A REVIEW ON OIL SARDINE

III. OIL AND MEAL INDUSTRY

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OIL INDUSTRY

It was in the early 20's of this century that the sardine oil industry developed and came to prominence in India, though the fishery dates back to 1320 A. D. In 1922-'23 a maximum production of about 12,500 tons of sardine oil has been recorded by about 700 small extraction units (Kini, 1968). Wide fluctuations have been noticed thereafter. The production of sardine oil and other byproducts in Kerala State during 1964 to '68 is given in table I.

The abundance of oil sardine fishery confined to a short period and the further probable increase in the quantum of landings likely to be brought about by the envisaged introduction of more and more small and large sized vessels will pose a real problem for the effective utilization of catch. In the off shore zone upto 80 m. depth, though the data are not sufficient, investigations have revealed substantial potential for pelagic fishes like sardine, mackerel and tuna. A series of investigations conducted with small purse seines operated from vessels of 36′ have consistantly yielded an average catch of 3.2 tons of sardines per haul in this region (Devidas Menon, 1971). The canning, freezing and transportation of the likely catch, coupled with other methods of preservation will be found inadequate to dispose the entire catch. It is here that the oil industry will be coming to stay. Further with the increasing demand for sardine oil in foreign countries and increased use of this commodity for various

TABLE I

*QUANTITY IN TONS OF DIFFERENT BYPRODUCTS PRODUCED IN KERALA STATE

Byproduct	1964-65	1965-66	1966-67	1967-68	1968-69	Average
Sardine oil	2073.13	1079.88	85.17	5.35	671.26	782.96
Fish Guano	7031.35	613.50	85.00	12.00	197.80	1963.66
Fish Manure	5909.18	433.00		3882.48	8808.10	4758.19
Fish Meal			6.08	84.73	22.08	37.63

* Kerala Fisheries Administrative reports

TABLE II

COMPARISON OF THE INDIAN SARDINE OIL WITH OTHER SIMILAR OILS

Property	Indian Sardine oil	British Columbia Herring oil	Canadian Pilchard oil	North American Menhaden oil
Sp. gravity at 15.5°C.	0.9218	0.9228— 0.9265	0.9290— 0.9370	0.9311
Colour Lovibond units in 1" cell (i) Yellow	70	20-35	40-75	—
(ii) Red	1	1.8 - 3.5	3.5 - 6.0	—
Refractive index at 25°C.	1.4755	1.4730— 1.4775	1.4785— 1.4802	— —
Iodine value	152-175	118-160	170-188	160
Free fatty acids as percentage of oleic acid	0.56 - 3.89	0.2 to 5.0	0.1 to 13.0	7.57
Saponfication value	192 - 195	182 - 189	188 - 199	189.3
Non-saponifiable matter %	1.3	0.5 - 1.7	0.1 - 1.25	1.6

industrial purposes within the country, the oil extraction industry will no doubt emerge as an ancilliary in the disposal of sardine. The sardine oil extraction industry, while making available the oil for a multitude of uses, will also make use of the residue for conversion to other important food items like fish protein concentrate, fish meal *etc.*

A thorough survey of the oil industry for the last two decades reveals that the extraction is done on a cottage scale in some isolated places near the landing centres and is not well organised. The method of extraction followed at present is a crude one, by cooking the fish in iron vessels, most often without adding sufficient quantity of water, and without proper attention throughout the operation. The oil thus extracted is of very poor quality, undesirable colour and odour and of inferior chemical characteristics. Central Institute of Fisheries Technology has worked out and demonstrated successfully a method of extraction of oil of very good characteristics giving an average yield of 12% during the season (Madhavan & Kaimal, 1968).

A striking contrast is presented by the characteristics of this oil when compared with some of the fish body oils of commercial importance produced in other countries (Anon, 1952).

Fatty acid composition of the lipids of oil sardine has revealed that they con-

tain high amount of poly-unsaturated fatty acids constituted by docosa hexaenoic and eicosa pentaenoic acids (Gopakumar & Rajendranathan Nair, 1966). Poly-unsaturated fatty acids are known to have pharmacological importance as they may keep the cholesterol content in the blood quite low thereby lowering the incidence of heart disorders (Velankar, 1968).

