Low Cost Freshwater Fish Pickle Using Cheap Citrus Fruit (*C. reticulata*)**

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The juice extracted from a locally abundant cheap variety of citrus fruit namely, *Citrus reticulata* was utilized for pickling. The paper highlights the trials made to select the optimum concentrations of acetic acid and sodium chloride to be used along with the juice of *C. reticulata* so as to obtain the best, product. The product can be stored well at room temperature for six months.

Pickling is one of the safest means of easy preservation of fish. It has been found that if a little care is taken in maintaining hygiene in course of its production and keeping the pH of the product below 4.0, which is believed to suppress the growth of all pathogenic organisms (Luh & Woodroof, 1975), it can have a considerable storage life.

A variety of marine fish pickles have been reported. No report could be traced for freshwater fish pickles except one (Chattopadhyay *et al.* 1982), which dealt with the processing and storage of three varieties of freshwater fish namely, *E. vacha, G. giuris* and *X. cancila* by pickling with acetic acid.

Materials and Methods

The fishes were dressed, washed well in running water and cut to sizes. The pieces were then fried for five min in mustard oil. A citrus fruit namely, *C. reticulata* was chosen for extracting juice with the help of hand operated juice extractors. An average sized fruit yielded 50 ml of juice, pH of which was 2.95. There was no change in pH of the juice on 1:1 dilution with potable water. First trials were conducted to select the optimum concentration of sodium chloride in the dipping liquid irrespective of the presence of acetic acid. The fried pieces were then dipped in the 1:1 diluted juice containing 2%, 3%, 4% and 5% acetic acid with 5% sodium chloride in all the cases. The changes in pH of the fish muscle at regular intervals were then studied to select the optimum concentration of acetic acid and dipping time that would give the most acceptable product with regard to texture and microbial safety. The following recipe was used for the purpose of pickling.

Fish (pre-treated fried pieces), g	1000
Salt, g	125
Turmeric powder, g	40
Chilli powder (red), g	40
Mustard seeds, g	30
Fenugreek seeds, g	5
Cumin seeds, g	30
Ani seeds, g	25
Garlic (dressed flakes), g	250
Ginger (grated), g	250
Green chilli (chopped), g	250
Mustard oil (for seasoning), ml	250
Filling liquid (1:1 juice containing 2% acetic acid), ml	800

Spices were at first dry heated and powdered. Green chilli, ginger and garlic were fried in mustard oil for about five minutes in a stainless steel vessel. Then all the spice powder and salt were added along with the pre-treated fish for mixing well for a while. Finally the prescribed amount of filling liquid was added. The pickle was packed in sterile glass bottles and stored at room temperature for shelf life studies. pH of the fish muscle was measured on 2:1::water: fish homogenates using pH meter; fat was

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estimated by the method of Bligh & Dyer using chloroform as the solvent; moisture and peroxide value were determined by the methods of A.O.A.C. (1975). Total volatile nitrogen (TVN) was measured by the microdiffusion method of Conway (1947). Alpha amino nitrogen was estimated by the method of Pope and Stevens (1939). Total bacterial count (TBC) and total mould count (TMC) were estimated by the standard pour plate methods using peptone-glucose--agar (pH 7.2, incubated at 37± 1°C) and Czapec-Dox medium (pH 3.5 incubated at 28 ± 1°C) respectively.

The organoleptic ratings were carried out by a taste panel of 10 members with the score '5' as the border line of acceptability on a '10' point scale.

Results and Discussion

The yield of the fish *R. chrysea* after dressing was 36% and yield of the fried fish on the basis of dressed fish was 55.60%, pH of the muscle of the raw and fried fish were 6.15 and 6.35 respectively. It was found that the presence of 5% sodium chloride in dipping solution imparted the best texture to the fried fish muscles.

Table 1 shows the changes in pH values of fried fish muscle on dipping in extracted juice (1:1 diluted with water) containing different concentrations of acetic acid with 5% sodium chloride. Sodium chloride was used in all the cases since from previous studies (Chattopadhyay *et al.* 1982) it was found that the dipping solution without salt caused considerable acid hydrolysis resulting in disintegration of muscle.

It was observed that the pH of the fish muscle dropped sharply during the first hour of dipping in all cases. After which the pH reduced gradually and at the end of fifth hour, the pH of the muscle almost reached equilibrium. It was also noted that the equilibrium pH value was far above the initial pH value of the dipping liquid which establishes that the fish muscle retains its buffering capacity even after frying. Similar findings were cited in earlier reports also (Chattopadhyay *et al.* 1982; Nair & Chattopadhyay, 1978).

Pickle was prepared after dipping the fried fish muscle in extracted juice (1:1 diluted with potable water) containing 5% acetic acid and 5% sodium chloride for four hours. The pre-treatment stage is the most important one since this helps in bringing down the pH of the fish muscle below 4.0. Hence the pre-treatment time must not be less than four hours. The changes in biochemical and microbiological parameters of the pickled product during storage at room temperature are cited in Table 2. There were no appreciable changes in pH of the pickle during storage and throughout the entire storage period, pH of the pickle remained below 4.0. Steady increase of TVN and alpha amino nitrogen were found during storage. High values of alpha amino nitrogen may be due to the acid hydrolysis of fish proteins. Peroxide values also increased considerably during storage but no rancid flavour was imparted

Table 1. *Changes in pH values of fried R. chrysea on dipping in extracted juice (1:1) diluted with water) containing different concentrations of acetic acid with 5% sodium chloride.*

Concentration of acetic acid	2%		3%		4%		5%	
Time (h)	pH muscle	pH dipping solution	pH muscle	pH dipping solution	pH muscle	pH dipping solution	pH muscle	pH dipping solution
0	6.35	2.65	6.35	2.60	6.35	2.60	6.35	2.55
1	4.45	3.20	4.35	3.15	4.25	3.05	4.15	3.05
2	4.35	3.35	4.30	3.40	4.20	3.30	4.10	3.20
3	4.20	3.95	4.15	3.95	4.10	3.85	4.00	3.65
4	4.15	3.95	4.10	4.00	4.00	3.95	3.95	3.90
5	4.15	4.10	4.05	4.00	4.00	4.05	3.95	3.90

Table 2. *Storage characteristics of fish pickle*

Period of storage	Moisture of fish muscle	pH of pickle	TVN of fish muscle (mg/100g)	Alpha amino nitrogen of fish muscle (mg/100g)	Fat of fish muscle (%w/w)	Peroxide value of fish muscle m.eq/kg of fish	Total bacterial count per g of pickle	Total mod count per g of pickle	Organoleptic score
Initial	53.21	3.85	5.52	45.31	5.58	65.39	1.85×10^3	10	9.0
One month	55.72	3.80	6.14	57.74	5.16	87.22	2.02×10^3	6	9.5
Two months	55.08	3.85	6.84	108.50	4.35	105.33	2.18×10^3	12	8.8
Three months	53.19	3.80	7.35	132.75	3.32	113.64	3.6×10^3	19	8.5
Four months	54.77	3.80	9.44	135.12	3.95	148.55	2.3×10^3	25	7.5
Five months	55.15	3.85	12.19	157.23	3.47	177.13	3.8×10^3	37	7.0
Six months	54.23	3.85	13.76	175.11	3.83	178.25	4.5×10^3	42	6.2

in to the product. The changes in the bacterial and mold counts were not significant. The observed increase in bacterial count might have been due to the presence of acidophilic bacteria. The pickle had a shelf life of six months.

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