STUDIES ON THE CHEMICAL QUALITY OF CURED FISH PRODUCTS FROM THE WEST COAST OF INDIA

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Introduction

Fish curing is one of the oldest industries of the coastal areas of India. It has been estimated that about 50 to 70% of the marine fish catches of India are at present being processed into cured products (*Government of India Publication*, 1951 *a* and *b*). Though fish curing is of this magnitude, it is one of the least developed industries of India, although efforts are being made in some of the maritime States such as Madras, Travancore-Cochin and Bombay, to improve curing by providing better facilities to the fishermen engaged in the industry. The methods practised are generally primitive and the attention paid to cleanliness and sanitation leaves much to be desired. Only 17·3% of the total fish landing is being cured through the Government fish curing yards (*Government of India Marketing Report*, 1951), the rest being processed in private yards which are not under the supervision of Government agencies.

Knowledge of the comparative merits of the various curing methods, practised in different parts of the country, is an essential prerequisite for developing improved techniques. The earlier published accounts of Nicholson (1930) and Govindan (1916) in Madras State and Sorley (1948) in Bombay State give details of the industry in the respective States and a more recent account is given in the *Marketing Reports of the Government of India* (1951). The present investigation was undertaken to form a preliminary idea of the chemical composition of cured fish products prepared by the indigenous processes adopted in different parts of the country.

Methods of Curing

The chief methods of curing, practised along the South and West Coasts, are: (1) Sun drying; (2) Dry salting; (3) Wet salting; (4) Pit curing; and (5) Colombo type of curing. In actual practice these techniques differ in finer details from place to place and are known by different names.

Sun drying.—Besides being the cheapest method of fish curing, the products obtained after sun drying have very high nutritive value, as compared to those cured by other processes, since the loss of body fluids is small

in this type of curing. As soon as the fishes are landed they are rinsed in sea-water and spread out on coir or cudjan mattings in the open air for drying. In certain areas no rinsing is done and at times the fishes are spread even on the open sandy beach.

In Bombay and areas north of Bombay fishes like Bombay-duck, marine eels, ribbon-fish, soles, etc., are usually sun-dried. Bombay-duck and marine eels are dried by hanging them on bamboo or wooden rods or even ropes stretched horizontally between two vertical poles. This method of drying is found to be very effective, since all the sides of the fish get dehydrated quickly and uniformly. Further, this also prevents contamination by sand and other extraneous matter.

The sun-dried samples collected were either too dry, as in the case of the Bombay-duck, the flesh of which was very stiff and hard, or too crumbled, as in the case of many samples of sardines, where the flesh was found to be in loose flakes with mould growth in between and with a coating of sand over the surface. The results of analyses of the different samples collected are tabulated in Table I. In almost all places it has been found difficult to obtain a good sun-dried product of a standard quality, owing to humid atmospheric conditions. In spite of continued drying the samples retain high moisture content which, in turn, facilitates early spoilage of the samples. Added to this is the negligence of the curers. The method of drying is invariably not satisfactory in many of the places visited. The fish are spread on open beach and a good amount of sand is blown into the product by wind, contributing up to 5 to 6% insolubles. Unscrupulous curers add sand into their cured fish for increased weight. At times, when the fish landings are heavy, the curers dry the fish on the hot sand itself. From the records of Saha and Choudhury (1951) and Saha, Deb and Sen (1949) it is clear that sun drying is adopted frequently in Bengal for the curing of freshwater fishes also. The sun-dried products, in general, are found to be unwholesome and mixed with a fair amount of sand and other materials from the mud. Another disadvantage is that the fish are often dried only on one side, resulting in the hardening of the flesh on that side, which prevents the further progress of dehydration from the inner tissues.

