INTERNATIONAL ASSOCIATION OF FISH MEAL MANUFACTURERS

TWENTY-SECOND ANNUAL CONFERENCE

TECHNICAL REASONS GIVEN BY BUYERS FOR IMPOSING PENALTIES AGAINST FISH OIL PRODUCERS

by

F.V.K. YOUNG

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RESEARCH REPORT

1982-1

1. Reasons relating to yield

1.1. High free fatty acid content

1.1.1. Examples of complaints

- FFA out of specification on receipt of oil by buyer.
- FFA in specification on receipt but increasing on storage.

1.1.2. Causes

- Presence of free water (greater than 0.2%) with or without enzymes, particularly if oil not given a final water wash "polishing" treatment.
- Overheating i.e. storage at over 35°C.

1.1.3. Effect

- Results in higher losses in the neutralisation stage of refining.

1.1.4. Principally associated with:

- 1.2. Low refining yield.
- 1.3. High "gum" content.
- 2.1. High moisture and/or dirt.
- 2.5. Soap content.

1.1.5. Counter-arguments

- Incorrectly sampled by buyer; non-representative sample.
- Incorrect FFA test; check method and reagents.
- Increase in FFA occurred during shipment or during storage in buyer's tanks due to dirty or wet tanks or overheating.

1. Reasons relating to yield

1.2. Low refining yield

1.2.1. Examples of complaints

- High American Oil Chemists' Society (AOCS) "Cup" or chromatographic loss or high "Wesson" loss - all these are laboratory methods of determining the refining loss.
- Unexpectedly high plant refining loss.
- High bleaching earth usage.

1.2.2. Causes

- High FFA in oil.
- High dirt in oil.
- High phosphatides ("gums") in oil.
- Dark colour of oil.
- Incorrect refining treatment.

1.2.3. Effects

- Increased costs.

1.2.4. Principally associated with:

- 1.1. High free fatty acid content.
- 1.3. High gum content.
- 2.1. High dirt content.
- 3.2. Dark colour.

1.2.5. Counter-arguments

- Apart from in the U.S.A. where they are principally used for soyabean and cottonseed oils, the laboratory tests are rarely used as quality control checks on incoming crude oils. They are used more for checking refinery performance. The tests are not easy to perform and do not give good repeatability.
- The refining yield is affected by dirt in the buyer's tanks.

1.2.5. (cont.)

- The refining process should be varied according to the oil quality. The refiner may not be using the correct process conditions e.g. not using or not using enough degumming acid; not using the correct strength or excess of caustic soda. The refining yield can be improved by using the correct conditions.
- For colour see item 3 - Reasons relating to oxidation.
- Neutral oil lost in neutralising and deodorising is recovered, at a lower value, in the acid oil by-product. Cost compensation should take this fact into account.

Notes

- The refining yield, or more specifically the neutralisation yield, is frequently expressed as the Refining Factor (RF).

$$R.F. = \frac{\%\ \text{loss in neutralising and washing}}{\%\ \text{FFA in the crude oil}}$$

The RF depends on the process used and on the oil quality. Normal RF figures for fish oil through a continuous refining line are between 1.8 and 2.2.

- Normal losses refining fish oil:

	Loss
- Neutralising and washing:-	2 x FFA %
- Bleaching depends on type of earth and filter press:-	½ to ⅔ of % of earth used
- Hydrogenation:-	Nil
- Post-hydrogenation refining depends on process { neutralising & bleaching or	1% or
{ bleaching only	0.5%
- Deodorising	0.5%

1. Reasons relating to yield

1.3. High gum content

1.3.1. Examples of complaints

- Oil frothy or thick (high viscosity) or dirty.
- High phosphorus content.

1.3.2. Causes

- A high level of phosphatides or protein breakdown products. These compounds can be dissolved in the oil, or as a colloidal suspension or larger dirt particles. Can be reduced by giving the oil a polishing wash. They are the result of enzyme action.

