Quality Control Measures in the Malaysian Palm Oil Industry

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INTRODUCTION

Malaysian palm oil is now exported to some 60 countries. Its acceptance world-wide is attributable to many factors, of which reliability and quality are certainly important.

The Malaysian palm oil industry can be divided into five main sectors according to their activities:-

Sectors	Activities
Plantations	Planting of oil palm and harvesting of fresh fruit bunches (FFB)
Palm oil mills	Processing of FFB into crude palm oil (CPO) and palm kernels
Palm kernel oil mills	Extraction of palm kernel oil
Palm oil processing	i) Refining and fractionation ii) Production of downstream products
Bulking installations	Storage and shipment

The industry has always recognized the importance of having stringent quality control in the various sectors. Dedicated efforts by those involved have certainly contributed to the overall success of this industry.

QUALITY CONTROL

Apart from genetic factors, various field operations affect palm oil quality. Thus the degree of ripeness of the crop and delays between harvesting and processing are important in this connection. Milling and refining operations also affect palm oil quality, and measures need to be taken to prevent degradation during these operations. Deterioration of quality in palm oil is mainly due to hydrolysis and oxidation. These reactions are affected by a number of factors, such as:-

i) *Moisture*
The presence of moisture can cause hydrolysis of palm oil triglycerides, with the formation of free fatty acids and partial glycerides.
Studies carried out by Chan (1979) and Chong *et al*. (1988) have indicated 0.19% as the optimum moisture level for crude palm oil, providing oxidative and hydrolytic stability.

ii) *Trace Metals*
In reactions between unsaturated fatty acids and oxygen, trace metals act as pro-oxidants believed to catalyse mainly the decomposition of hydroperoxides.

The natural levels of copper and iron in crude palm oil have been reported to be in the ranges of 0.01 - 0.18 ppm and 0.5 - 1.0 ppm respectively (Abd Gapor and Ong, 1982; Jacobsberg, 1983; Chong and Abd Gapor 1983). Contamination during processing and handling could increase the amount of trace metals in oils.

The ultimate aim of the processing of palm oil is to obtain products which meet the requirements of the end users. Besides meeting the normal specifications on colour, FFA, moisture and impurities, and compositional parameters, the products are expected by the buyers to be of a certain stability towards hydrolysis, oxidation or colour deterioration. Measures to achieve the requirements include controls: on raw materials delivered to the processing plant; on materials during processing as a check that proper processing has been carried out; on finished products; and on processing conditions.

Crude Palm Oil

Quality control steps are undertaken at various stages in the extraction of crude palm oil from the fruit bunches. The incoming fruits are graded as hard, ripe and overripe bunches. Hard and underripe bunches as well

as overripe and rotten bunches are discouraged through discounts on the normal price. Mills owned by plantations are able to establish good co-operation with estate managements to ensure proper harvesting and delivery of fresh fruits. At the mill, the fruit bunches are handled on a 'first-in-first-out' basis. This system ensures minimum delay in sterilization, which is the first unit operation at the mill. Sterilization not only inactivates the enzymes which cause hydrolysis of the oil, but also helps loosen and soften the fruits for further processing.

After sterilization the fruits are stripped from the bunches, digested and pressed. The oil together with the water and non-oil solids is clarified. Water and impurities are separated and the clarified oil is then further purified. It is dried in a vacuum drier to minimize oxidation and finally cooled to 60 °C before storage. A residual moisture content of about 0.19% is aimed at to minimize further hydrolysis. Buyers of crude palm oil expect a product which has a low content of free fatty acids, moisture and impurities, good bleachability, minimum oxidation, and good stability to further oxidation and hydrolysis. Crude oils are sold according to the trading specifications of the Malaysian Oil Palm Growers' Council (MOPGC) (*Table 1*).

