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CONTENTS

PRODUCTION AND QUALITY OF INDONESIAN FISH OIL: CASE STUDY IN MUNCAR (EAST JAVA) AND BALI

By

Hari Eko Irianto
Slipi Research Station for Marine Fisheries
Jln. Petamburan VI, Jakarta 10260, Indonesia

ABSTRACT

A survey of production and quality of Indonesian fish oil was carried out in Muncar and Bali. Thirteen fish oil producers in Muncar and six fish oil producers in Bali participated. The results indicated that fish oil could be obtained from fish meal processing and the cooking step in canned fish processing. Raw materials used by fish meal processors producing fish oil are whole fish and fish waste, mainly oil sardine. Mostly, the fish oils were sold at Rp. 201-300,- and the main buyers were local fish oil traders and animal feed companies.

The fish oil quality varied chemically and physically. However, the fish oils collected from canning waste were of a better quality than oil obtained from the fish meal processing. The omega-3 fatty acid content of Indonesian fish oil was relatively high at 20.6-29.5% of total fatty acids.

1. INTRODUCTION

Fish oil is widely known for its therapeutic effects on several human diseases, it has been traditionally prescribed by medical practitioners because of its importance as a source of vitamin A. However, most Indonesians have not been aware of these facts. Thus, the fish oil industry does not receive proper attention and is not well developed.

The development of fish oil industries should be directed to local and export markets as well as to substitute imported fish oil products. The abundant raw materials which have not been efficiently utilized could be used to support the development of an efficient industry rather than a low-value by-product.

A survey of Indonesian fish oil was conducted to investigate current production methods and quality of the fish oil and to determine the present status in the fishing industry, especially in Muncar (East Java) and Bali.

2. METHODOLOGY

The survey was conducted in fish meal and canned fish factories producing fish oil around the Bali Straits, where most Indonesian fish meal and fish canning factories are concentrated. Thirteen factories in Muncar and six factories in Bali participated in the survey. One of them was a traditional fish meal processor. A conventional fish meal producer is defined as one using a standard modern fish meal processing unit. Labour costs here are relatively low. In comparison, the traditional fish meal producer is one using very simple processing equipment, where high labour costs are significant. The survey was carried out by direct interview of factory managers and staff. A copy of the questionnaire used during the survey is shown in Appendix 1.

Fish oil samples, collected during the survey, were held in polypropylene bottles with 200 ppm BHT antioxidant. The samples were analyzed for free fatty acid value, refractive index (20°C), colour (absorbance at 490 nm) and fatty acid profile.

3. RESULTS AND DISCUSSION

3.1 Fish oil/fish meal processing in Indonesia

Two commercial processing methods for fish meal production were encountered during the survey. A wet rendering process used by 18 processors, and a cooking process without pressing used by one factory. In this latter process, the fish was boiled and then air dried, without pressing.

All fish meal factories surveyed were able to separate fish oil from the liquid phase obtained after pressing. All processing methods use heat treatment as an integral part of fish meal production. In this case, heating or cooking is used to coagulate or denaturate fish protein to facilitate mechanical separation of liquids from solids. Under these conditions, fat cells are also ruptured, releasing the oil into the liquid phase (Bimbo, 1990; Kinsella, 1987; Ilyas et al., 1985). The efficient liberation of water and oil by cooking and pressing is an important aspect in producing high quality fish meal (Beraquet et al., 1984). In the wet rendering method, the liquid phase is released during the pressing step. In the cooking method without pressing, the liquids are released into the cooking water from which fish oil can be subsequently separated. Production of fish oil from all types of raw materials was conducted by all factories except in one case where oil was not separated from tuna offal.

Three factories use an alkali refining process to improve fish oil quality, particularly for FFA value reduction.

3.2. Raw Fish Used for Fish Oil/Oil Production

Raw fish used to produce fish meal in the factories surveyed is listed in Table 2. Generally, fish meal processors producing fish oil utilize whole oil sardine (Sardinella longiceps) and sardine waste from canneries as raw material. Other fish species used in fish meal processing were mackerel and tuna. Where a mixture of fish species is reported these consisted primarily of sardine, scad, mackerel and red snapper. Fish waste used for raw material was obtained from canneries and consisted of heads, tails and offal.

3.3 Prices and Buyers of Fish Oil

Unfortunately, some factories surveyed did not answer the questions relating to product prices, and buyers of their fish oil. Therefore, the results presented in Table 3 are limited to those factories which provided sufficient detail.