1.3.3. Effects

- These compounds act as emulsifying agents and increase losses due to emulsification if the oil is not treated with a water wash and/or phosphoric acid or other degumming agent before neutralisation.
- Increase oil losses due to increased sludge in storage tanks.
- Give emulsion problems when splitting soapstock with sulphuric acid for the production of"acid oil".
- Can produce darkening of oil at high temperatures ($> 160^{\circ}C$)

1.3.4. Principally associated with:

- 1.2. Low refining yield.
- 2.1. High moisture and/or dirt.

1.3.5. Counter-arguments

- Contamination with sludge in buyer's storage tank.
- Check phosphorus content. Phosphorus is converted to phosphatides by multiplying by 30. There is little information on "normal" levels of phosphatides in fish oils but in general over 1% ($\sim$ 300 ppm P) can be taken

1.3.5. (cont)

as a high level and 0.2 to 0.5% (~ 60 to 170 ppm P) as good to average.

- Refining process parameters could be improved.
- Financial loss should be based on difference between neutral oil and acid oil prices (see 1.2.5.)

2. Reasons relating to contamination

2.1. High moisture and/or dirt

2.1.1. Examples of complaints

- As in heading.

2.1.2. Causes

- Poor separation in centrifuge.
- No polishing water wash.
- Contamination during storage or transport.

2.1.3. Effects

- High refining losses
- General reduction in quality.

2.1.4. Principally associated with:

- 1.1. High free fatty acid content.
- 1.2. Low refining yield.
- 1.3. High gum content.

2.1.5. Counter-arguments

- Contamination during storage or transport.
- Non-representative sample.

2. Reasons relating to contamination

2.2. Contamination with mineral oil

2.2.1. Example of complaint

- As in heading.

2.2.2. Causes

- Contamination during storage or transport.
- Wax esters mistakenly identified as mineral oil.

2.2.3. Effect

- Renders oil unusable for edible purposes.

2.2.4. Principally associated with:

- 2.3. Low saponifiable value/high unsaponifiable matter content.

2.2.5. Counter-arguments

- Check test method - fluorescence under U.V. light may be due to wax esters or other non-toxic oil component. (Only reliable methods known to writer are:-
  - Leatherhead Food RA method,
  - Bories and Tulliez, J.Sci.Fd.Agric. 1977, 28, 996-9
  I.A.F.M.M. has copies of both methods.)
- Contamination during transport and storage.

2. Reasons relating to contamination

2.3. Low saponification value/high unsaponifiable matter content

2.3.1. Examples of complaints

- As in heading.
- Nutritionally harmful.
- Contains mineral oil.
- Contaminated.
- Effect on sale of acid oil.
- Will cause high losses or is indicative of poor quality.

2.3.2. Causes

- Increased unsaponifiable matter is attributed primarily to an increase of wax esters. The effect is considered to be seasonal and dependent on the diet of the fish.

2.3.3. Effects

- The hydrocarbon fraction of the unsaponifiable matter is reported to be virtually completely removed from the oil during deodorisation. The hydrocarbon content is about 10% of the unsaponifiable matter. Higher hydrocarbon contents would therefore result in higher losses, but not significantly so when viewed against the variation in deodoriser loss normally encountered.
- It is stated that the high unsap oil results in a reduction in the yield of distilled fatty acids after splitting the acid oil. The tolerable unsap upper limit in this effect is not known. Unconfirmed information has been received that the residual "foots" from the distillation step can be sold for inclusion in animal feed.

2.3.4. Principally associated with:

- 2.2. Contamination with mineral oil.

2.3.5. Counter-arguments

- Nutrition: Certain fish "oils" with very high wax contents have been found to be harmful when fed in substantial quantities to rats (M.Mori, Japanese Soc.Scientific Fisheries, 1966, 32, (2), 137-145; Y.Hashimoto, "Marine

2.3.5. (cont)

Toxins and Other Bioactive Marine Metabolites", Japan Scientific Societies Press, 1979). Currently there is no evidence of harmful effects on humans from the levels of unsaponifiables found in the common industrial fish oils. It is believed that these levels pass through the body unchanged and without effect.

