

DETERMINATION OF OPTIMUM CONDITIONS FOR COOKING AND TREATING INTACT FISH SLICES WITH SPECIAL REFERENCE TO BONE SOFTENING

M. QUDRAT-I-KHUDA, S. FAZL-I-RUBBI, H. RAHMAN AND N.A. KHAN

East Regional Laboratories, Pakistan Council of Scientific and Industrial Research, Tejgaon, Dacca

In continuation of preliminary studies,¹ which showed the feasibility of using chemicals to soften free bones without the fleshy portions of the fish, experiments have been carried out on the effects of different pertinent chemical agents on fish and fish constituents. The flavour, the palatability, the odour and changes in proteins of such flesh are all very significant from the consumer's points of view.² These qualities have therefore been determined through the judgements of a panel of tasters and observers, and optimum conditions for cooking fish in the presence of suitable chemicals have been determined on the basis of these tests.

Experimental

Materials.—The chemicals used were mostly guaranteed reagents, while some (citric acid, sodium citrate, borax, etc.) were of B.P. grade. Fresh lemon juice after sterilization was utilized. The fish "foli" (*Notopterus Motopterus*), "iliisha" *Hilsai lisha*, and "putti" (*Barbous puntio*) were purchased from the local markets.

Apparatus and Methods.—Three slices of each fish were cooked in each of several beakers (250 ml.) placed on a sand bath made of a big aluminium pan diameter 14" and 7.5" depth with 1" thick layer of sand. The temperature of the sand bath was maintained at about 110°C. the cooking solutions being at 98° to 100°C. The fish slices were just covered by a chemical solution or by plain water in the control in each beaker for all series of experiments. The fish slices were stirred with glass rods (one in each beaker) at regular intervals during the processes of cooking, which lasted one hour in all cases except those mentioned otherwise. Each series of experiments was conducted on one sand bath under uniform conditions as far as practicable.

From more than forty three chemical agents tried in the preliminary investigation,¹ only sixteen were used in the present experiments. Each chemical treatment was tried in several ways: (a) alone (Table I), (b) together with spices and oil (Table II), (c) the chemical solution being added to fish slices being fried with spices and oil (Table III). Additional experiments were then made following up the above observations: the innocuous borax solution was used in combination with a glycerine solution which further enhances cooking processes³ (Table IV).

In order to confirm some of the previous observations the fish slices immersed in a few chemical solutions were subjected to plain heat treatment for various periods of time (Table V). The main series of experiments were conducted with "foli," an inexpensive fish of complex bony structure, while the costly fish, "ilisha," and also a small fish, "putti," were treated only with chemical solutions of favourable concentration (Table VI). In the main series, pieces of "foli" were also treated with extreme concentrations of acetic acid in order to set out the limitations to its use. On the basis of the foregoing experiments, supplemented by further repetitions using the optimum concentration of chemicals, the cooking procedures were standardized (Table VII). Attempts were also made to determine the free acidity due to hydrolyzed amino acids in all cooked samples of fish.

The data recorded in Tables I to VII were obtained through an organized panel of tasters and observers. The persons involved in the tasting panel were trained to avoid bias by the decisions of one another. The identity of the sample was not disclosed to any person concerned. The majority opinion was accepted and a specific symbol was used.

Results and Discussion

The results of different experiments are shown in the Tables I—VII, wherein symbolic notations are used, and the chart shows the meaning given to the various symbols in each topic of investigation: turbidity, tolerance, surface effects (visual perception), chemical effects on proteins, degree of bone softening and degree of water retention. A glance through the tabular results reveals several points:

- (a) Spice and oil eliminate bad odour in certain chemical treatment (cf. items 6 and 7 in Tables I—III).
- (b) Spice and oil do not interfere with other observations made with chemical substances.
- (c) Borax provides better cooking media for fish.
- (d) The feasibility of using chemicals is established and the best conditions (cf. Table VII) are determined.
- (e) Fish cooked under these optimum