Table 1

Fish oil production information obtained during the survey

		Number of factories
a. Fish meal production method:		
1. Wet rendering process		18
2. Cooking without pressing		1
	Total	19
b. Oil separation after pressing/cooking		19
1. Factories separating the oil		0
2. Factories not separating the oil	Total	19
c. Relationship between oil separation and raw material:		
1. Separation applied to all raw materials		18
2. Separation not applied to all raw materials		1
	Total	19
d. Refining:		
1. Factories refining the oil		3
2. Factories not refining the oil		16
	Total	19

Table 2

Raw fish used for fish oil/meal production

Raw fish	Fish species	Factories using as raw material
Whole fish	Sardine	15
	Mackerel	1
Mixture of fish species		5
Fish waste	Sardine	7
	Tuna	2

Note: A factory might use more than one raw material type

The price of fish oil varied from Rp. 100 -/l to Rp. 500-/l. In the main, fish oil was sold at a price between Rp. 201.-/l-Rp. 300.-/l. One factory sold fish oil according to its free fatty acid (FFA) value: Rp. 425.-/l for fish oil having FFA value less than 5% and Rp. 300.-/l for fish oil having FFA value more than 7%. Another factory reported that the price of canning waste oil was higher than the price of oil obtained from fish meal processing. (1994 US$1 = Rp. 2200).

Table 3

Price and buyers of fish oil

	Number of factories
a. Price* (Rp./l):	3
100 - 200	12
201 - 300	2
301 - 400	1
401 - 500	
b. Buyers:	
1. Fish oil traders	8
2. Feed companies	8

Note: * A factory could give more than one price

Results show that fish oil buyers were mainly local fish oil traders and animal feed companies.

3.4 Chemical and Physical Properties of Fish Oil

During the sample collection, it was revealed that fish oil was also obtained from the pre-cooking steps during the canning operation. Pre-cooking is normally done by steaming the fish for approximately 20 minutes. Indeed, one of the purposes of the pre-cooking step during fish canning is to release body lipids if the fish are excessively oily or if the oil has a very strong flavour (Warne, 1988; Codex Alimentarius Commission, 1976). It is known that when fish flesh is heated, a significant proportion of water is released from the protein. The amount varies, approximately 17.5% for tuna, 19-34% for sardines, depending on the endogenous fat content (Van Den Broek, 1965).

Results of chemical and physical analysis of fish oil collected from fish meal and canned fish factories during the survey is presented in Table 4. In general, the results show that Indonesian fish oil varied chemically and physically. All fish oil samples from either fish meal processing or canning operations were obtained from oil sardine and in one case, from tuna waste. Factories using whole fish and fish waste as raw materials did not separate the oil in terms of the raw material used. Fish oil obtained from the fish canning operation was collected during the pre-cooking operation.

Fish oil quality grading by fish meal processors was directly related to FFA, in which the worse quality, the higher FFA values. Refining treatment significantly improved the quality of fish oil obtained from the fish meal factory, especially in terms of FFA and absorbance values.

With regard to FFA values, the quality of fish oil processed using fish waste was comparable to one processed from whole fish, in which the FFA values of the former oil were in the range of the FFA value of the latter oil. The same occurrence was also noted for refractive index and absorbance values. However, all fish oils obtained from fish waste meal processing tended to have a brown colour with absorbance value ranging from 1.34 to 2.43; while the canning waste oil was yellow with absorbance value of 0.27.

Generally, the fish oil collected from canning waste had a lower FFA value than the oil separated from fish meal production. It is worth re-emphasizing that the source of FFA is from hydrolysis of triglycerides (Windsor and Barlow, 1981). In this regard, different methods of oil extraction are likely to play a major role in determining the final oil quality. A relatively short heating time of 20 minutes at +- 100°C (Directorate General of Fishery, 1984), and the use of the whole fish in the fish canning process are likely to contribute to minimal triglyceride hydrolysis. Fish oil produced from a fish meal processing involves more heating of the fish pulp. For example, in fish meal processing, the fish pulp is cooked at 90°C for 30 minutes and then dewatered. The liquid phase containing the oily emulsion is then reheated to 90°C prior to oil separation (Hoffmann, 1989). In this process the opportunity for accelerated triglyceride hydrolysis is relatively high. The other major factor affecting fish oil quality is undoubtedly raw material quality. Low quality fish, normally processed into fish meal, may have also caused the fish oil produced to have a high FFA value, since, according to Young (1982), spoilage in fish is responsible for increased free fatty acid content by lipases/enzymatic activity.