- Mineral oil: This is generally a case of mistaken identity. (See 2.2.)
- Contamination: The high levels of unsaponifiables are normally due to the diet of the fish.
- Losses/quality: There is no evidence of significantly higher losses, of processing trouble or of reduced quality from fresh oil with the levels of unsaponifiables encountered seasonally in the fish currently processed on an industrial scale. From the writer's enquiries most refiners do not check the level of unsaponifiable matter in the oil.

2. Reasons relating to contamination

2.4. Soap Content

2.4.1. Examples of complaints

- As in heading.

2.4.2. Causes

- The refining of the oil or part of it with alkaline materials.
- Contamination during transport or storage.

2.4.3. Effects

- The soap itself has no effect on refining.
- The presence of soap will catalyse the production of fatty acids on storage.
- The refining of the oil is carried out at elevated temperatures (60 to 90°C) and results in a reduction in the content of natural antioxidants. During subsequent storage the colour of the oil becomes fixed and oxidation is more rapid than in the crude oil.

2.4.4. Principally associated with:

- 3. Claims relating to oxidation e.g. high oxidation values, poor flavour stability of the refined deodorised hardened product, poor bleachability.

2.4.5. Counter-arguments

- Road tankers or storage tanks may have been cleaned using alkaline agents and not properly rinsed.
- Sample bottles not rinsed after cleaning.
- The analytical method most commonly used is the Wolff, or titrimetric, method. The test is satisfactory for gross contamination ($>$ 100 ppm) but must be carried out scrupulously for lower levels.
- The Codex Alimentarius Commission's "Recommended International General Standard for Edible Fats and Oils not covered by individual Codex Standards" Section 5 "Contaminants", 5.3. "Soap Content" sets the maximum permissible level at 0.005% m/m (i.e. 50 ppm).

3. Reasons relating to oxidation

3.1. Poor oxidation stability of refined, deodorised, hydrogenated (RDH) product.

3.1.1. Examples of complaints

- Rapid development of off-odours or -flavours in the RDH oil or in the baked product.
- Poor stability in oxidation test e.g. A.O.M. (Active Oxygen or Swift Method); Schaal oven test; FIRA-Astell test.

3.1.2. Causes

- High level of oxidation in the crude oil as measured by peroxide and anisidine or other such tests.
- High levels of trace metals, copper and iron in the crude oil. Can arise during transport and storage.
- Contamination of a good crude oil by remnants of poor quality oil in a dirty storage tank.
- Poor refining practice e.g. storage at any stage in the refining process for too long and/or at too high a temperature. In general the oil should be passed through the refining/hydrogenation process as quickly as possible. If storage is to exceed 12 hours, the liquid fish oil should be cooled to $<40^{\circ}C$ and the hydrogenated oil to $10^{\circ}C$ above its melting point. The RDH oil should be used within 24 hours of deodorisation. For consistency of solids content of the hydrogenated oil it is frequently stored for two weeks. If this is done, the storage should be at low temperature and should follow the post-hardening refining treatment.

3.1.3. Effects

- Off-flavours or off-odours develop rapidly in the margarine, shortening or final product (biscuits, cakes) making them unacceptable. The odours in particular are noticeable in a kitchen or bakery where such oils are being used. The long life required of biscuits makes them particularly susceptible to this defect. RDH fish oil is generally not acceptable for frying for this reason.

3.1.4. Principally associated with:

- 1.1. High FFA content (in the crude oil).
- 3.2. Poor bleachability/dark colour.
- 3.3. Overheating of the oil.
- 4.1. Poor hardening performance.

