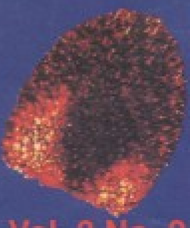
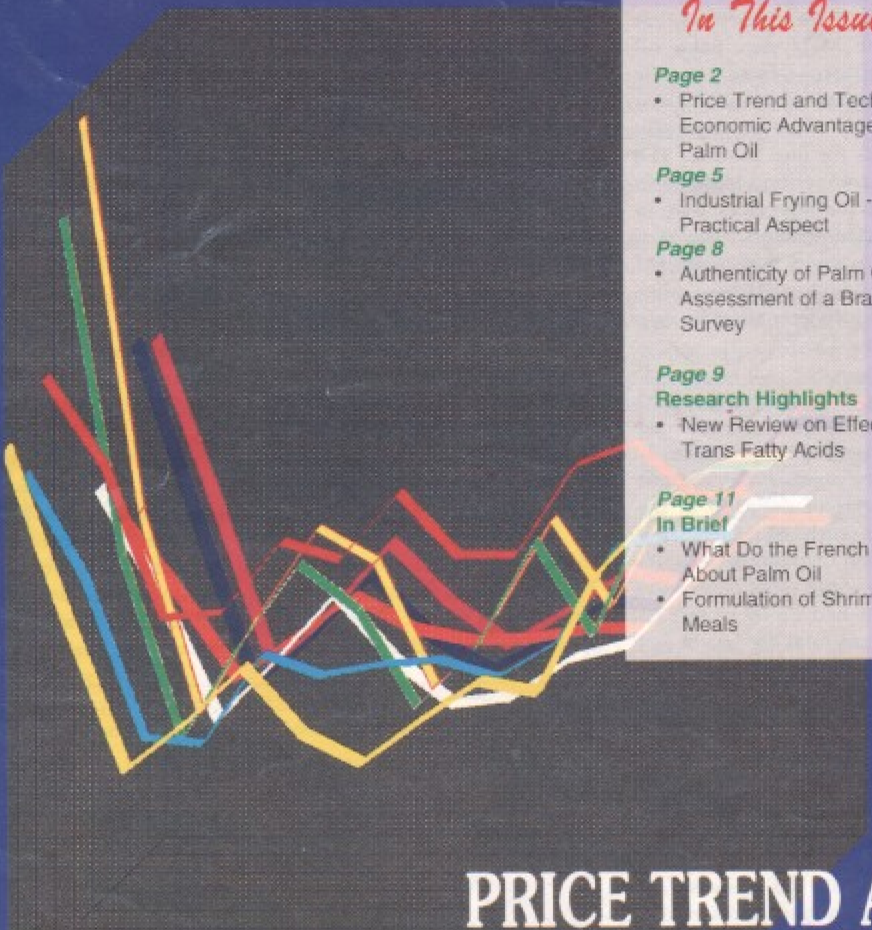


PALM OIL technical bulletin

Vol. 3 No. 2
April-May 1997



In This Issue...

PRICE TREND AND TECHNO-ECONOMIC ADVANTAGES OF PALM OIL

ISSN 1394-4983
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A Publication of the Palm Oil Research Institute of Malaysia (PORIM) P.O. Box 10620, 50720, Kuala Lumpur, Malaysia

PRICE TREND AND TECHNO-ECONOMIC ADVANTAGES OF PALM OIL

by
Ramli Abdullah,
Mohd Nasir Hj. Amiruddin and
Hamirin Kifli

One of the challenges that the Malaysian palm oil industry faces is the competition from more than a dozen oils and fats that are basically substitutes for one another. The vigorous competition resulted in highly fluctuating prices, that, in turn, affected demand. Malaysian palm oil, in a way is also affected by the behaviour of these price patterns which later affect its own trade value.