CHART.—EXPLAINING THE SYMBOLS USED IN THE TABLES

Symbols used	Turbidity	Tolerance	Surface effects	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
+	Turbid	Edible	Affected	Mild effects on surface	Mildly malleable	Normal	Normal
++	————	Edible and tasteful	Definite change	Surface mildly hydrolysed	Malleable	Slightly juicy	„
+++	Very turbid (dark)	Edible and highly tasteful	————	Partially hydrolysed	Fully malleable	Juicy	„
++-	————	May be edible	Slight change	Slight hydrolysis	Slightly malleable	Less juicy	„
+ -	Doubtful	May not be edible	————	Doubtful	Doubtful	Doubtful	„
-	Clear solution (normal)	Hardly edible	No effect (normal)	No change (normal)	No effect	Slightly dehydrated	Not good
--	————	Not edible	————	————	————	Dehydrated	„
---	————	Obnoxious	————	————	————	Very much dehydrated and granular	„

TABLE I.—HEAT TREATMENT OF INTACT FISH AT 98°—100°C.

No. of test	Solutions used	Observations (after) one hour					
		Turbidity	Tolerance	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
1	Citric acid 1.25%	+	+	+ (-)	+	+	+
2	„ „ 2.5%	+ -	-	++	+	+	+
3	Acetic acid 1%	++	+	+	+	+	+
4	„ „ 1.5%	+	-	+	+	+	+
5	„ „ 2%	+	--	+	+	-	+
6	„ „ 2.5%	-	---	++	+	-	-
7	„ „ 3%	-	---	+++	++	-	--
8	Acetic acid 2%	++	---	-	+	-	+
	Sodium citrate 1%						
	„ acetate 1%						
9	Citric acid 2.5%						
	Borax „ 0.2%	-	---	+	+	+	+
10	Citric acid 2.5%	-	+	+	+	+	+
	Borax „ 0.2%						
11	Sodium phosphate 1%	+++	++-	+	-	-	+
	o-Phosphoric acid (2 drops in 100 ml.)						
12	Borax 0.5%	-	+++	+	+-	+	+
13	„ 1%	-	+++	++	+-	+	+
14	„ 3%	-	+++	+++	+-	++	+
15	„ 5%	-	++	+++	++	++	+
16	Lemon juice (fresh)	-	-	+	-	+	+
17	Water as control	-	+	-	-	+	+

TABLE II.—COOKING OF INTACT FISH WITH SPICES AND OIL.

No. of tests	Observations (spices and oil) one hour				
	Tolerance	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
1	+ + -	-	-	+	+
2	+	+	+	+	+
3	+	+	-	+	+
4	+	+	+	+	+
5	+	+	+	+ -	+
6	+	+	+	+	+
7	+	+ +	+	+	+ -
8	+	+ -	+ +	+ -	+
9	+	+	+ -	-	+
10	+	+ +	+	-	+
11	+ -	+ -	+ -	-	+
12	+ +	-	+	+ + +	+
13	+ +	-	+	+ +	+
14	+ +	-	+ +	+ + -	+
15	+ +	-	+ +	+	+
16	+	+ +	+ -	-	+
17	+	-	-	+	+

TABLE III.—COOKING OF INTACT FISH WITH SPICES FRIED IN OIL.

No. of tests	Observations (spices and oil) one hour				
	Tolerance	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
1	+	+	-	+ -	+
2	+	+	+	+ -	+
3	+	+ + -	-	+ -	+
4	+	+ + -	+	+ -	+
5	+	+ + -	+	+ -	+
6	+	+ + -	+	-	+
7	+ -	+ +	+	-	+
8	+	+	+	+	+
9	+	+	+ + -	+	+
10	+	+ -	+ + -	+	+
11	+	-	+ + -	+ + -	+
12	+ + +	+ -	+	+	+
13	+ +	+ -	+	+	+
14	+ +	+	+	+	+
15	+ +	+	+ + -	+ +	+
15a (Borax 10%)	+ +	+ +	+ + -	+ +	+
16	+	+ +	+	+ -	+
17	+	-	-	+	+

TABLE IV.—SPECIAL HEAT TREATMENT OF INTACT FISH AT 98°—100°C.

No. of test	Solutions used	Observation after one hour				
		Tolerance	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
1	Borax 3% + Glycerine	++	+	+	++	+
2	Borax 5% + Glycerine	++	++	+	++	+
3	Borax 10% + Glycerine	++	++	+	++	+
4	Water 200 ml. Glycerine 0.5 ml.	+	-	-	+	+
5	Water 100 ml.	+	-	-	+	+

TABLE V.—HEAT TREATMENT OF INTACT FISH UNDER DIFFERENT CONDITIONS.
(TEMPERATURE OF SOLUTIONS : 98°—100°C.)