3.1.5. Counter-arguments

- Knowledge of the oxidation values at the time of shipment and on arrival at the buyer's installation.
- Knowledge of no trace copper contamination in the extraction plant e.g. from brass or bronze in contact with the oil.
- Look for contamination with old oil or copper and iron (rust) or for overheating during transport or storage, including following arrival at the buyer's premises.
- Poor refining practice as outlined in 3.1.2.
  Note: the refiner should protect the deodorised oil by addition of citric acid; this is not infrequently forgotten or missed out for cost reasons.
- The oxidation tests mentioned in 3.1.1. are unreliable due to various problems with the apparatus.

3. Reasons relating to oxidation

3.2. Colour complaints

3.2.1. Examples of complaints

- A. Poor bleachability; dark colour.
- B. Oil darkens during hydrogenation or deodorisation.
- Increased refining costs to obtain acceptable colour.

3.2.2. Causes

A. - Colour fixation due to oxidation with particular reference to trace iron content.
- High level of pigments in the fresh crude oil.
- Overheating ($> 50^{\circ}C$)

B. - High sulphur in conjunction with high (> 0.5 ppm) iron or nickel.

3.2.3. Effects

A. - Use of more and stronger caustic soda solutions and extra and/or more active bleaching earth in refining process, with consequent increase of costs. (See "Extra Effort and Cost ...." report 3/4/80,V.Young)

B. - Oil is either rejected and has to be re-refined or can only be used for margarines because of high colour.

3.2.4. Principally associated with:

- 1.1. High FFA content (in crude oil)
- 3.1. Poor oxidation stability of RDH oil.
- 3.3. Overheating of oil.
- 4.1. Poor hardening performance.

3.2.5. Counter-arguments

A. - High colours in otherwise good quality crude oils will be removed during caustic soda refining, bleaching and high temperature ($250^{\circ}C$) deodorising.

3.2.5. (cont)

- A bleaching and heating test can be carried out on the oil and compared with previous results from oils of known quality.
- The problem can be the result of contamination and poor storage conditions or overheating.

B. - This problem is normally associated with high nickel content (>0.5 ppm) in combination with traces of sulphur. With correct processing the nickel level after the post-hardening refining treatment will be less than 0.2 ppm, at which level darkening will not occur.

3. Reasons relating to oxidation

3.3. Oil has been overheated

3.3.1. Examples of complaints

- High colour/colour fixed.
- Smell of oil not fresh, or burned.
- Coefficients of extinction ($E^{1cm}_{1\%}$ 233 and/or 268nm) are high.

3.3.2. Causes

- The oil has been accidentally heated to over 50°C in the presence of air and possibly light.
- Steam of too high pressure (> 3Kg/cm^2) has been used to melt the stearin which settles to the bottom of the tank under cold conditions.

3.3.3. Effects

- The natural pigments in the oil are degraded to compounds which colour the oil more deeply and are not as readily removed by bleaching clays.
- The heat causes isomerisation of the fatty acids producing more conjugated double bonds which are indicated by increases in the coefficient of extinction.
- The oil may smell burned.

3.3.4. Principally associated with:

- 3.1. Poor oxidation stability of the RDH oil.
- 3.2. Poor bleachability; dark colour.

3.3.5. Counter-arguments

- This problem normally arises during ship transport in cold climates.
- It may also occur if heating steam is accidentally left turned on.
- The colour and bleachability of the oil should be checked before despatch, or a reference sample should be stored in a full, screw-capped, brown bottle in a refrigerator so that the tests can be carried out if a complaint is received.

4. Reasons relating to hydrogenation

4.1. Poor hardening performance

4.1.1. Examples of complaints

- Excessive hydrogenation time.
- Increased hydrogenation catalyst consumption.
- High sulphur content in crude oil.
- Internal standard refining and hydrogenation test indicates poor oil quality.