Despite the above and other related challenges, Malaysia had succeeded in achieving its current premier status as the number one producer and exporter of palm oil in the world. As such, her increasing contribution of palm oil exports relative to world palm oil exports in the past had given an impact on the world total exports of oils and fats. This means that without the Malaysian contribution, the exports performance of world palm oil would be adversely affected due to the declining production from the traditional producers such as Nigeria (Yusof, 1988).

Thus palm oil has gained fast prominence in the world scenario of oils and fats. This rapid emergence could be associated with: i) the rapid expansion of oil palm cultivation areas in Malaysia in the past few decades, and ii) the world's willingness to accept the oil as a whole. There are many factors contributing to such an achievement. Accordingly, it is the purpose of this paper to discuss them with special emphasis on the price patterns of palm oil products and their equivalents and also their techno-economic advantages over other oils and fats.

Price Trends

The price of any oils or fats is determined by the forces of supply and demand. There is some kind of market arrangements where buyers and sellers are in contact with one another. Forces of supply acting through the sellers and the forces of demand acting through the buyers determine the price.

In the long term, international prices of oils and fats form a unique pattern. Oils and fats with similar characteristics and end-uses are highly correlated with one another and follow a general price level (*Figure 1*). They are also highly substitutable with one another. Deviations usually reflect a change in the market share of an individual oil or fat. Hence an increase in the market share of an individual oil or fat is often associated with a decline in its price relative to the general price level of these oils and fats as a whole. Prices of dissimilar oils and fats, on the other hand, are largely independent and hence the substitution between them is weak (Anon, 1979). A closer look at *Figure 2* will illustrate these relationships. Thus there exists different groupings of prices such as the one between RBD palm olein and soybean oil, another group between palm kernel oil and coconut oil and lastly between RBD palm stearin and tallow. For the period of 1990 to 1995, prices of these selected oils and fats were on the increasing trend, but they (except that of palm kernel oil and coconut oil) dropped in 1996.

Techno-Economic Advantages of Palm Oil

As mentioned above, palm oil competes with other major oils and fats, including soybean, rapeseed, sunflowerseed, and coconut oils and tallow. Its ability to sustain or improve its export share is an

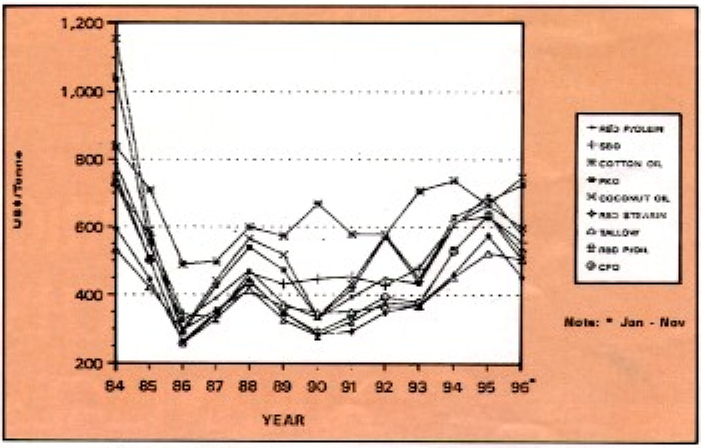

Figure 1. Prices of Selected Oils and Fats (1984-1996)

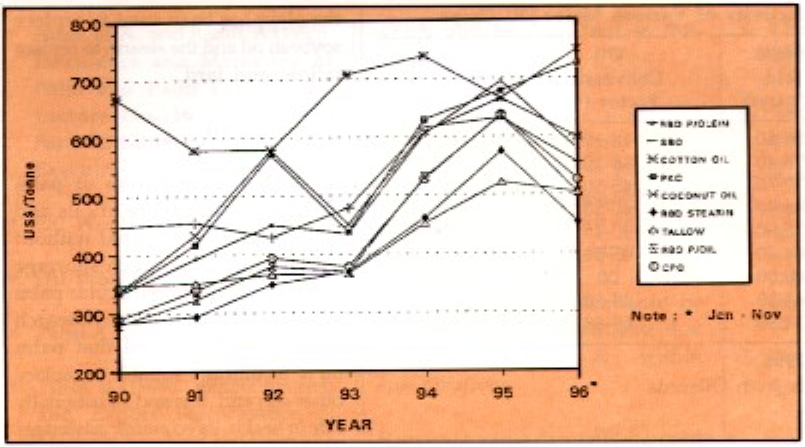

Figure 2. Prices of Selected Oils and Fats (1990-1996)

indication of its competitiveness in the oils and fats market. As a result, trade in palm oil has been increasing in the past and almost fast catching up with soybean oil.