TABLE 1. MOPGC SPECIFICATIONS FOR CRUDE PALM OIL

FFA	:	5% max
Moisture and impurities	:	0.25% max

Refined Palm Oil Products

Quality control at the refinery begins at the reception of raw material, *i.e.* the crude oil received in lorry tankers is routinely checked for purchase specifications such as moisture, impurities and free fatty acids. Other quality parameters such as iodine value, deterioration of bleachability index (DOBI), phosphorus and iron may also be monitored. After the oils have been gum-conditioned with a suitable dosage of food grade orthophosphoric acid (0.05% - 0.1%), the phosphatides (gums), oxidation products and impurities are removed during adsorptive cleansing or earth bleaching. The earth dosage varies in the range of 1% - 2%, depending on oil quality. Optimum conditions and requirements for the refining process are carefully worked out based on equipment design, oil quality and bleaching earth efficiency. The phosphorus content and the colour of the bleached oil are routinely monitored. The bleached oil is steam deodorized at 250 °C - 270 °C to remove free fatty acids, and other volatiles. Oil from the refining process is sampled hourly and tested for FFA, colour, moisture and impurities.

Other parameters that may be monitored include the phosphorus content, iron, iodine value, slip melting point and cloud point. Phosphorus levels in refined oils should be below 4 ppm in order that the oils will remain stable to hydrolysis. Studies showed a greater increase in FFA on storage in oils with a higher phosphorus content and this becomes significant at a phosphorus content above 4 ppm (Siew, 1987). For premium quality products, oxidative and colour stability tests are also carried out.

Refiners, at the request of buyers, add antioxidants to the refined oils. Studies in PORIM (Abd Gapor and Ong, 1989) on the effectiveness of BHA, BHT, TBHQ and citric acid on the stability of RBD palm oil showed that TBHQ was the most effective antioxidant and that it acts synergistically with citric acid. As a synergist, citric acid acts as a metal complexing agent which chelates trace metals. Abd Gapor and Ong also found that ascorbic acid was an effective antioxidant for RBD palm olein.

Crude palm oil contains about 800 ppm of a mixture of natural antioxidants comprising alpha-tocopherol (22%), alpha-tocotrienol (20%), gamma tocotrienol (46%) and delta tocotrienol (12%), and about 60% of the initial concentration remains in the oils after refining.

Palm Kernel Products

After the crude oil has been pressed from the fruit, the fibres are removed from the nuts, which must then be prepared for cracking. When the nuts are cracked, the shells are separated from the kernels. Poor separation would result in a high level of shells mixed

with the kernels and subsequently in the palm kernel cake. The kernels must be dried to the optimum moisture level to prevent mould growth and free fatty acid formation. Nut conditioning and cracking must be carried out with the minimum of kernel breakage. The kernels are sold according to MOPGC-MEOMA-POMA* specifications (*Table 2*).

When the palm kernels are received at the crushing plant, they are checked for free fatty acids, moisture and shell content. They are then cooked, and the oil when pressed out is analysed for free fatty acids, moisture and impurities, iodine value and colour. The residual palm kernel cake is analysed for oil content, moisture, shell and dirt, and checked according to specified requirements (specifications in *Table 2*). The moisture content must be kept to a minimum as specified in order to prevent mould growth during storage.

QUALITY ASSURANCE AND THE ROLES OF THE VARIOUS ORGANIZATIONS AND ASSOCIATIONS

Palm Oil Research Institute of Malaysia (PORIM)

PORIM was established in May 1979, taking over and expanding the research on oil palm which had previously been carried out by the Malaysian Agricultural Research and Development Institute (MARDI). The following are its major activities:-

i) Research on the chemistry and technology of palm oil aimed at improving efficiency of extraction and refining and ensuring high quality.

ii) End-use research to increase the proportion and improve the performance of palm oil in existing uses, both for edible and non-edible products, and to find new uses.

