IAFMM FISH OIL BULLETIN
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THE SUBSTITUTABILITY OF P.H. FISH OILS VEGETABLE OILS AND ANIMAL FATS

PARAMETERS GOVERNING SUBSTITUTABILITY

1. LEGISLATION

Example (a) Docosenoic acid regulations. Example (b) South African "Yellow" margarine may not contain marine or animal fats with the exception of up to 1.0% of milk fat.

2. RELIGIOUS RESTRICTIONS

Apply mainly to pig fats but, depending on degree of orthodoxy, are also applied to other animal fats and marine oils.

3. MARKET PREFERENCE

Regional markets and market sectors have strong biases mainly against but occasionally for marine oils.

4. HEALTH/DIETARY FACTORS

"All vegetable" and "Polyunsaturate" labels have become synonymous, although this need not be the case. "Diet" margarines, for example

in W. Germany, contain no hydrogenated fats, which excludes fish oil from the blends.

5. COSTS

5.1. Example of comparative costs

The following data relate to the refining and hydrogenating of fish oil and soyabean oil in August 1982. The costs are all-inclusive.

	Fish Oil	Soyabean Oil
Chemical data		
Crude oil FFA %	5.0	0.5
Crude oil I.V.	145	130
Hydrogenated product I.V.	75	70
Raw material and by-product prices		
Crude oil price £/tonne	200	280
Acid oil price £/tonne	145	245
Processing Costs		
Refining cost £/tonne	70	60
Hydrogenation cost £/tonne	40	35

In this case, with the values given for crude oil FFAs and I.V.'s, and crude and acid oil prices, the PH Fish Oil costs £15/tonne more to produce than the PHSBO. The important items in these cost differences are given below (para.5.2).

5.2. Specific Items of Costs

Certain stages in the processing of the oils are cost significant when comparing fish oil and soyabean oil. These will be dealt with individually.

Caustic soda and refining loss

Using the figures in 5.1 above and an acid oil factor (AOF) of 2.0 for both oils, the cost of the loss of crude oil to acid oil is £5.2/tonne higher for fish oil than for soyabean oil.

$$\text{The AOF} = \frac{\text{\% acid oil produced}}{\text{\% FFA in crude oil}}$$

The AOF varies with the type of plant employed, the FFA of the crude oil and the quality of the crude oil, but an AOF of 2.0 is reasonable for average quality FO and SBO refined in a continuous centrifugal refining plant.

The comparative cost is dependent on the crude FFA and the prices of crude oils and acid oils.

Caustic soda usage

The higher the free fatty acid the more caustic soda (NaOH) is used. The amount of NaOH used is calculated to neutralise the FFA with an excess allowed depending on crude FFA and oil quality.

Using the 5.1. figures, an excess of 20% for both oils, and £62/tonne of 50% NaOH solution, the additional cost for caustic soda for fish oil is **£1.0/tonne oil.**

Bleaching earth

For average quality oils about 0.4% more earth would be used on the fish oil than on the soyabean oil. The filter cake, which is of negligible value, contains about 33% oil i.e. the oil loss is approximately half the weight of the bleaching earth used. The cost of a high quality bleaching earth is about £200/tonne.

The total extra cost for fish oil over soyabean oil from these figures is **£1.2/tonne oil.**

Hydrogen consumption

$1m^3$ of hydrogen is required to reduce the iodine value of 1 tonne of oil by 1 unit.

In 5.1 I.V. drop SBO = 60
FO = 70

Therefore $10m^3$/tonne oil more H_2 for FO.

U.K. cost of hydrogen, August '82, £19.18/$100m^3$.

Therefore additional cost for fish oil = **£1.9/tonne oil.**

Catalyst consumption

This is more difficult to calculate because of the practice of some hydrogenators of reusing catalyst.

Considered on a single use basis the catalyst consumptions are approximately:

SBO 0.02% as nickel
FO 0.06% as nickel

A high quality catalyst containing 22% nickel costs (August '82) £3150/tonne.

The extra cost for fish oil in this case is **£5.7/tonne oil.**

It is common practice for selectivity reasons for catalyst to be used only once for the hardening of soyabean oil. Catalyst re-use is more customary with fish oil. A combination of these practices will significantly reduce the £5.7/tonne figure given above.

6. TECHNICAL FACTORS

6.1. Crude Oil Quality

Fish oil is more variable than competitive oils both in fatty acid composition and in such standard quality criteria as oxidation levels, trace element contents, colour and free fatty acid content. The compositional factor results in a greater degree of variability in the hardened product than is found, for example, in soyabean oil, and the quality factors make the oil more difficult to refine and affect the shelf-life of the end product.