The competitiveness of palm oil can be looked in terms of its techno-economic advantages over other oils and fats. The economic advantages are its supply reliability, productivity, cost of production, and price competitiveness. These will be discussed below.

a) Supply Reliability

Palm oil is produced from the fruits of the perennial tree called oil palm. It is the most reliable in supply since the tree, once planted will be in production for 25 years or more. As a consequence, one can almost predict its supply. Production of oils and fats from other perennial crops such as coconut and olive have been fluctuating. In total, production of oils and fats from perennial crops would increase to 24.8 million tonnes by the year 2000 (Nasir and Ramli, 1995) (*Table 1*).

Production of oils and fats from annual crops are unstable due to uncertain weather conditions, demand, supply and price of other substitutes. As a consequence, depending on the above factors, planting intentions can be altered very fast. Thus long term forecasts for annual crops are not very reliable. These oils and fats appeared to have suffered some setbacks with indications of some loss of market shares.

Another source of oils and fats is the land and sea animals. Tallow, which falls in this category of oils and fats, did not expand in line with world expansion in the oils and fats market. It is being replaced by other more competitive oils and fats such as palm stearin in the world market.

b) Productivity

Besides its reliability in supply, oil palm is also the most efficient producer of oil among the oil crops. *Table 2* shows that oil palm is capable of producing 3200 kg of palm oil and 456.6 kg of palm kernel oil, giving a total of 3656.6 kg of

Table 1. World Production of Oils and Fats ('000 tonnes)

Source/Year	1984	1995	2000*
Annuals:	33737	51350	57294
Soybean oil	13276	20231	23317
Groundnut oil	3262	4252	4629
Sunflowerseed oil	5877	8635	9962
Corn oil	1029	1817	1780
Castor oil	389	516	456
Linseed oil	781	688	843
Sesame oil	551	705	702
Cottonseed oil	3346	3875	4776
Perennials:	10757	22278	24808
Palm oil	6280	15201	17498
Palm kernel oil	767	1971	2175
Coconut oil	2058	3258	3306
Olive oil	1652	1848	1829
Animals:	19090	20373	23164
Tallow & Grease	6327	7639	735
Lard	4878	5808	6857
Butter as fat	6290	5804	7012
Fish oil	1550	1122	1560
Total	**63584**	**94001**	**105266**

Note: * – PORIM forecast
Sources: Oil World Annual 1996
Oil World 1958-2007

Table 2. Average Productivity of Various Major Oil Crops

Crop	1995/96 Yield (kg/ha/yr)	Oil Conversion Factor (%)	Oil Equivalent kg/ha/yr
Soyabean	1989.10	18-19	367.90
Cottonseed	976.40	18-20	185.50
Groundnut	937.70	45-50	445.40
Sunflowerseed	1244.40	40-50	528.90
Rapeseed	1415.90	40-45	601.80
Sesameseed	404.40	45-50	192.10
Palm	16000.00	20	3200.00
Palm kernel	961.30	45-50	456.60
Copra	534.30	65-68	355.30

Sources: Oil World Annual 1996
Fuels and Chemicals from Oilseeds

palm oil products per year from a hectare of land. Compared to soybean, it is about ten times more productive since only 367.9 kg of soybean oil can be obtained from a hectare of soybean crop.

c) Cost of Production

Comparative cost studies on production costs of oil crops indicate that oil palm has significant cost advantages over alternative oilseeds grown in temperate countries (*Table 3*). The low comparative cost to produce palm oil has encouraged more countries to cultivate the crop.