Dry curing.—Next to sun drying the most widely practised method is dry curing or dry salting or ordinary cure. Salt is used to effect partial expression of moisture from the fish tissues and also to serve as an added preservative. But the ratio of salt to fish varies from place to place, depending mostly on the size and fat content of the fish and on the season of curing. Large fishes like seer, pomfrets, cat-fish, jew fish, perches, etc., are invariably

Analyses of sun-dried samples of fish collected from different fish curing centres along the West Coast of India

No.	Species	Place of collection	Moist. %	Insol. %	NaCl %	T.V.N. mg./100 g.	Total nitrogen %	Protein % (N×6.25)	Ash %	P_2O_5 %	CaO %	Iron mg./100 g.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Euthynnus* sp. ..	.. Paramakudy	30·5	..	6·9	165·0	8·788	54·92	12·8	3·37	2·0	9·0
2	*Sardinella* sp.	.. ,,	28·0	..	7·2	165·0	6·507	40·67	17·8	4·08	3·6	7·5
3	*Otolithus* sp.	.. ,,	28·0	..	8·7	48·5	8·012	50·07	20·0	3·61	4·1	6·1
4	*Sillago* sp. ..	.. ,,	33·5	..	11·0	115·5	6·550	40·94	20·5	3·88	5·8	9·0
5	*Engraulis* sp.	.. ,,	21.5	..	7·2	89·1	8·900	55·62	18·3	4·09	6·2	17·5
6	*Upeneus* sp.	.. ,,	28·0	..	12·9	125·4	7·720	48·25	21·9	3·43	..	10·5
7	*Sardinella* sp.	.. Kovilpatty	13·8	2·7	3·0	274·0	9·220	57·75	15·7	7·25	6·0	17·5
8	*Engraulis* sp.	.. ,,	15·0	5·2	0·7	198·0	10·240	64·00	16·5	4·77	3·2	19·3
9	*Pellona* sp. ..	.. ,,	19·7	1·4	0·7	274·0	9·779	61·12	16·9	2·82	1·1	21·0
10	*Sardinella* sp.	.. ,,	22·7	1·8	0·7	287·0	9·681	60·50	10·9	2·51	1·0	21·0
11	*Engraulis* sp.	.. Vizhingam	42·3	0·1	0·6	166·0	6·418	40·12	17·0	3·39	1·3	7·0
12	*Sardinella* sp.	.. ,,	38·0	0·2	1·8	141·1	5·514	34·46	22·6	5·44	3·2	122·5
13	*Anchoviella* sp.	.. Cape Comorin	16·4	1·4	3·7	151·2	8·980	56·12	19·3	4·71	2·7	49·0
14	*Sepia* sp. ..	.. ,,	23·3	1·2	4·7	167·0	8·120	50·75	10·9	2·78	0·8	24·5
15	*Cynoglossus* sp.	.. Narakkal	33·5	0·2	12·3	157·9	7·590	47·44	20·2	3·22	2·4	12·3
16	*Engraulis* sp.	.. ,,	38·5	0·1	13·5	208·3	6·418	40·12	21·2	4·64	3·2	7·0
17	*Engraulis* sp.	.. ,,	39·0	0·1	15·2	157·9	6·600	41·25	20·5	2·59	1·9	15·8
18	*Leiognathus* sp.	.. ,,	38·5	0·1	13·2	134·4	5·600	35·00	18·6	3·17	1·8	10·5
19	*Engraulis* sp.	.. ,,	42·5	..	12·3	161·3	..	..	18·3	2·80	1·5	5·3
20	*Trichiurus* sp.	.. Sewri, Bombay	13·8	..	1·5	168·0	11·910	74·44	11·2	2·49	2·2	8·8
21	*Trichiurus* sp.	.. ,,	18·5	..	1·9	182·0	11·220	70·13	11·0	2·28	2·2	39·4
22	*Sciæna* sp. ..	.. ,,	18·2	..	2·1	224·0	11·025	68·94	12·1	4·61	6·6	45·6
23	*Coilia* sp.	.. ,,	16·4	..	2·1	182·0	11·760	73·50	9·3	2·55	..	52·5
24	Prawn ..	.. ,,	18·0	..	1·8	100·8	8·810	55·06	18·8	2·60	..	56·0
25	*Harpodon* sp.	.. ,,	22·1	..	7·5	252·0	9·380	58·63	14·2	2·57	1·6	38·5
26	,,	.. ,,	21·6	..	5·9	260·4	9·730	60·88	12·2	3·30	1·5	41·4
27	,,	.. ,,	21·6	..	10·0	196·0	9·660	60·37	17·1	2·54	..	31·5
28	,,	.. ,,	20·7	..	5·3	232·0	10·240	64·08	12·7	2·09	1·3	41·6
29	,,	.. ,,	17·9	..	4·7	168·0	11·130	69·56	12·2	2·62	..	14·0
30	*Sardinella* sp.	.. Majali	15·4	..	3·8	154·0	11·900	74·37	6·6	2·63	..	..

