FURTHER STUDIES ON THE INDIAN SARDINE OIL

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Introduction

In the west coast during the months of October to March large quantities of oil sardines (*Sardinella longiceps*) are caught by the rampani and other types of gill nets. The bulk of the catch is processed to oil and guano. A study of the different methods adopted in the west coast for the production of the oil and the quality of the oil is described in an earlier paper by Kamasastri (1960). In this paper the oil collected from the same centres and few more centres were studied for their quality and storage characteristics as the data on the commercial oils are lacking in the literature. Sardine oil was extracted in the laboratory in similar lines adopted by the trade with slight modifications to improve the quality of the oil. The chemical composition of the oils and the storage changes were studied along with the commercial oil samples stored at temperatures prevailing in Cochin (28–33° C).

Extraction of the Laboratory Oil Samples

100–250 kg. of fresh sardines landed at Manassary (near Cochin) were put in sufficient quantity of boiling water and cooked for 30–45 minutes. The cooked material was taken out and pressed through a canvas bag with the help of a lever press. The oil-water mixture was allowed to settle for a short time and the top oil layer was removed with very little stick water. The oil-water mixture was allowed to settle for overnight after saturating it with common salt to avoid protein degradation during the settling period. The addition of common salt prevents the spoilage of the protein particles and aids in precipitating the suspended impurities in the oil-water mixture. Next day the oil was syphoned. The separated oil was heated to just over 100° C. to remove the traces of water in the oil. The clear oil was filtered and stored in sealed tins. Centrifuging of the oil-water mixture can be adopted where the facilities are available. In the modern refining methods centrifuging is resorted.

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METHODS

The analysis for the various chemical constituents for the laboratory and commercial samples was done according to the A.O.A.C. methods. The colour of the oil is measured at different wavelengths in the Beckman Du spectrophotometer. 1 c.c. of the oil is diluted to 10 c.c. with ethylene dichloride and the optical density measured at different wavelengths at a temperature of 29° C. The O.D. is multiplied by 10 and the readings are given. The oxidised acids were determined according to Fahtion's method described by Nonaka (1957). After initial chemical analysis of the oil samples were stored in closed bottles for storage studies.

RESULTS

The analysis of the various chemical constituents like specific gravity, saponification value, iodine value, acid value, peroxide value, nitrogen content, unsaponifiables and oxidised acids for the laboratory extracted and commercial oil samples are presented in Table I.

The changes in the free fatty acids, Peroxide value and Iodine value of the oils during the storage period are given in Table II.

The colour of the oils as measured by the optical density of the oil at different wavelengths is given in Table III.

The effect of storage on the sardine oil in plain and brown bottle is given in Table IV.

DISCUSSION

It is seen in Table I that the colour of the oil in the commercial samples varied from yellow to black. The acid value in the dark-coloured oils is generally more when compared with light-coloured oils. The percentage of the oxidised acid and the nitrogen content are more in dark-coloured oils. Matsuhashi (1954) found that the content of the oxidised acids is more in dark-coloured oils. In the samples collected from Malpe and nearby places no peroxides were detected. This is in agreement with the observations made during 1957 season. The unsaponifiable matter was also less in the samples collected from Malpe. High percentage of nitrogen and oxidised acids were noticed in the commercial samples when compared with the oils extracted from the laboratory. The dark colour of the oils is partly due to the scorching of the fish during the extraction stage where the skin pigments and pigments of the other parts of the body (mainly the Carotenoids) are oxidised and impart a dark colour. The dark colour of the oil is also due to the different

TABLE I

Chemical and Physical characteristics of the Sardine oil samples collected during the season 1960–61

S. No.	Sample and place of collection	Date of analysis	Colour of the oil	Specific gravity 25/25°C	Saponification value	Iodine value Hanns.	Acid value	Insoluble acids %	Peroxide value N/500 thio./1 gm. of fat	Unsaponifiable matter %	Nitrogen %	% Oxidised acids
1	Commercial sample, Pudiangadi	15 days old	Dark brown	0·9234	195·5	170·3	40·17	92·30	0·14	0·83	0·04	2·77
2	do.	do.	Brown	0·9262	195·8	167·2	23·05	92·43	2·73	0·87	0·05	1·81
3	do.	do.	Dark brown	0·9230	196·3	170·8	33·88	92·45	0·32	0·87	0·05	1·96
4	Commercial sample, Irringal	do.	Black	0·9239	195·9	157·3	40·21	92·43	7·64	1·04	0·21	3·88
5	Commercial sample, Mangalore	4 years old sample	do.	0·9264	192·9	152·4	69·00	92·43	0·52	1·02	0·15	2·96
6	Commercial sample, Malpe	15 days old	Yellow	0·9258	195·1	173·5	6·21	92·21	Nil	0·56	0·03	0·44
7	do.	do.	Dark brown	0·9253	193·4	171·6	21·69	90·44	Nil	0·70	0·02	2·45
8	Commercial sample, Udayavara	do.	do.	0·9239	195·7	175·8	34·45	91·66	Nil	0·57	0·02	0·99
9	Commercial sample, Malpe	do.	Dark brown to black	0·9202	198·0	161·0	53·46	88·06	9·2	0·69	0·04	3·9
10	do.	do.	Light brown	0·9260	194·4	161·0	8·81	94·52	Nil	0·70	0·03	1·44
11	Laboratory sample Cochin	Stored in tin Fresh	Lemon-yellow	0·9253	192·3	166·8	0·87	95·50	2·14	1·20	0·01	0·54
12	do.	do.	do.	0·9264	193·3	171·0	0·56	94·90	1·05	1·10	Nil	0·63
13	do.	do.	do.	0·9281	193·2	165·0	0·59	95·60	2·4	1·10	Nil	0·66
14	Laboratory samples, Sardines scorched and pressed, Cochin	do.	Brown	0·9281	193·0	160·6	3·43	94·60	2·7	1·15	0·01	0·98
15	Laboratory sample, Cochin	do.	Lemon-yellow	0·9281	193·0	168·0	0·56	95·75	1·9	1·12	Nil	0·56