Table 3. Comparative Costs of Production of Selected Oils and Fats

Country	Oil	Cost US$/ tonne
Indonesia	Palm	185
Malaysia	Palm	240
USA	Soyabean	400
Canada	Rapeseed	648
EEC	Rapeseed	900

Sources: Bastin, Mielke

d) Price Competitiveness

Continuously increasing trade availability coupled with its much lower cost of production have made the prices of high quality palm products from Malaysia to be very competitive. In analysing the prices it should be noted that they are either on FOB or CIF basis. It should also be observed that palm products could be processed products while the other selected oils are in the crude form. A rule of thumb that can be used in bringing FOB prices to CIF Rotterdam would be to add the following to the FOB prices:

- US$45.00 per tonne freight charges,
- 0.4% of FOB value for insurance,
- 0.25% of FOB value as arrival loss,
- 2.75% of FOB value as financial charges, and
- US$1.00 per tonne port charges.

(It is important to note that the freight cost depends on the size of the consignment).

The technical advantages of palm oil can be looked in terms of its flexibility to be used as it is or in fractionated forms to produce a wide range of products either for edible or inedible purposes. Palm oil has good oxidative stability, and its interesterification property significantly modifies its crystallisation behaviour. It has also been known as a good heavy duty frying medium because of its relatively low polyunsaturation and its slip melting point which is low enough to avoid excessive waxiness in most applications. Research findings have shown that palm oil is safe to human health.

The technical and economic advantages of palm oil over other oils and fats have enabled it to be used in many applications. Thus the olein has been used to replace soybean oil and the stearin to replace tallow and lard.

Conclusion

Malaysian contribution of palm oil to the world trade of oils and fats is significant in that without it there would be much shortage of oils and fats, in particular palm oil, in the world market. Research findings have proved that palm oil is technically suitable to replace other oils and fats and nutritionally safe to health. Its economic advantage of supply reliability assured its steady supply in the past and consequently guarantees it in the future. In addition, its low cost of production and high productivity assures its competitiveness to produce and the most productive crop to plant in future on a limited available land.

Palm oil is also very price competitive and was sold at discounts to soybean oil most of the time. However the prices of palm oil and other oils and fats are determined by supply and demand factors and there are occasions when the price of palm oil happens to be high such as in 1995. It is expected that the price of palm oil would be lower than that of 1995. The price situation in 1996 showed testimony to this.

Acknowledgement

The authors would like to thank the Director General of PORIM for his kind permission in allowing the preparation and publishing of this paper.

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INDUSTRIAL FRYING OIL – PRACTICAL ASPECTS

by

*P. Van Twisk and L. M. Du Plessis**

In the last issue, the article, "Industrial Frying Oil - Basic Aspects" (P. Van Twisk, 1997) has discussed the suitability of palm olein as a frying medium. But, like any business, deep-frying has to be managed in order to get the best results and prevent oil abuse. If management and control are neglected, the desired results will not be achieved with subsequent sub-standard quality and financial loss. In oil management, specifications and auditing (supplier of oil and processor) are two vital elements which will be discussed in this paper.

Specifications

The first step towards good oil management is the setting of written specifications for fresh oil to be agreed upon by the supplier.

Every delivery of oil should be accompanied by a certificate that the consignment is within specifications.

Rancimat value can only be used as a criterion in the case of refined oil. During the frying process other chemical data should be used to determine oil quality.

Although palm olein is a stable oil, our experience has shown that tertiary butyl hydroquinone (TBHQ) antioxidant has a pronounced effect on stability. The analyst from the suppliers and processors must work in close collaboration in order that the same testing procedures are used. This will prevent conflict or dispute in a case where a consignment is found to be out of specification.