split, along either the dorsal or ventral line, from snout to caudal fin and entrails removed. Small fishes like silver-bellies, sardines, etc., are not split open nor are the entrails removed. In the case of fleshy fish, deep scores are also made to facilitate quick penetration of salt into the inner tissues. In curing work conducted outside Government curing yards fishes are stacked in the brining tank and salt is added indiscriminately. In these cases the ratio of salt to fish often ranges between 1 : 5 and 1 : 7 with respect to big fishes, while with smaller fishes the ratio is found to be very much altered—generally between 1 : 8 and 1 : 10. In fish curing yards managed by State Governments definite ratios have been fixed for different kinds and sizes of fish and for different seasons of the year (Appendices I and II). The curers do not follow any hard and fast rule regarding the period of brining. Generally the fish is kept with the salt for a period of 12 to 18 hours. The market demand also seems to have much to do with the period allowed for brining. If the demand is high curers do not hesitate to remove the fish and get them ready for sale within about 10 hours after the application of salt. On the other hand, if the market demand is dull they allow longer period for salting.

After brining the fishes are removed from the tank and are given a superficial washing with the self-brine itself. Curers are of the opinion that if they resort to washing of the brined fish in fresh sea-water, they lose considerably in the weight of the finished product, even though it is found to give a better appearance. Instances of the self-brine formed in one lot being used, without filtration or clarification, for salting fresh batches of fish are also common. However, they add more salt to the self-brine to keep up the salt concentration. The results of analyses of 56 specimens of dry cured samples are tabulated in Table II.

In the Kanara District of Bombay, fishes like the mackerel, *Otolithus*, *Lactarius*, etc., are also being cured after 'gibbing', and the process is locally called " Mona Cure ". This is essentially a dry cure, except that the fishes are not slit open. Instead the entrails of the fish are removed by pulling them out through the mouth cavity. The abdominal cavity is thoroughly washed and filled with salt (in the proportion of 1 : 4 during wet weather and 1 : 5 during the dry weather) and the fish cured in the usual way. Even though this is a very elegant method of curing, it has only limited application, owing to its time-consuming nature.

Wet curing.—Wet curing is another major method met with in the areas surveyed, but is not prevalent in places north of Bombay. It is usually known as " Ratnagiri method " and in the Konkan Districts of Bombay

State it is known by the local term *kharavani*. In this process the salt is added in three instalments, half of the apportioned quantity at the beginning being rubbed on to the cut surface of the fish and the other half in two lots during the two subsequent days. The finished product is marketed without drying.

In certain fish curing centres of Travancore-Cochin State the application of the entire apportioned quantity of the salt to the fish is carried out at the beginning itself instead of the three-stage application. This single stage of salt application is usually done in the case of medium-sized fishes like the mackerel, sardines, small-sized cat-fishes, etc.

At Alleppey, in Travancore-Cochin State, wet curing is done in a slightly different way in the case of medium-sized fishes like the sardines and the mackerels. The fish are gutted and thoroughly washed in sea-water and a liberal amount of salt is placed in the body cavity of the fish, after which they are neatly arranged in a close-woven cylindrical bamboo basket. A little amount of salt is sprinkled above each layer of the fish. The process is continued till the basket is full. Each basket will hold about 1,250 sardines of 6" length. Approximately 1½ maunds of salt is required for every thousand sardines. When the basket is full, it is marketed immediately, without allowing any time for the salt to penetrate into the fish.

Pit curing.—This is another method of wet curing which is being slowly given up and at present it is only occasionally practised in the area under survey. On a limited scale some curers in the area around Tuticorin and Cape Comorin are doing pit curing. Pit curing is generally done when there is an exceptionally heavy landing of fish, which could not all be dealt with by other methods. A rectangular pit of about 2' depth is dug in the sandy beach and the bottom and the sides are lined up with cudjan leaf matting. Large fishes are gutted and washed, while small ones are treated whole. Fish and salt are mixed in an approximate proportion of 1 : 4 and are stacked in the pit till it is three-fourth full. The fish stack is then covered by a mat and the pit is closed by putting sand over and sometimes trampled upon so as to apply some pressure on the underlying fish. After 36 to 48 hours the pit is opened and the fishes are taken out and marketed without any washing or drying. The cured product is unwholesome, has a bad smell and, not infrequently, is infested with maggots.