4.1.2. Causes

- The nickel catalyst used in hydrogenation is "poisoned" (loses its activity) due to the adsorption on to its surface of chemicals containing sulphur or oxidation products or halogens (chlorine, bromine and iodine). The refining process prior to hydrogenation should remove about half of the sulphur compounds and a large proportion of the oxidation products but it has very little effect on the halogen-containing compounds.

4.1.3. Effects

- Increased costs. In bad cases a double hydrogenation treatment may be required, the first with "used" catalyst to absorb the poisons and the second to produce the hydrogenated fat.

4.1.4. Principally associated with:

- 1.1. High FFA content of the crude oil.
- 1.3. High gum content.
- 3.2. Colour complaints.

4.1.5. Counter-arguments

- Determine sulphur content of despatched crude oil sample (should be < 30 ppm).
- Carry out refining and hydrogenation test. If this cannot be done on the oil extractor's premises there are independent laboratories where the test can be carried out.

4.1.5. (cont)

- If applicable, point out that other quality parameters are good, thus indicating that there should be no problem with hydrogenation.
- The oil may have been contaminated with another old or poor quality oil - fresh oil pumped on top of old oil is a frequent occurrence.
- The refining process may be inadequate.
- The hydrogenation catalyst may be insufficiently active.
- Check the buyer's refining and hydrogenation test procedure. It should include:-
  - a degumming treatment with phosphoric acid,
  - at least one neutralisation with strong (4 Normal) caustic soda solution,
  - efficient washing of the oil to reduce the soap content to < 100 ppm,
  - bleaching with at least 1% of an acid-activated bleaching earth for 30 minutes at $90^{o}C$,
  - filtration followed immediately by
  - hydrogenation using an active (unused) catalyst.

Vec MR Young

22 JUN 1982

FISHING INDUSTRY RESEARCH INSTITUTE

INCORPORATED ASSOCIATION NOT FOR GAIN

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ALL LETTERS TO BE ADDRESSED TO THE DIRECTOR

ALLE BRIEWE MOET AAN DIE DIREKTEUR GERIG WORD

UNIVERSITY OF CAPE TOWN
UNIVERSITEIT VAN KAAPSTAD
PRIVATE BAG / PRIVAATSAK
RONDEBOSCH 7700, R.S.A.

15 June 1982

Dr S M Barlow
Director General
IAFMM
Hoval House, Orchard Parade
Mutton Lane
POTTERS BAR, Herts. EN6 3AR
England

Dear Stuart.

TECHNICAL REASONS GIVEN BY BUYERS FOR IMPOSING PENALTIES AGAINST FISH OIL PRODUCERS

In a circular letter to Scientific Committee members dated 24 May 1982 (your ref. SMB/RE/1982/42/S) you requested comments on the relevance of the list of 'reasons' drawn up by Vernon Young. Dr Spark studied the list carefully and from his comments I deduce that all the features mentioned are of some relevance although, as you know, we have reservations about the suitability of some of the quality criteria used. Vernon Young may find it advisable to also circulate his proposed 'answers' to the Scientific Committee members for comment before distribution to fish oil producers.

Kind regards.

Yours sincerely,

J P H Wessels
DIRECTOR

JPHW:EHM

P.S. We have still not received the Proceedings (yellow-covered) of the Chile meetings.

Record of Proceedings for Chile sent 23/6/82.

c.c. M.F. Young

ICELANDIC FISHERIES LABORATORIES
SKÚLAGÖTU 4, REYKJAVÍK, ICELAND
TELEGRAMS: FISKRANNSÓKN, TELEPHONE 20240

International Association of Fish
Meal Manufacturers,
Hoval House Orchard Parade
Mutton Lane, Potters Bar EN6 3AR
U.K

Your ref.:

Our ref.: PÓ/jás.

Date: June 22nd 1982.

Attn.: Director General Stuart M. Barlow Ph.D.
Ref. SMB/RE/1982/12E

Dear Stuart

This is in reply to your letter dated 3rd February 1982. ~~We just had a problem a few months ago by a parcel of fish~~ oil which was rejected by a buyer and then sold to another customer at a lower price. The ffa of the oil exceeded the contractual limits. But the customer also claimed that the oil was of poor hardenability and there was a carryover of poor quality of the hardened fat into buiscuits, I think it was.