Audit of Supplier

The objective of a factory audit of an oil supplier is to determine whether the prospective supplier is capable of and committed to the supplying of oil that will meet the user's specifications and standards. There should be a close cooperation between supplier and food processor. The following items form part of such an audit:

1. Make it clear to your supplier why you require a high stability oil and the purpose of the specifications.
2. Check the company structure and history: how experienced and informed is the R&D department.
3. Check on current product range and customers.
4. General appearance of factory premises:
   - Outside
   - Inside
   - Offices

   talk to factory operators where possible.
5. Factory/processing:
   - Are there processing and quality control (Q.C.) manuals
   - Production capacity
   - Engineering capabilities
   - Hygiene/cleaning programme
   - Back up system/contingency planning
6. Do the suppliers understand ISO 9000
7. Refined Oil:
   - Method of refining (caustic/physical)
   - Storage
   - Specification - can it be readily met
   - History of analysis
   - Exposure to metal contaminants
   - Exposure to light
   - Exposure to air
   - Certificate of analysis (in-house or independent laboratory)
   - Possibility of contamination with other oils.
8. Laboratory:
   - Facilities
   - Expertise
9. Arbitration in case of dispute
10. Suppliers to retain samples of crude as well as refined oils for six months at 4°C maximum.
11. Possibility of nitrogen sparging:
    - During storage
    - During transportation

* *PVT Consultants cc, South Africa and L.M. Du Plessis of Foodtek, CSIR, South Africa*

Auditing of a supplier may seem harsh and unnecessary but it must be borne in mind that oil is relatively expensive in relation to other raw materials and constitutes a major proportion of the end product.

Audit of Snack Factory

It is of little use if the supplier of the oil complies with the most stringent specifications but management is not followed through by the food processor (*e.g.* snack manufacturer). Deterioration of oil during processing can be caused by hydrolysis, oxidation and polymerisation and one has to try and prevent or minimise these as far as possible. The following aspects are part of good oil management by the food processor:

1. Oil receiving at factory:
   - Check certificate of analysis
   - Check condition of delivery tanker, piping, seals
   - Sampling from tanker for laboratory analysis before off-loading:
     - Temperature of oil
     - Free fatty acids (FFA)
     - Peroxide value (PV)
     - Antioxidant(s)
     - Colour
     - Odour
     - Taste
   - Sample of Rancimat stability determination
   - Procedure when oil is out of specification
   - Procedure when oil complies with specification
   - Cleanliness at receiving end - piping, brass couplings
   - Any danger of metal contamination
   - Is air drawn into system during pumping
   - Is receiving tank on a load cell
   - Condition of receiving/storage tanks: mode of temperature control
   - Does filler pipe extend to the bottom of the receiving tanks
   - Is the system equipped with a filter bag
   - When were tanks last cleaned
   - Is the storage tank equipped with a manhole for inspection purposes.

2. The following aspects must be well managed during the frying process:
   - Oil turnover time
   - Is there any aeration before oil reaches fryer
   - Is there excessive aeration in the fryer
   - Are there points in the manufacturing process where metal contamination could occur
   - Is there excessive water carry over into the fryer
   - Control of frying temperatures and recording procedures
   - Quality control of the frying process
   - Are there any signs of condensate drip back into fryer
   - Is oil cooled during stoppages (ideally there should be no stoppages)
   - Are there any points where hot spots could develop
   - Is the feed rate of product (*e.g.* potato slices) constant
   - Are there filter screens in the system
   - What is the delta T (difference between inlet and outlet temperatures - should be 10-23°C)
   - Are paddles and belts operating during heating up of fryer or when no product is fed into fryer.

3. Boil oil (cleaning of fryer):
   - How often
   - What is the procedure
   - Is all water and cleaning solutions removed before filling up with oil
   - What is done with the oil which is removed before boil-out.

4. Safety:
   What are the safety procedures in the case of fire or overheating of the oil.

Discarding of Oil

If good manufacturing practices (GMP) are followed, it should not be necessary to discard frying oil due to constant replenishment and oil uptake. However, external circumstances could lead to unacceptable oil deterioration and therefore constant monitoring of the oil during the frying process must be done by the quality assurance department. Oil should be discarded and the fryer cleaned when FFA value reaches 0.5%, when there is excessive smoking or when a pungent odour is evident. Under GMP, discarded oil should not be fed back into the system.