Colombo type of curing.—Apart from the fish curing systems described above, certain curers of South Kanara and Malabar are practising the Colombo type of curing (Nicholson, 1930). Unfortunately samples of fish

TABLE II

Analyses of dry cured samples collected from different fish curing centres along the West Coast of India

No.	Species	Place of collection	Moist. %	Insol. %	NaCl %	T.V.N. mg./100 g.	Total nitrogen %	Protein % (N×6.25)	Ash %	P_2O_5 %	CaO %	Iron mg./100 g.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Cybium* sp. ..	.. Tuticorin	46·5	..	7·0	317·0	..	..	10·1	0·62	..	..
2	*Histiophorus* sp.	.. ,,	44·5	..	13·2	50·0	..	..	13·5	1·21	..	..
3	*Elacate* sp. ..	.. ,,	43·0	..	15·6	82·5	..	..	17·1	0·87	0·8	10·5
4	*Lutjanus* sp. ..	.. ,,	41·0	..	14·3	182·0	..	..	19·1	0·76	0·6	10·5
5	*Lethrinus* sp...	.. ,,	38·5	..	21·1	105·6	..	..	25·0	1·50	2.0	21·0
6	*Lethrinus* sp...	.. ,,	51·0	..	16·4	353·0	..	..	16·7	0·74	0·8	15·7
7	*Sphyræna* sp.	.. ,,	40·5	..	17·2	89·0	..	..	20·0	1·26	0·9	35·5
8	*Euthynnus* sp.	.. ,,	41·5	..	12·9	105·6	..	..	13·4	1·06	0·6	20·4
9	*Serranus* sp. ..	.. ,,	45·0	..	17·6	145·2	..	..	20·2	0·90	1·1	17·5
10	*Carcharias* sp.	.. ,,	42·0	..	18·1	59·4	..	..	21·0	1·03	1·0	21·0
11	*Caranx* sp. ..	.. ,,	41·4	..	14·3	99·0	..	..	16·2	0·98	0·6	12·3
12	*Arius* sp. ..	.. ,,	33·0	..	15·9	34·3	..	..	21·0	1·76	1·7	17·5
13	*Chorinemus* sp.	.. ,,	38·5	..	9·0	231·0	..	..	12·8	0·91	0·6	8·9
14	*Serranus* sp. ..	.. ,,	41·5	..	13·2	221·0	..	..	18·7	1·28	2·5	12·3
15	*Coryphæna* sp.	.. ,,	33·5	..	15·9	59·4	..	..	24·2	0·90	..	..
16	*Trygon* sp. ..	.. ,,	41.5	..	15·0	178·2	..	..	16·5	0·62	..	..
17	*Hemirhamphus* sp.	.. Kovilpatty	39·7	0·9	11·3	297·0	6·457	41·00	19·0	1·72	1·8	22·5
18	*Chirocentrus* sp.	.. ,,	39·5	1·2	11·3	291·0	6·800	42·50	16·3	1·18	..	7·0
19	*Euthynnus* sp.	.. Vizhingam	38·7	0·5	12·2	84·0	7·260	45·40	14·4	0·84	0·1	22·3
20	*Carcharias* sp.	.. ,,	41·5	0·2	11·1	77·2	6·990	43·70	14·4	3·24	0·1	14·0
21	*Cybium* sp. ..	.. ,,	41·3	0·2	13·4	25·0	6·460	41·00	14·1	0·79	0·2	8·2
22	*Arius* sp. ..	.. ,,	42·7	0·2	14·3	128·0	6·460	41·00	15·6	0·79	0·1	9·1
23	*Caranx* sp. ..	.. ,,	42·3	0·1	14·0	108·0	3·800	23·75	14·9	0·89	0·2	6·1
24	*Histiophorus* sp.	.. ,,	38·0	0·2	14·7	53·8	4·630	28·94	16·2	0·84	0·3	15·3
25	*Cybium* sp. ..	.. Cape Comorin	42·3	0·4	13·4	118·0	6·140	38·40	15·2	0·94	0·2	8·8