TABLE II

Storage studies of the sardine oils at laboratory temperatures

S. No.	Sample	Free fatty acids as % of oleic					
		Storage period					
		Initial	One month	Four months	Seven months	Nine months	Eleven months
1	Pudiangadi ..	21·07	25·17	27·00	30·03	32·50	33·95
2	do. ..	10·95	13·26	14·79	15·27	16·37	17·96
3	do. ..	17·06	21·06	23·92	24·28	26·32	29·45
4	Iringal ..	21·21	25·86	31·34	34·95	38·50	45·44
5	Mangalore ..	34·73	34·63	38·32	41·49	44·60	49·84
6	Malpe ..	3·13	3·53	4·54	4·57	5·0	5·76
7	do. ..	10·92	11·61	12·93	13·00	13·82	14·80
8	Udayavara ..	17·35	18·50	19·89	25·60	26·14	27·31
9	Malpe ..	26·90	27·13	31·08	31·08	32·50	35·90
10	do. ..	4·44	4·50	5·18	4·26	4·4	4·94
11	Laboratory sample, Cochin ..	0·44	0·44	0·47	0·68	0·84	1·17
12	do. ..	0·28	0·24	0·38	0·44	0·42	0·44
13	do. ..	0·30	0·55	0·73	0·73	0·81	1·05
14	do. ..	1·73	1·73	1·74	1·76	1·82	2·0
15	do. ..	0·28	0·26	0·35	0·4	0·44	0·48

S. No.	Sample	Peroxide values (No. of ml. of N/500 thio. per 1 gm. of fat)					
		Storage period					
		Initial	One month	Four months	Seven months	Nine months	Eleven months
1	Pudiangadi ..	0·14	0·50	1·4	3·6	6·5	14·79
2	do. ..	2·73	2·5	2·9	3·2	3·5	6·99
3	do. ..	0·32	0·48	1·0	1·7	2·08	3·31
4	Iringal ..	7·64	5·2	2·5	1·74	0·02	Nil
5	Mangalore ..	0·52	0·60	1·04	2·5	2·09	2·86
6	Malpe ..	Nil	Nil	Nil	Nil	Nil	5·5
7	do. ..	Nil	Nil	Nil	0·15	0·13	2·2
8	Udayavara ..	Nil	Nil	Nil	Nil	0·69	0·67
9	Malpe ..	9·2	4·2	2·1	Nil	1·51	7·46
10	do. ..	Nil	4·0	5·9	5·9	9·12	10·58
11	Laboratory sample, Cochin ..	2·14	2·5	2·99	3·0	3·17	3·09
12	do. ..	1·05	1·05	1·05	1·04	3·18	3·69
13	do. ..	2·4	3·5	3·5	4·1	4·2	4·5
14	do. ..	2·7	2·7	2·7	2·1	3·5	4·0
15	do. ..	1·9	1·9	2·0	2·2	2·5	3·50

S. No.	Sample	Iodine values (Hanus method)					
		Storage period					
		Initial	One month	Four months	Seven months	Nine months	Eleven months
1	Pudiangadi ..	170·3	162·3	150·8	143·6	136·3	134·0
2	do. ..	167·2	165·0	164·9	164·5	154·5	149·9
3	do. ..	170·8	167·5	157·5	149·7	141·5	137·2
4	Iringal ..	157·3	157·3	144·6	138·0	126·4	109·0
5	Mangalore ..	172·4	165·0	158·0	152·3	146·0	141·8
6	Malpe ..	173·5	172·0	168·4	163·7	158·4	156·6
7	do. ..	171·6	170·5	168·3	165·6	150·4	142·6
8	Udayavara ..	175·8	157·7	155·6	152·6	147·1	142·8
9	Malpe ..	161·0	159·3	156·5	153·9	147·5	144·3
10	do. ..	161·0	161·0	158·0	157·3	150·8	150·5
11	Laboratory sample, Cochin ..	166·8	165·0	162·0	160·6	157·5	159·4
12	do. ..	171·0	170·5	167·0	165·1	160·7	161·4
13	do. ..	165·0	162·3	160·5	159·8	157·5	155·3
14	do. ..	160·6	160·6	158·4	154·8	154·5	153·4
15	do. ..	168·0	165·0	162·5	162·3	160·4	158·6

TABLE III

Optical densities of the sardine oil samples taken at 29° C.