Conclusion

Deep-frying of food in oil has been, is and will also in future, be a very important processing method because of its unique function. Very few oils in their unhydrogenated state can be used in industrial frying. Here palm olein has proved itself an outstanding frying medium. Palm olein is stable, poses no health risk under controlled frying conditions and actually has good nutritional properties. Having said that, good oil management from start to finish is of utmost importance to ensure that all requirements are met.

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AUTHENTICITY OF PALM OIL – ASSESSMENT OF A BRAZILIAN SURVEY

Contributed by
B.A. Elias & T.P. Pantzaris

Over the last five years, for which there are complete data (1990-1995) world palm oil production increased by more than 38% (Oil World Annual, 1995; 1996) as other countries, encouraged by Malaysia's success, are taking up oil palm cultivation. Increasingly palm oil from new origins is entering international trade, but is it palm oil as we know it?

A recent survey of Brazilian palm oil was reported by Traveres, M and Barberio, J C (1993) and the data presented, although very unusual, seem to have passed unnoticed by everyone. Our observations are given below:

Materials and Methods

In establishing the identity of purity of oils, one of the most useful and decisive tests involves the examination of their fatty acid composition. Indeed the fatty acid composition has been described as the 'fingerprint' of an oil, but this is very much an exaggeration. Different oils often have overlapping ranges of fatty acid composition (FAC) and the limits of natural variation are not known with certainty. The latest Codex FAC range limits for palm oil for example, are very different from those three years previously.

In the case of Malaysian palm oil, its basic characteristics were determined in 1979/80 in a classic study by the Malaysian Agriculture Research and Development Institute (MARDI) from a very large and well-planned sample of 215 specimens, the results of which were later incorporated in the Malaysian Standard MS814:1983.

Table 1. Major Fatty Acid Composition (FAC) of Palm Oil – Codex and Brazilian Survey Values

FAC	Codex 95/17		Brazilian PO (n=73)		
	Normalised Mid-range	Range Limits	Mean	S.d.	Range Limits
C16:0	43.0	41.0 – 47.5	39.0	3.4	31.9 – 57.3
C18:1	38.8	36.0 – 44.0	43.2	2.6	23.8 – 47.5
C18:2	9.0	6.5 – 12.0	11.5	1.7	6.4 – 14.7
IV	52.5	50.0 – 55.0	58.0	1.8	50.3 – 62.9

Given the narrow genetic base of South East Asian palms and the uniformity of climate and rainfall, the characteristics of Malaysian palm oil can safely be assumed to apply to palm oil from the whole of that region, but for world palm oil we think the most appropriate standard would be that of Codex (1997) (*Table 1*). Regrettably, unlike the Malaysian Standard, Codex does not give mean or standard deviation values, only range limits, which very much restricts the statistical tests we can carry out and its usefulness. But in this case, our task is made a little easier by the fact that we are dealing with a survey and surveys almost invariably reject very unusual values. We can take it therefore that the reported ranges were not due to one or two freak results.

The survey of Brazilian palm oil in question was summarised in a poster at PIPOC 1993, by Travares and Barberio, who took a fairly large sample of 99 specimens from the Brazilian retail market and interestingly rejected 26 of them as being adulterated. This alone says a lot about the prevalence of adulteration and trading standards in some markets. On the remaining 73 samples considered pure, the research reported the FAC, iodine value (IV) and refractive index.

Results and Discussion

In palm oil, palmitic, oleic and linoleic acids account for over 90% of the total FAC and *Table 1* shows the values reported for the Brazilian survey, with corresponding Codex values for comparison. Since Codex does not give mean values we have calculated normalised mid-range values in their place and it is seen that the Brazilian oil contains on the average, much less palmitic acid and more oleic and linoleic acids. Also, all the ranges are very much wider (up to 3.9 times in the case of palmitic acid) and overlap those of Codex, even though this oil is from one country while the Codex ranges apply to all origins. Furthermore the frequency distributions appear to be strongly skewed, positively in the case of palmitic and negatively in the case of oleic acid, linoleic acid and IV, which indicate that the sample was not of uniform composition.