26	*Sardinella* sp.	.. Cape Comorin	38·8	0·3	17·2	276·0	6·100	38·13	19·6	1·56	0·8	14·0
27	*Chirocentrus* sp.	.. „	40·5	0·2	15·4	208·0	6·100	38·13	19·2	1·64	0·7	7·0
28	*Trichiurus* sp.	.. „	40·0	0·5	21·5	319·0	6·100	38·13	21·6	1·95	0·8	12·3
29	*Lactarius* sp...	.. „	35·5	1·0	16·3	229·0	4·910	30·69	23·2	1·20	0·7	21·0
30	*Carcharias* sp.	.. „	40·1	..	21·0	319·0	6·020	37·62	21·3	0·80	0·3	13·1
31	*Leiognathus* sp.	.. „	37·3	0·1	17·2	161·0	6·270	39·20	21·1	2·40	0·7	12·3
32	*Cybium* sp. ..	.. Quilon	44·7	..	13·5	287·0	5·490	34·30	19·5	2·56	0·2	13·1
33	*Chorinemus* sp.	.. „	45·5	..	14·2	254·0	3·398	33·75	17·3	2·71	0·2	17·5
34	*Thunnus* sp. ..	.. „	38·5	..	18·7	251·0	6·240	39·00	20·6	2·96	0·4	17·5
35	*Arius* sp. ..	.. „	43·4	..	18·8	271·0	5·224	32·65	20·9	2·66	0·3	19·3
36	*Histiophorus* sp.	.. „	35·1	..	10·5	224·0	7·532	47·06	14·3	1·43	0·2	14·0
37	*Trichiurus* sp.	.. Narakkal	29·8	0·1	15·9	148·0	7·250	45·31	20·2	1·19	0·6	8·8
38	*Caranx* sp. ..	.. „	40·5	..	16·5	151·0	5·780	36·13	20·0	3·84	3·9	35·0
39	*Arius* sp. ..	.. „	46·9	0·1	12·3	252·0	5·340	33·44	16·2	1·46	1·1	19·3
40	*Carcharias* sp.	.. „	31·3	..	18·8	134·0	5·200	32·50	23·1	4·84	3·6	14·0
41	*Sciæna* sp. ..	.. „	37·5	0·1	18·2	118·0	6·350	39·69	21·5	2·69	1·3	15·7
42	*Caranx* sp. ..	.. Sewri, Bombay	29·4	..	20·2	280·0	7·710	48·19	20·2	1·89	1·0	7·0
43	*Sardinella* sp.	.. Malwan	34·7	..	12·3	78·0	5·250	32·81	15·4	2·15	0·8	..
44	*Cybium* sp. ..	.. „	20·0	..	20·9	42·0	7·700	48·13	24·8	0·66	0·3	..
45	*Sardinella* sp.	.. Karwar	37·5	..	11·7	89·6	5·584	34·90	15·9	2·50	0·8	..
46	*Zygæna* sp. ..	.. „	39·4	..	16·4	95·2	6·400	40·00	18·5	6·07	0·1	..
47	*Rastrelliger* sp. (MONA)	„	34·7	..	13·1	119·1	7·231	45·19	17·7	1·75	0·8	..
48	*Trygon* sp. ..	.. „	37·0	..	11·7	196·0	7·160	44·75	15·1	2·20	1·5	..
49	*Carcharias* sp.	.. Bingi	39·4	..	10·5	467·6	6·430	40·19	12·7	3·05	..	..
50	*Sardinella* sp.	.. „	36·4	..	14·3	196·6	7·000	43·75	15·2	2·78	..	..
51	*Leiognathus* sp.	.. „	37·3	..	15·8	187·6	6·589	41·19	17·3	2·67	..	..
52	*Caranx* sp. ..	.. „	38·2	..	12·8	103·6	7·060	44·13	14·3	0·81	0·2	..
53	*Carcharias* sp.	.. Majali	40·8	..	13·0	112·0	6·400	40·00	15·5	1·55	..	..
54	*Carcharias* sp.	.. Chendia	40·0	..	14·6	252·0	6·039	37·75	15·8	1·03	0·2	..
55	*Sardinella* sp.	.. „	36·9	..	15·4	148·0	6·864	42·81	16·9	1·33	0·5	..
56	*Caranx* sp. ..	.. „	37·4	..	13·0	103·6	6·821	42·64	15·1	2·37	..	..

cured by this process could not be collected during the present survey and hence data on the chemical composition are not available.