We really did not know what to do except to estimate sulphur etc. For to be able to make any comment we would have to be equipped with a pilot plant for refining, hydrogenation, deodorization and production of test products most suitable as the big hardening companies have.

I would imagine that the requirements of the buyers and users of fish oils are being strengthened which probably is a general tendency of the business today. It is therefore important for the sellers to be prepared to answer such claims as above mentioned. I therefore think it would be of great importance for the producers and sellers to have a more detailed document by Mr. Young on these problems, which certainly will turn up more often in the future than hitherto.

As to point 4 of Youngs enumeration I think it would be necessary to have such things as hardening performance and refining/hardening test results and carry-over tests performed in commercial laboratories by standard methods approved by manufacturer-seller of fish oils and buyers-users of fish oils.

I look forward to Mr. Youngs comments.

We also have incidences where buyers make claims as above even if the ffa content is not exceeded.

Sincerely
Páll Ólafsson

SILDOLJE- OG SILDEMELINDUSTRIENS
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NORWEGIAN HERRING OIL AND MEAL INDUSTRY
RESEARCH INSTITUTE

Telegrams: Sildeforskning – Telephone: (05) 16 45 70
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- 3 MAR 19[illegible]

February 26th 1982

5033 Fyllingsdalen .....
Bergen, Norway

International Association of Fishmeal Manufacturers
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Potters Bar
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Your ref:
Our ref: NU/kb

TECHNICAL REASONS GIVEN BY BUYERS FOR IMPOSING PENALTIES AGAINST FISH OIL PRODUCERS

We refer to your sircular letter dated February 3rd. As far as we can see Mr. Young has listed most of the complaints claimed by buyers. By our opinion the most important points are: 1.1 - 1.2 - 2.1 - 2.4 - 3.3 - 4.1 - 4.2.

In our contracts with the Norwegian buyers of fish oil, we have also specifications describing the colour of fish oil. Sometimes it is difficult to fullfill these regulations. Further it is specified that the smell of the oil must be "fresh" (whatever we mean by that). We may get complaints based on this criterion and sometimes the reasons for complaining is obvious.

Kind regards
NORWEGIAN HERRING OIL AND MEAL INDUSTRY
RESEARCH INSTITUTE

Nils Urdahl

Nils Urdahl

NORDSEE

15 MAR 1982

»NORDSEE« Deutsche Hochseefischerei GmbH, Postf. 10 12 48, 2850 Bremerhaven

HAUPTVERWALTUNG

Dr. S.M. Barlow
Director General
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Hoval House, Orchard Parade, Mutton Lane
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Großbritannien

Abteilung	Ihr Brief vom	2850 Bremerhaven
Zentral-Laboratorium	3rd February 1982	11th March 1982
v. J./N	SMB/RE/1982/12/E	

Technical reasons given by buyers for imposing penalties against fish oil producers

Dear Dr. Barlow!

We have only very small comments on Mr. Young's list.

2.2 (Contamination with mineral oil or other foreign material)

We never had problems coming from such contaminations (Perhaps important for developing countries)

3.2 When German factories producing fish products for human consumption by deep frying fish with hydrogenated fish oils (15 years ago!) the oxidation and flavour stability was very bad. But there were no problems for the producers of shortenings and margarines.

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Kurt Querfeld · Günter Schmidt
Adalbert Scholl-Poensgen · Jörg Speiser
Vorsitzender des Aufsichtsrates:
Jürgen Schrader

3.5 During storage and transport the oil is only heated on ~35 °C.
(What is overheated ? 60 °C ?)

Kind regards

" N o r d s e e "
Deutsche Hochseefischerei GmbH
- Zentral-Laboratorium -

(E. von Jan)