TABLE 2. SPECIFICATIONS FOR PALM KERNEL PRODUCTS

Joint MOPGC-MEOMA-POMA	Moisture	7% max	10%	rejectable
Domestic Contract for Palm Kernels	Dirt and shell	6% max	10%	rejectable
	FFA (as lauric acid)	5% max		
Domestic Contract for Palm Kernel Cake (MEOMA 12)	Protein	14% min		
	Oil	8% min		
	Moisture	9.5% max		
	Dirt and shell	15% max	18%	rejectable
For Export				
Crude Palm Kernel Oil	FFA	5% max		
	Moisture and impurities	0.5% max		
	I.V.	19 max		
Crude Palm Kernel Olein	FFA	5% max		
	Moisture and impurities	0.5% max		
	I.V.	25 max		
	Cloud point	8 °C max		
Crude Palm Kernel Stearin	FFA	5% max		
	Moisture and impurities	0.5% max		
	I.V.	9 max		
Refined Palm Kernel Oil	FFA	0.1% max		
	Moisture and impurities	0.1% max		
	I.V.	16.2 – 19.2		
	Lovibond colour ($5\frac{1}{4}$" cell)	2R max		
	Taste	Bland		

* *MEOMA = Malaysian Edible Oil Manufacturers' Association*
POMA = Palm Oil Manufacturers' Association

iii) Research on nutritional aspects of palm oil.
iv) Provision of technical advisory services to refiners and users of Malaysian palm oil (locally and overseas) by supplying up-to-date information on palm oil, helping to solve processing formulation problems and also giving advice on the handling and transportation of palm oil with the aim of preserving the quality of the oil at the users' end.
v) Techno-economic studies relevant to the Malaysian palm oil industry.
vi) Biological research, especially to help towards reducing costs of production and improving yield. Such research is concerned with genetics, breeding, propagation (including tissue culture), physiology, agronomy, control of pests and diseases, and utilization of by-products.

Certificate of Competency Schemes

The certificate of competency scheme for refineries was introduced by PORIM in 1983 with the objective of establishing the capability of refineries in terms of skills and facilities to produce a consistent, high quality oil. The scheme does not qualify the quality of a specific batch of oil. The evaluation is based on defined criteria and divided into five main sections, namely General, Quality Control, Factory Operations, Storage and Disposal of Products, and Safety and Maintenance. Certificates are valid for one year and re-evaluation is carried out at the end of the award year. Although participation is voluntary, the Certificate of Competency Scheme has been accepted by the majority of the Malaysian refiners and they represent about 90% of the Malaysian refining capacity. The number of refiners taking part and the average score over the five years from 1984 to 1988 are shown in *Table 3*, which indicates a steady improvement in performance.

It is important for refineries to observe cleanliness and hygiene and they are given due attention during the assessment. It must be emphasized here that companies packing products for direct use by consumers must use clean containers complying with the food and health regulations of the importing countries.

Following the success of the Refiners' Certificate of Competency Scheme, a similar scheme was introduced for palm oil mills in 1984. To date, out of the 241 mills, 165 operating mills are participating. Based on the results of assessments conducted once every two years, an improvement in the performance of the mills has also been observed.

Other Research and Development Activities

Some of the activities of PORIM which bear upon quality enhancement are outlined below:

a) Breeding research programmes.
b) Research on biological aspects of bunch ripeness in harvesting.
c) Farm mechanization projects to improve harvesting practices and reduce bruising of fruits.
d) Identification of the nature of exogenous impurities and endogenous minor components and their role in causing deterioration of quality.
e) Laboratory analytical cross-checks to ensure reproducibility and accuracy of results.
f) Studies on stability.
g) Nutritional studies.

TABLE 3. CERTIFICATE OF COMPETENCY FOR REFINERIES

Certificate Year	Number of Refiners	Average Score (per cent)	Number Failed
1984	19	78.9	0
1985	21	79.9	0
1986	25	80.4	1
1987	25	82.2	1
1988	25	82.7	0

Source: Berger, MacLellan and Thiagarajan (1989)

Other efforts include the conduct of various courses such as the Mill Engineers' Course, the Lipid Course and the Ship-Shore Surveyors' Course, as well as seminars and workshops.