Composition of Salt used in the Curing Industry*

During the course of the survey, about 16 samples of salt were collected from the various fish curing centres. The results of analyses are given in Table V.

Discussion of Results

Sun drying.—From the analytical data gathered it is clear that the sun-dried products are highly variable in quality. The moisture content is often high, reaching as far as 42·3%, while the lowest value recorded is 13·8%. The sodium chloride varies between 0·75 and 10%, while occasionally it was as high as 13%. Since in sun drying salt is not used, this high percentage of sodium chloride is unusual. The dried fish might have been stored on salt-laden floors of godowns along with salted fish or even with salt. Salt might also have come from salty sand of the beach where the fish were dried or the curers might have used the same mat on which they dry the salt fish. In some of the samples, the total volatile nitrogen is also found to be very high, indicating a high degree of spoilage. The T.V.N. varied from 50 to 300 mg./100 g. of cured fish. The samples were generally characterised by high protein, phosphorus, calcium and iron contents. In some of the smaller varieties of fish the analysis was done on the whole fish without removing the bones. The high percentage of calcium and phosphorus might be attributed to the bones.

Dry curing.—The moisture content varies between 30% and 50%. A single instance of 20% moisture has been recorded in the case of a sample collected from Malwan at the 'Model Fish Curing Yard' of Bombay State. The maximum of 50% was recorded in the case of *Lethrinus* collected from Tuticorin. In most of the samples the moisture level is high and far above the maximum limit generally accepted for dry cured fish (Lafont, 1951). The total volatile nitrogen shows a wide degree of variation, between 25 and 300 mg./100 g. of fish, in exceptional cases going up to 467·6 mg./100 g. The NaCl varies between 7% and 21% (wet basis). In some of the samples the chloride content is much below the minimum prescribed, whereas in others it is higher than the maximum. Almost all the samples had a high

* The tentative standards fixed by the Indian Standards Institution for common salt for fish curing (*vide* IS, 594–1954) are as follows:—

Sodium Chloride (NaCl)—Minimum 96·0% by weight.

Matter insoluble in water—Maximum 1·0% by weight.

Matter soluble in water other than NaCl—Maximum 3·0% by weight.

TABLE III

Analyses of wet cured fish samples collected from different centres along the West Coast of India

No.	Species	Place of collection	Moist. %	Insol. %	NaCl %	T.V.N. mg./100 g.	Total nitrogen %	Protein % (N×6·25)	Ash %	P_2O_5 %	CaO %	Iron mg./100 g.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Sardinella* sp.	.. Cape Comorin	42·2	0·3	12·2	188·0	5·830	36·44	16·4	1·97	1·4	12·5
2	*Carcharias* sp.	.. Quilon	50·9	..	15·8	313·0	4·390	27·43	19·1	2·66	0·2	12·3
3	*Sardinella* sp.	.. Alleppey	46·2	..	14·3	116·0	4·940	30·88	17·1	1·36	0·5	10·5
4	*Carcharias* sp.	.. ,,	50·5	..	10·0	116·0	5·120	32·00	13·0	2·98	0·2	13·1
5	*Sardinella* sp.	.. ,,	47·3	..	14·3	149·0	4·630	29·00	18·4	3·57	0·4	10·5
6	*Lactarius* sp...	.. Narakkal	33·0	0·2	16·1	235·0	6·830	42·69	22·8	2·74	1·4	17·5
7	*Cybium* sp. .. (from Arabia)	.. Sewri, Bombay	50·9	..	15·5	280·0	5·600	31·00	17·1	2·28	0·5	2·2
8	*Trygon* sp. ..	.. Ratnagiri	45·9	..	16·3	369·0	6·700	34·31	18·5	0·55	0·2	..
9	*Carcharias* sp.	.. ,,	50·6	..	17·6	280·0	4·700	29·38	18·2	2·15	0·8	..
10	*Sardinella* sp.	.. ,,	44·6	..	16·4	305·0	4·880	30·50	20·4	0·66	0·3	..
11	*Arius* sp. ..	.. ,,	47·1	..	16·0	202·0	5·400	33·75	18·5	2·50	0·8	..
12	*Sardinella* sp.	.. Majali	39·3	..	12·1	67·0	6·090	38·06	15·7	0·72	0·3	..
13	*Rastrelliger* sp.	.. Chendia	43·5	..	13·8	146·0	6·300	36·30	16·7	0·85	0·2	..

content of mineral matter (ash) and this may partly be contributed by the salt and partly by the bones present in some of these fishes. The iron content seems to be lower than in sun-dried products.