No. of test	Solutions used	Observations					
		Tolerance	Chemical effects on proteins	Surface effect	Degree of bone softening	Degree of water retention	Duration
1	Citric acid 2.5%	++	+	+	+	+	1 hr.
2	Citric acid 2.5% Borax 0.2%	+	++	++	++	+	"
3	Acetic acid 4%	+ -	++	++	++	-	"
4	Borax 2%	+	-	-	-	+	"
5	" 4%	+	+	+	+	++	"
6	" 5%	+	+	+	+	++	"
7	" 10%	+	+	+	+	+++	"
8	Water	+ -	-	-	-	Normal	"
1	Citric acid 2.5%	+	++	+	+	-	2 hrs.
2	Citric acid 2.5% Borax 0.2%	-	++	++	+	-	"
3	Acetic acid 4%	+	++	++	++	-	"
4	Borax 2%	+	+	+	+	+	"
5	" 4%	+	+	+	+	+	"
6	" 5%	+	+	+	+	+	"
7	" 10%	+	+	+	+	+	"
8	Water	+ -	-	-	-	Normal	"
1	Citric acid 2.5%	+	++	++	++	-	3 hrs.
2	Citric acid 2.5% Borax 0.2%	+	+	+	+	-	"
3	Acetic acid 4%	+	++	++	++	-	"
4	Borax 2%	+	+	+	+ -	++	"
5	" 4%	+	+	+	+ -	++	"
6	" 5%	+	+	+	+ -	++	"
7	" 10%	+	+	+	+ -	++	"
8	Water	+	-	-	-	Normal	"

TABLE VI.—TREATMENT OF INTACT FISH SLICES UNDER OPTIMUM CONDITIONS.

Name of fish in pieces	Solutions used	Tolerance	Chemical effects on proteins	Degree of bone softening	Degree of water retention	Odour
Ilisha	Acetic acid 1.0% (a)	+	-	+	-	+
	Citric 1.5% (b)	+	-	++	+	+
	Borax 5.0% (c)	+	++	++	++	+
Putti	a	+	-	+	-	+
	b	+	-	++	+	+
	c	+	+	++	++	+
Foli	Acetic acid 10.0%	-	+++	+++	---	-

TABLE VII.—OPTIMUM CONDITIONS FOR COOKING INTACT FISH SLICES WITH CHEMICALS IN PRESENCE OF SPICES.

Chemicals	Range of concentrations	Duration hrs.	Temperature	Heating arrangements
Acetic acid	0.5 — 2.0%	$\frac{1}{2}$ — 1 $\frac{1}{2}$	95 — 98°C.	Water or steam bath
Citric	0.5 — 3.0%	1 — 2	110 — 120°C.	Sand bath
Borax	3.0 — 7.5%	1 — 2	110 — 120°C.	„ „
Lemon juice	Same as in fruits	1	105 — 110°C.	„ „
Water (control)	110%	1 — 1 $\frac{1}{2}$	95 — 98°C.	Open burner or electric heater (controlled)

conditions show several desirable features. (cf. Table VI).

These observations point the way to future progress in work on fish bones softening in the intact fish through suitably adapted chemical treatment. The hydrolysis of proteins to amino acids during such cooking process was not significant enough to be detected by the ordinary titration methods. It therefore appears that the fundamental aspects of protein loss, nutritive degradation, toxicity and others that might be caused by chemical treatments, have been essentially controlled. Further work is in progress and the results will be published later.

Acknowledgement

The authors wish to thank Dr. Salimuzzaman Siddiqui, Director, Pakistan Council of Scientific and Industrial Research, Karachi, for his helpful suggestions during the progress of the work.

References

1. M.Q. Khuda, S. Fazl-i-Rubbi, and N.A. Khan, paper read at the tenth Pakistan Science Conference, March, 1958.
2. Md. Sweetman and I. Mackeller, *Food Selection and Preparation*, (John Wiley and Sons, Inc., New York, 1954), 4th edition.