S. No.	Sample	Colour of oil	Optical density (mμ)				
			420	460	550	630	670
1	Pudiangadi	Dark brown	..	4·55	1·25	0·60	0·50
2	do	Brown	..	3·5	0·85	0·38	0·35
3	do	do	6·6	4·1	1·1	0·50	0·35
4	Iringal	Black	20·0	11·05	3·75	1·35	0·95
5	Mangalore	do	17·0	10·0	3·25	1·30	0·90
6	Malpe	Lemon-yellow	1·0	0·63	0·075	0·075	0·075
7	do	Black	20·0	11·5	3·2	1·10	0·65
8	Udayavara	Dark brown	8·3	4·7	1·25	0·48	0·35
9	Malpe	do	10·0	5·4	1·45	0·55	0·35
10	do	Light brown	3·45	1·7	0·40	0·25	0·20
11	Laboratory sample, Cochin	Lemon-yellow	0·75	0·55	0·075	0·075	0·075
12	do	do	0·80	0·65	0·075	0·075	0·075
13	do	Yellow	1·65	1·1	0·15	0·05	0·05
14	do*	Brown	9·60	4·9	1·0	0·40	0·35
15	do	Lemon-yellow	0·75	0·60	0·075	0·075	0·075

* Sardines were scorched during boiling and the oil extracted.

TABLE IV

Analysis	One month	Two months 15 days	Four months	Six months	Seven months	Nine months 15 days
Sardine oils stored in plain glass bottles						
1. Acid value ..	11·52	11·40	11·20	11·98	12·43	12·96
2. F.F.A. % as oleic ..	5·8	5·74	5·64	6·03	6·26	6·53
3. Iodine value (Hanus) ..	161·0	160·0	156·2	150·0	160·6	159·0
Sardine oil stored in brown bottle						
1. Acid value	11·52	10·94	11·5	11·95	12·54	13·05
2. F.F.A. % as oleic	5·8	5·41	5·8	6·02	6·31	6·57
3. Iodine value (Hanus)	161·0	151·0	155·0	147·0	155·0	156·0

degrees of freshness of the fish at the time of processing and the long settling periods of the oil-water mixture after the extraction. The oils extracted from the spoiled fish are dark in colour.

Experiments done on the factors responsible for the bad quality of the commercial oils showed that the degree of freshness is related to the high acid value and the varying colour of the extracted oils. The acid value increases to 3–4 times its original value when the settling period of the oil-water mixture is exceeded to 72 hours. Iodine value and the peroxide value are not much effected during this period. The foul odour to the commercial oils are imparted during the settling period. During the extraction stage a part of the oil is oxidised and the protein particles in the stick water decomposes during the settling stage and the ammonia and other basic nitrogenous products aids the oxidised acids in imparting dark colour to the oil. It is seen from Table I that the oxidised acids in the commercial oils are more (unpublished work). Experiments done by Nonaka (1957) on the discolouration of fish oils showed that the volatile basic nitrogenous products forms the second factor in the discolouration of the auto-oxidised oils. The discolouration by mere oxidation of the oil is very little. The variation in the quality of the different commercial oils is mainly due to the different degrees of freshness of the fish before processing, long settling periods and to a certain extent to the overheating before storage.

From Table II it is seen that the increase in the free fatty acids and peroxide value in the laboratory extracted oils is little when compared with the commercial oil samples. Good quality oils stored in sealed tins will remain for one year without much deterioration. It is also observed that the peroxides show a rise and fall during the storage period.

From Table III it is seen that the optical density decreased as the wavelength is increased. All the samples showed a high absorption in the region of 420–460 mμ. This is characteristic of the carotenoid group of pigments in the oil samples. The oils collected from the different places varied in their colour. In grading the vegetable oils the red and yellow units are being widely used in the industry. To make a uniformity in reading the colour of the sardine oils, the absorption of these oils in the blue, green, yellow, orange, and red regions were taken and tabulated. The grading of the different sardine oils on the basis of the absorption measurements and visual colour can be said that at 460 mμ the lemon-yellow oils have an O.D. multiplied by 10 ranged from 0·55–0·60, yellow oils from 1·10–1·70, brown to dark brown oils 3·50–5·40 and black oils from 10·0–11·50.

Summary

A survey of the quality of the sardine oil from different places in the west coast was done. The storage changes in the commercial oils and the laboratory extracted oils were given. The deterioration in the good quality oils is comparatively less than the commercial oils. Dark colour of the oil is associated with high percentage of oxidised acids, nitrogen content and high acid value. Storage of oils in plain and brown containers has little effect on the iodine value and acid value.

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