Wet curing.—The peculiarity of the wet cured fish, collected from the different places, is that the flesh is soft. This is mainly because of the high moisture content of the samples. Table IV indicates that some of the samples contain above 50% moisture. The samples are often characterised by very high salt content (up to 35% on dry basis). But, in spite of this high salt content, the samples collected from the fish curing yards in Bombay show very high T.V.N. values, indicating a high degree of spoilage. In the salting process only half of the apportioned quantity is mixed with the fish during the first day and the other half is added equally between the second and third day. Added to this the self-brine, which carries a good percentage of salt, is allowed to drain off continuously. Although the final figures will show a high proportion of salt, there is every likelihood that the fish do not get enough salt during the initial stages of salting, thereby accelerating spoilage. In Alleppey the entire salt is added in one lot and in samples from this place the values of T.V.N. are comparatively low.

Pit curing.—The samples contain a high moisture content, generally above 40%. The salt content is also very high and the T.V.N. values remain low, except in one instance, where the T.V.N. value was 666 mg./100 g. of fish. This latter sample was collected from the market, where it had been kept for a long period.

Quality of salt used in fish curing.—Very often the curers have been found to express the opinion that the issue rate of salt from the Government curing yards is not sufficient. This deserves due consideration in view of the fact that the salt issued at the different curing centres is highly variable in quality. Sodium chloride content was found to vary between 78% and 96% on original moisture basis. Similar variations in the composition of salt used in the fish curing industry have been noticed by Venkataraman and Sreenivasan (1955) also. Some of the samples of salt were highly impure, with dark brown colour and a high percentage of undesirable constituents such as insolubles, calcium, magnesium and sulphate. For example, most of the samples collected from Travancore-Cochin were characterised by very low sodium chloride content (Table V). These samples also show high magnesium chloride and calcium sulphate. It is interesting to note that the two samples collected from the fish curing yard at Quilon show widely different values in their chloride as well as Ca, Mg and SO_4 contents. The salt samples issued at the fish curing

TABLE IV

Analyses of pit-cured samples collected from the fish markets at Paramakudy and Kovilpatty in Madras State

No.	Species	Place of collection	Moist. %	Insol. %	NaCl %	T.V.N. mg./100 g.	Total nitrogen %	Protein % (N×6.25)	Ash %	P_2O_5 %	CaO %	Iron mg./100 g.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	*Sardinella* sp.	.. Paramakudy	35·5	..	17·4	165·0	..	..	26·2	3·06	2·3	10·5
2	*Arius* sp. ..	.. „	45·5	..	18·6	132·0	..	..	16·6	1·56	2·8	14·0
3	*Hemirhamphus* sp.	.. „	40·5	..	16·3	126·0	..	..	19·6	..	3·2	12·8
4	*Rastrelliger* sp.	.. „	45·5	..	17·4	132·0	..	..	22·4	..	2·2	8·9
5	*Mugil* sp. ..	.. „	44·0	..	17·4	139·0	..	..	23·8	..	1·8	12·1
6	*Lactarius* sp.	.. Kovilpatty	40·9	1·0	..	666·0	6·830	42·59	17·9	1·69	..	15·7
7	*Caranx* sp. ..	.. „	42·5	0·8	15·8	221·0	..	..	18·6	1·44	..	12·3