INDUSTRIAL UTILIZATION

It has remained an age-old practice of fishermen to use sardine oil for painting the bottom of their fishing crafts. A small portion of the better grade oil had been used for edible purpose as well (Aggarwal, 1968). The other important applications of this low grade oil produced commercially are in fat liquoring of leather, tempering of metals, batching of jute and insecticidal soaps (Anon, 1962). (Generally fish oils employed as fungicides and insecticides are sometimes modified in minor way to improve the natural fungicidal activity. Such fish oil preparations are less potent than organic insecticides; however, they are non-toxic to man, unlike the latter). The high unsaturation, easy susceptibility to oxidation, flavour reversion and related changes create technological problems in its use in hydrogenated product, soap manufacture and domestic consumption (Madhavan & Kaimal, 1968). In recent years, refined deodorised herring oil is being used for canning fish, particularly in Norway. It has been reported that use of cold cleared and winterised sardine oil either as such or in admixture with ground nut oil in varying proportions can be successfully used as the medium in the canning of sardines. It has also been noticed that hydrogenation done at atmospheric pressure itself is quite rapid and can bring down the I. V. to 100,

TABLE III

COMPARISON OF THE QUALITIES OF COMMERCIAL OIL TO THAT PREPARED BY THE IMPROVED METHOD

	Commercial oil	Oil prepared by improved methods
Colour	Deep brown to black	Light yellow to brown
Clarity at room temperature	Turbid	Clear
Odour	Rancid	No rancid odour
Refractive index	1.4780	1.4755
Sp. gravity	0.9250	0.921
Moisture %	0.25 - 0.62	0.20 - 0.40
Nitrogen	0.02 - 0.10	Nil
Saponification value	190 - 198	192 - 195
Iodine value	99 - 161	152 - 175
Perodixe value	0.4382 - 7.2	0.32 - 2.7
Unsaponifiable matter %	0.84 - 1.55	0.83 - 1.55
Free fatty acids %	5.8 - 49.58	0.56 - 3.89

when the typical rancid and fishy odour is removed and the oil is stabilised. Controlled direct interesterification of the hydrogenated oil thus prepared gives a butter-like consistency (Sen & Revankar, 1968).

Refined sardine oil could be used in the manufacture of hard soaps after hydrogenation at about 100 p. s. i. g. and at temperature of 150-170°C using 2% Rufert nickel catalyst for 5 hours when the oil becomes hard pale white solid having I.V. 10 (Aggarwal, 1968). The neutral sardine oil can be split into fatty acids by fractional distillation into three groups:-

(a) Fraction resembling mowah fatty acids having I. V. ranging from 65-82 with a yield of 47-58% constituting both saturated fatty acids upto and including C_{18} with comparatively low fishy odour, which if properly mixed with other oils can be used in the manufacture of laundry soaps;

(b) A low yield of 5-20% poly unsaturated fraction with I. V. of about 220, comprising mainly of arachidonic, clupanodonic and other unidentified fatty acids, useful in paints;

(c) A non-distillable polymerised unsaturated fatty acid, neutral sardine oil and unsaponifiables which has found acceptance in varnish manufacture (Kotwal & Pai, 1968).

Application of fish oil fatty acids in the manufacture of oil-modified alkyd resins using pentaerythrytol and phthalic anhydride has been discussed (Ahluwallah, 1968). M/s Godrej Soaps Pvt. Ltd. announced the introduction of fish oil fatty acids, a mixture of polyunsaturated fatty acids arachidonic and clupanodonic under the name "Distilled fatty acids" (paint type) which is claimed to have high unsaturation (I. V. in the range 230-250) of the conjugated type. A lower grade fish oil prepared by the same firm is called "Polymerised oil" suitable for dark colour varnishes (Ahluwallah, 1968).

A further breakthrough in the possible application of modified sardine oil for the industrial purposes was achieved as a result of the investigations carried out at the Central Institute of Fisheries Technology. Conversion of sardine oil into factice, a filler in rubber compounding industry (Kaimal & Madhavan, 1967), use as a vehicle in surface coating material (Kaimal, Pillai & Madhavan, 1967), and as printing ink base, as an additive in lubricating oil etc. (Madhavan & Kaimal, 1968) have been successfully tried. Attention is now being focussed on the preparation of possible chemicals that could be obtained from sardine oil.