In *Table 2* we have calculated the percentage by which the Brazilian FAC and IV ranges overlap those of Codex and it is seen that for palmitic acid, about 74% is outside, for oleic acid it is 66% and for linoleic acid is 34%.

The above considerations lead strongly to the conclusion that the Brazilian oil was from *Elaeis oleifera* with or without some *Elaeis guineensis*. Also the fact that a specimen with palmitic

Table 2. Percent of Brazilian Ranges Outside Codex Limits – Major Fatty Acid Composition (FAC)

FAC	Range (Max-Min) Codex	Brazilian PO	% Outside*
C16:0	6.5	25.4	74.4
C18:1	8.0	23.8	66.4
C18:2	5.5	8.3	32.7
IV	5.0	12.6	60.3

* (Brazilian-Codex)/Brazilian x 100%

acid content as high as 57.3% was not considered adulterated by the researchers and was not rejected with the other 26 mentioned earlier, indicates that there were several specimens with such high values. High palmitic acid values show presence of palm stearin. The conclusion we draw therefore is that the "palm oil" in this survey consisted of mixtures of *Elaeis oleifera* and various proportions of palm stearin. Under the Codex Standard, palm oil is the whole oil from *Elaeis guineensis*.

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RESEARCH HIGHLIGHTS

NEW REVIEW ON EFFECTS OF *TRANS* FATTY ACIDS

by
Pantzaris, T P & Elias, B A

Trans fatty acids raise total cholesterol and LDL cholesterol in a similar way to saturated fatty acids, two researchers concluded in a paper published last September in the *Journal of the American College of Nutrition*.

Khosla of Wayne State University and K.C. Hayes of Brandais University, USA, reviewed numerous studies on the effect of *trans* fatty acids on plasma lipoproteins in humans. The earlier studies found no harmful effects but their results were flawed because their subjects were not fed enough cholesterol, the researchers believe. In contrast, recent studies did find adverse effects in *trans* fatty acids, due largely to the availability of more advanced methods for the study of lipoproteins. These findings have great significance in view of the fact that the Foods and Drugs Administration is considering whether to require labelling of *trans* fatty acids in food products.

Khosla and Hayes cited a number of studies which found adverse impact of *trans* fatty acids on plasma lipoprotein profiles. In particular, the study by R.P. Mensink and M.B. Katan compared the effect of altering the *trans*, saturates and oleic acids by 10%, when the subject were fed normal dietary cholesterol and calories, but three times the average level of *trans* fatty acids. The results showed a 5% increase in total cholesterol and 10% increase in the LDL/HDL cholesterol ratio over and above that caused by the saturated fat diet.

This study had been criticised for the high level of *trans* fatty acids in the diets it used, but a follow-up study by M.B. Katan and P.L Zock, using significantly lower levels of dietary *trans* fatty acids, gave similar results. Interestingly, this study also found that stearic acid, which is usually considered to be neutral in its effect on serum cholesterol levels, gave results similar to those of the *trans* fatty acids. It is ironic that following the widespread publicity of the adverse effects of saturated fatty acids in the diet, many consumers have switched to diets richer in *trans* fatty acids, which are probably just as objectionable, if not more so.

The main source of *trans* fatty acids is the hydrogenated fats which typically contain 10-30% *trans* isomers. Consumption of *trans* fatty acids varies greatly in the population with some groups consuming three times the average.

The effect of *trans* fatty acids is probably more pronounced in people who are genetically predisposed to high serum cholesterol. P.J. Nestel *et al.* found 6.5% higher total cholesterol and 9.3% higher LDL/HDL cholesterol ratio among such people when they consumed diets rich in *trans* fatty acids than when they consumed diets rich in saturates in general, or palmitic acid in particular.