TABLE V

Analyses of salt samples

No.	Place of collection	Moist. %	Percentage on dry basis						
			NaCl	Insol.	$CaCO_3$	$CaSO_4$	$CaCl_2$	$MgSO_4$	$MgCl_2$
1	Tuticorin	6·10	90·53	1·65	Nil	..	Nil	0·65	3·13
2	Vizhingam	10·74	88·88	3·71	0·15	3·77	Nil	0·59	2·04
3	Vizhingam	13·27	90·44	1·48	0·15	2·06	Nil	1·33	3·78
4	Cape Comorin	9·20	91·37	1·33	0·22	0·77	Nil	1·77	2·57
5	Quilon	3·48	96·68	0·68	0·07	0·30	0·36	Nil	0·22
6	Quilon	13·91	92·68	2·22	0·20	1·10	Nil	0·93	2·48
7	Alleppey	11·36	91·73	1·00	0·23	0·83	Nil	1·42	2·64
8	Narakkal	2·75	98·22	1·30	0·13	0·49	Nil	0·26	0·09
9	Ratnagiri (Uran salt) ..	1·68	94·73	0·61	0·17	0·94	Nil	0·12	0·61
10	Malwan (Uran salt)	7·28	98·91	0·58	0·25	0·86	Nil	0·94	1·21
11	Karwar (Uran salt)	8·04	90·51	0·80	0·13	1·30	Nil	0·87	1·39
12	Bingi (Sanighatta)	6·10	90·65	1·92	0·27	1·54	Nil	0·82	1·19
13	Chendia (Uran salt)	8·94	97·05	1·69	0·15	1·82	Nil	0·64	1·21
14	Kilakkarai	5·10	93·61	2·21	0·17	1·14	0·34	Nil	0·56
15	Thankachimadom	5·06	95·10	2·48	..	1·38	Nil	0·19	0·48
16	Palk Bay (Lagoon salt) ..	2·45	98·37	0·59	..	1·06	Nil	0·18	0·40

yards of Bombay State appear to be of better quality, containing more sodium chloride and less of calcium and magnesium compounds than those issued in Travancore-Cochin State. Anyway it is desirable to review the salt proportion fixed by the different State Governments in relation to the NaCl content and the maximum allowable impurities. The importance of the purity of the salt, used for curing, need hardly be stressed and any effort made to have an analytical check on the quality of the salt issued will go a long way in improving the quality of the cured product.

Summary

A survey of the major fish curing centres in the Travancore-Cochin and Bombay coasts was undertaken. Samples of salt and cured fish, representative of the different methods practised in the above areas, were collected and analysed for their chemical constituents. Samples were also collected from three important dry fish marketing centres in the country and analysed.

The data indicate wide differences in the quality of the cured products collected from the different localities. The analyses of the salt samples show that in most cases the composition of salt used by the curers does not come within the tentative standards proposed for salt for fish curing purpose. The poor quality of the cured fish products can possibly be ascribed to the defects in the methods adopted in each area and to the low NaCl content of the salt or alternately to the high percentage of impurities in the salt.

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APPENDIX I

*Statement showing Proportion of Salt to be issued for Curing Fresh Fish under Local System of Curing during Dry and Wet Weather prescribed by Madras Government**

Name of fish	Wet weather scale for			Dry weather scale for		
	Small	Medium	Large	Small	Medium	Large
Seer-fish, *Chorinemus*, parrot-fish, pomfret, *Polynemus*, butter-fish, shark, skate, etc.	1:5	1:4	1:3	1:6	1:5	1:4
Cat-fish	1:6	1:4	1:3	1:7	1:5	1:4
Jew-fish	1:8	1:5	1:4	1:10	1:6	1:4
Chirocentrus, Barracuda, etc.	1:6	1:5	1:4	1:7	1:6	1:5
Mackerel (whole), *Lactarius*, *Trichiurus* and horse-mackerel	1:7	1:6	1:5	1:8	1:7	1:6
Sardines, *Dussumieria*, silver-belly, *Engraulis*	1:8	1:7	1:6	1:9	1:7	1:6
Anchovies, soles ..	1:9	1:8	1:8	1:10	1:9	1:8

* *The Madras Fisheries Manual*, 1942, pp. 115–16.

APPENDIX II

*Statement showing the Proportion of Salt to Fish as determined by the Departmental Model Fish Curing Sheds of Bombay**

Name of fish	Wet weather		Dry weather	
	Wet cure	Dry cure	Wet cure	Dry cure
Seer-fish, Jew-fish ..	1 : 3	1 : 5	2 : 7	1 : 6
Cat-fish, sharks, mackerel (split)	..	1 : 5	..	1 : 6
Pomfrets	1 : 4	1 : 5	1 : 5	1 : 6
Otolithus, Mackerel (MONA)	..	1 : 4	..	1 : 5
Mackerel (light-brined) and sardines	..	1 : 7	..	1 : 8
Prawns	..	1 : 5	..	1 : 5

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