6.2. Contamination

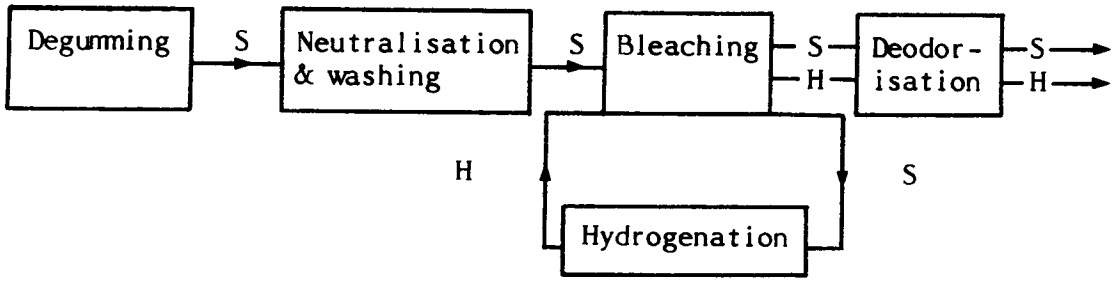
The high susceptibility of fish oil to oxidation requires a completely separate system for the processing of fish oil up to the crude hardened stage. Substantial additional plant costs are therefore involved if crude soft fish oil is to be refined alongside vegetable oils.

6.3. Refining Process

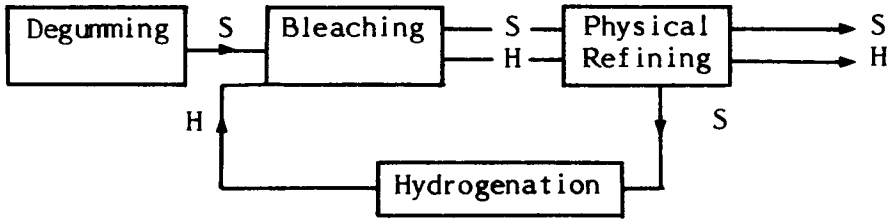
Processing Block Diagram

A) Caustic soda refining.

S = liquid oils
H = hydrogenated oils



B) Physical Refining



Physical refining, or deacidification by distillation (see block diagram B) is becoming more widespread due to environmental pressures. Because of crude fish oil's very variable quality, and particularly its content of proteinaceous material, phosphatides, trace metals, pigments and sulphur, it has hardly even been considered for treatment by the physical refining process.

Apart from the reduction of environmental problems, physical refining has the considerable advantage over caustic soda refining of a marked reduction in losses, particularly for oils with free fatty acid contents over 2%, as shown below:-

Oil with 3% FFA

Caustic soda refining:	Refining Factor 2.0:	Loss 6.0%
Physical refining:	Refining Factor 1.2:	Loss 3.6%

6.4. Product End-Use

The specific purpose for which a product is designed influences the oils and fats which may be used in the fat blend. In the following list of products brief reasons are given where hardened fish oil is unsuitable. The list is illustrative and is not complete:

PRODUCT	COMMENT
Table margarine	Suitable
Industrial margarines	Suitable
Shortenings	Suitable
Frying fats	Unsuitable: rapid odour development
Bread fats	Suitable
Cocoabutter substitutes	Unsuitable: melting curve not sharp enough
Cream fats	Unsuitable: very sensitive to off-flavours
Biscuit dough fats	Suitable
Salad cream	Unsuitable: fractionation yield too low

As pointed out in the "Premium Use....." paper (1981/23/G) HFO does have some advantages over vegetable oils in the industrial margarines and shortenings fields.

6.5. Alternative Blends

When considering the relationship of cost and substitutability the equivalent products must be compared. For example, in certain cases HFO is exchanged with straight palm oil or lard or hydrogenated soyabean oil as a so-called middle melting point fat. In other cases HFO will be considered as a partial replacement for liquid soyabean oil.

The following example shows that there is an additional cost advantage in the use of HFO when its price is below that of liquid SBO.

Oil prices: HSBO £375/tonne
SBO £340/tonne
HFO £310/tonne

	Blend A	Blend B	Blend C
	HSBO 35 60% SBO 40%	HFO 35 60% SBO 40%	HFO 30 80% SBO 20%
Cost	£361/t	£322/t	£316/t

Saving of B vs A = £39/tonne
but saving of C vs A = £45/tonne

7. OTHER FACTORS

Plant availability

Vegetable and fish oils must be kept separate to prevent contamination of the vegetable oils by unhardened fish oil. There may be a shortage of fish oil (or vegetable oil) refining capacity which can affect a decision to increase one or other type of oil.

A hardener may be buying HFO for price reasons and therefore underutilising vegetable oil capacity. In this case a narrowing of the price margin will persuade him to make an earlier change to vegetable oil to reduce total overhead costs.

Company financial position

A loss or low profit situation will persuade a refiner to stay with a lower priced poorer quality oil when in other circumstances he would move to the higher quality higher priced oil.

Company policy

Company policy is affected by market trends. The market tendency currently is towards all-vegetable products but, in the U.K. at least, this tendency is countered by the recession. The differential at which a change will be made will therefore vary from country to country and from company to company.

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11.8.82.