The RI values of the oils also varied and the source of the oil did not give any specific indication on RI value. The absorbance value of the oils were significantly influenced by the source of the oils.

The canning waste fish oil had a much lower absorbance value than the oil from fish meal processing. The canning waste oil showed a yellow colour while the colour of the oils from the fish meal operation were darker, ranging from yellowish brown to very dark reddish brown. The difference in the colour is probably due to the method of oil extraction. It has been reported by Brody (1965) that excessive heat applied to fish for prolonged periods results in the production of darker oil. Chemically, these darker oils probably arise from heat-induced protein breakdown products acting as catalysts to accelerate autoxidation of the endogenous oil. This situation is exacerbated by the use of improperly cleaned containers contaminating the oil. For example, it is known that the oxides of metals such as iron, lead, and copper, when dissolved in oil containing water and free fatty acids, can accelerate the oxidation and darkening of fish oil (Brody, 1965). The raw material, oil sardine, may have affected the colour of the oil, the third grade oil sardine darkening the fish meal oil significantly more than the oil produced from canning waste, where first grade oil sardine was used (Irianto and Fawzya, 1987). The raw material for fish production should be as fresh as possible in order to yield light coloured oil. Oil extracted from deteriorated raw material yields dark oil (Brody, 1965). In fact, the oil sardine used to produce fish meal is the sardine which does not meet the quality requirements for processing into other products: canned fish, boiled salted-fish, and dried salted fish.

The refining process did not affect the fatty acid profiles, since the relative amounts for each fatty acid types of refined oil were still in the range of the amounts for the identical fatty acids analyzed in unrefined oil. The use of different raw materials, (whole fish or fish waste), also did not indicate any difference in fatty acid profiles. Fish oil obtained from the canning process had a similar fatty acid profile to the oil collected from fish meal processing. Table 4 shows that omega-3 fatty acids contained in those oils were in the range of 20.6-29.5%. Analysis of sardine oil conducted by Setiabudy (1990) indicated that this oil contained 25.2% omega-3 fatty acids, which falls into the range found in this study for Indonesian oils. The level of omega-3 fatty acids in fish is known to be a function of fish species, age, sex and season (Moeljanto, 1982).

4. CONCLUSIONS

Fish oils in Indonesia come from two sources: canning and fish meal processing, using sardine as the main raw material. Chemically and physically the oils from canning were of a higher quality than oil recovered during fish meal processing. The relatively high levels of omega-3 fatty acids in Indonesian fish oils suggests that the industry should seriously evaluate oil usage as a high quality product suitable for human consumption, rather than for non-human food purposes, such as animal feeds, as the survey results reveal.

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Appendix 1

Questionnaire used for fish meal factory survey

Fish Meal Factory Survey

1. Raw materials used for fish meal production in your factory (your answer can be more than one):

( ) one species: ( ) sardine
( ) mackerel
( ) scads
( ) others, ...
( ) mixture of fish species, mainly..............................
( ) fish wastes: ( ) canning waste, mainly.........................
( ) industry............, mainly................
( ) others, ...

2. In terms of the above raw materials, please specify the percentage of each raw material used in your factory.

....% one species: .... sardine
.... mackerel
.... scads
.... others, ...
....% mixture of fish species
....% fish waste: .... canning waste
.... industry ....
....% others, ...

3. What is the method used for fish meal production in your factory?

( ) wet rendering method
( ) dry rendering method
( ) other methods, please specify....................

4. Do you separate the oil from press liquor?

( ) Yes
( ) No

If "No", what are raw materials which you do not separate their oils?

Please specify..

5. Do you refine the oil for human consumption?

( ) Yes
( ) No

If "Yes", what is the method being used to refine fish oil in your factory?

( ) alkali refine method
( ) molecular distillation
( ) thawing fractionation
( ) others..

Additional information:

Factory : ....
Location : ....
Fish oil packaging : ....
Fish oil selling price : ....
Fish oil buyers : ( ) food companies
( ) pharmaceutical company
( ) fish oil traders
( ) exporter
( ) others, ...

Raw material price:
- sardine Rp...............
- mackerel Rp...............
- scad Rp...............
- mixture of fish Rp...............
- fish waste Rp...............