IN BRIEF

27608

WHAT DO THE FRENCH SAY ABOUT PALM OIL

by
N. Chandrasekharan

The French publication "Plantations, reserche, developpment" from the Centre for Research in Agronomy and Development (CIRAD) in Paris carried a paper by Voituriez T, titled 'Les substitutions entre huiles vegetale' in a recent issue (3:239-244, 1996). The paper commends that the use of palm oil as a cooking oil, deep frying oil and in the manufacture of margarines are to its advantage. This is also borne by the fact that since the 1980s, countries in the European Union and Asia are importing and consuming more and more palm oil.

Even though palm oil ranks first in world trade, there is extensive promotion and research development for the purpose of increasing demand and diversifying uses.

The publication highlights the advantages of palm oil in deep frying over other oils, and stresses the fact that it is not prone to oxidation. This is important, as the production of fatty deposits on food as well as the oxidation phenomenon, reduce the number of dippings and increase costs.

It also points out that palm stearin is favoured for use in margarines. Hydrogenation is essential for soft oils. However, little or no hydrogenation is required for palm oil, and it is currently almost impossible to manufacture industrial margarine and a frying oil at low cost without incorporating palm oil. For this, blenders and margarine manufacturers decide, according to market prices of the different oils, in what proportion these oils should be added to the blend.

As for the prospects, vegetable oil consumption trends will primarily depend on the growth rate of GDP and on the population growth in Asian countries. Palm oil is forecast to capture a sizeable share of the market because of its competitiveness. Further, the hidden costs in hydrogenation and the harmfulness of the non natural *trans* fatty acids resulting from such a process will also influence consumer preferences.

This paper is once again testimony to the safety and versatility of palm oil as another edible oil necessary to meet the growing demands for oils and fats in an expanding world.

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FORMULATIONS OF SHRIMP MEALS

by
Pantzaris, T P & Elias, B A

The fishing industry has now reached the ceiling of its possible productivity which is limited by the natural laws governing the rates of reproduction of marine life. But the world population is increasing at an alarming rate - 90 million per annum in the short term and much more in the long term and when this is coupled with increases in per capita income, it becomes crystal clear that we shall be depending more and more on aquaculture.

With regard to shrimp production from aquaculture, the main regions are South East Asia and South America. In a recent paper (Feed Milling International, September 96) Bernard Devresse of INVE. Company of Belgium, one of the largest manufacturers of feeds for aquaculture, discusses the difference in the shrimp feeds used in these two regions. South American feeds are sold at about half the price of the South East Asian feeds and this is ascribed to differences in formulations, concentration of production into larger units and keener competition in South America. Also South East Asian feeds contain about 10% more protein and correspondingly less starch than South American ones.

Table 1 gives the nutrient requirements of marine shrimp and it is seen that while protein is the major component and starch is second, fat is the third. Very important requirements are the highly unsaturated fatty acid HUFA ω-3, mainly C20:5 and C22:6 which are normally provided by fish oil, but only 1-2% is needed in the diet, while the average content in commercial feeds is about 12%.

A better formulation would be to reduce HUFA to a level much nearer to what is essentially required and provide the balance of fat from palm oil. Fish oils are very prone to oxidation and palm oil will go a long way towards remedying this situation. The feed will have a longer shelf life and the consequent reduction in peroxide value will be more beneficial and promote better growth of the shrimp.

Table 1. Nutrient Requirements of Marine Shrimp (*Penaeus monodon*) in South East Asia (%)

Protein	40
Lipids	< 8
Ash	< 15
Starch	20 – 25
Calcium	< 2-2.5
Phosphorus	> 1.5
PUFA C18:2 ω-6	> 0.5
HUFA, ω-3	> 1.0
Phospholipids	2.0
Cholesterols	0.2 – 0.4

We invite readers to send in their comments, suggestions and technical news which could be published in this newsletter.

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