slowly and steadily in keeping with bacterial count. Although BHA was used to the extent of 0.05%, little peroxide formed initially which increased slowly till two months storage and then decreased gradually. Peroxide initially formed was further broken down to other compounds leading to decline in peroxide value. Free fatty acid increased slowly but steadily with storage period showing extent of fat degradation. Overall acceptability decreases gradually with storage period. The colour of the product turned light brownish after one month in storage, which intensified during 4 month storage. Collins *et al.*, (1976) reported the storage life of 4 months of an intermediate fish product at 37.8^0 C. However, even after four months storage, the product was acceptable, although it developed little brown colour and texture became little rubbery. No off flavour was detected except some acid smell (that of acetic acid and propionic acid). There was no rancid flavour. The product was free from mould growth.

Although by definition intermediate moisture food products are supposed to be plastic enough that they may be directly cooked, but the product described in this communication needs one hour soaking in water before cooking. Soaking removes excess salt present in the product. Some portion of the acid is also leached, reducing the strong acid smell in the product rendering it more acceptable. Soaking also improves texture and juiciness of the product.

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