It may not be wrong to envisage a great potential for the oil and industries based on that if sardine oil of supreme quality is made available. The only hazard that may affect the industry is the fluctuation observed in the raw material landing.

Fish meal

It has been stated earlier that during glut seasons the whole fish as such were used as manure. The most common form of fertilizer is as fish guano, the residue left after oil extraction by the crude method. This is generally beach-dried and is found to contain 8-10% nitrogen and a good amount of phosphates. Being well cooked, this desintegrates easily and mixes with soil quickly and is believed to be 15-20 times richer than ordinary cattle manure.

The trimmings and waste from the sardine canning factories, when this is taken up on a large scale, will constitute a good source for manure. A piece of investigation has been reported from Central Institute of Fisheries Technology for preparing a liquid fertilizer from fish and shrimp wastes with 2 different NPK ratios, 8:8:16 and 7:10:15, suitable for common crops like coconut. arecanut, ginger, tapioca, pepper and vegetables (Ismail & Madhavan, 1970).

The press cake left after extraction of oil from oil sardine forms one of the chief sources of raw material for the manufacture of fish meal. Lean fish and wastes from fish canneries also are important raw materials. India had the privilege of exporting sizeable quantities of fish meal until recently, but reduced considerably as the meal produced was of inferior quality. Now the Indian Standard Institution have laid down quality specification for fish meal to be used as live stock feed (Anon, 1967) Organised fish meal industry shows signs of revival and emergence to prominence. In late 50's an experimental unit with a throughput capacity of 1 ton fish has started functioning at Calicut under Kerala Fisheries Department followed by the one with 15 tons Capacity in Bombay. In late sixties, three more plants, one at Jaffrabad in Gujerat with 15 tons capacity and another in Margao with 40 tons capacity and the third at Malpe with 40 tons capacity were commissioned. A plant under the Integrated Fisheries Project with a capacity of 40 tons was started in Mandapam in 1970. Another plant with 25 tons capacity was commissioned in 1972 at Azhikode under the Kerala Fisheries Corporation.

The total installed throughput capacity thus available presently is more than 175 tons per day. However, the shortfall in production compared to the installed capacity, is alarming. Our plants idle most of the time. The gap to some extent can be made up by utilising low-cost trash fish, wastes from prawn and fish canneries etc. This valuable protein source with all the essential amino acids and minerals like phosphorus and calcium can be made use of as the main ingredient in the feeding stuff of our domestic animals and poultry. At any rate, with the proposed increase in the fishing activities and the expected high landings of fish in general and judicious exploitation of sardine fishery raw materials for fish meal manufacture will be available in adequate quantity and by proper processing export market can be re-established thereby contributing to our national income.

Whereas insufficient material compel the plants to be kept idle, relatively lower catches of trash fish have again to be wasted without proper utilization, being inadequate for economical operation of bigger plants. This can be greatly overcome by using a rotary fish meal dryer designed by CIFT suitable for handling smaller quantities of fish, in fishing villages (Chakraborty, *et. al.*, 1970).

Fish protein concentrate

Sardine press cake can profitably be utilised for human consumption after converting it to fish protein concentrate. In a country like India where the per capita intake of protein is far below the essential requirement, as our staple food is based on rice and other cereals, emphasis should be given for the conversion of sardine press cake into fish protein concentrate. Investigations carried out at CIFT (unpublished) and CFTRI (Lahiry *et. al*, 1962) have shown that solvent

extraction of the odor-bearing compounds and residual fat from the sardine press -cake prepared under sanitary conditions can result in a more concentrated light coloured flour containing more than 80% protein of almost blunt taste. It has been proved by the experiments done at CIFT that such a product can be employed for the enrichment of other traditional food products as well as in delicacies both for children and convalescent people (unpublished). The product in addition to being nutritious can be incorporated into a variety of foods like chapathis, breads, soups, flakes etc. without imparting any fish flavour, thus making it palatable to those who do not like fish taste.

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