Roles of Government Departments and Agencies and Trade Associations

The Palm Oil Registration and Licensing Authority (PORLA) was established by Act of Parliament in 1977 for the purpose of promoting an orderly development of the oil palm industry. Under the Palm Oil Industry (Quality Control) Regulations 1983 and the Palm Oil Industry (Licensing) Regulations 1979 PORLA is empowered to discharge the function of controlling the quality of oil for export as well as enforcement on surveyors and chemists. PORLA's licensees, including exporters, are required to declare the quality specifications of the products which should be in accordance with what is contained in the contracts.

It is important to note that all palm oil products leaving Malaysia are sampled by officers from the Customs Department and sent for analysis at the Chemistry Department. This is done for determination of duty rates and indirectly assures that palm oil products of approved specifications are exported from Malaysia. The Ministry of Health and Local Authorities issue Health Certificates on request from exporters who have to comply with the requirements of the importing country. These Health Certificates are issued in accordance with the Code of Practice for the Processing and Refining of Palm Oil, Palm Olein and Palm Stearin.

Members of the industry also conduct their own research on various aspects of quality improvement. In addition, trade associations such as the Malaysian Oil Palm Growers' Council (MOPGC), the Malaysian Edible Oil Manufacturers' Association (MEOMA), the Palm Oil Refiners' Association of Malaysia (PORAM) have regular meetings (through their Technical Committees) to discuss matters related to quality.

STANDARD AND TRADE SPECIFICATIONS

The identity characteristics of palm oil, palm olein and palm stearin are as specified in the Malaysian Standards for palm oil, palm olein and palm stearin, shown in *Table 4.*

Processed palm and palm kernel oils are traded on the basis of set specifications agreed between buyer and seller. The trade specifica-

TABLE 4. IDENTITY CHARACTERISTICS FOR PALM OIL PRODUCTS AS SPECIFIED IN MALAYSIAN STANDARDS

	Range		
	Palm Oil	**Palm Olein**	**Palm Stearin**
Saponification value mg KOH/g oil	190.1 – 201.7	194 – 202	193 – 205
Fatty Acid Composition (%)			
C12	0 – 0.4	0.1 – 0.5	0.1 – 0.4
C14	0.6 – 1.7	0.9 – 1.4	1.1 – 1.8
C16	41.1 – 47.0	38.5 – 41.7	50.5 – 73.8
C18	3.7 – 5.6	4.0 – 4.7	4.4 – 5.6
C18:1	38.2 – 43.5	40.7 – 43.9	15.6 – 33.9
C18:2	6.6 – 11.9	10.4 – 13.4	3.2 – 8.5
C18:3	0 – 0.5	0.1 – 0.6	0.1 – 0.5
C20	0 – 0.8	0.2 – 0.6	0.3 – 0.6
Iodine value (Wijs)	50.6 – 55.1	56.6 – 60.6	21.6 – 46.0
Slip melting point, °C	30.8 – 37.6	19.0 – 23.0	46 – 56

Source: Malaysian Standards MS 814 : 1983, 815 : 1983 and 816 : 1983

tions of PORAM and MEOMA are as shown in *Appendices I* and *II*. Refineries are also capable of producing products meeting more stringent buyers' specifications and also products tailor-made to customers' specific requirements.

CONCLUSION

In this paper, we have described control measures undertaken right from the harvesting stage through to the point of export to ensure the high quality of the products. Aspects of quality assurances and the roles of various organizations and associations have also been described. To ensure that the end customers obtain the benefits of these measures, quality preservation along the transportation chain is highly desirable and should be practised.

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APPENDIX I

PORAM STANDARD SPECIFICATIONS FOR PROCESSED PALM OIL

1. Neutralized Palm Oil	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25)	0.25% max. 0.1% max. 50-55 33-39
2. Neutralized & Bleached Palm Oil	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.25% max. 0.1% max. 50-55 33-39 20 Red max.
3. Refined, bleached & Deodorized (RBD)/Neutralized, Bleached & Deodorized (NBD) Palm Oil	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.1%max. 0.1% max. 50-55 33-39 3 or 6 Red max.
4. Crude Palm Olein	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25)	5.0% max. 0.25% max. 56 min. 24 max.
5. Neutralized Palm Olein	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25)	0.25% max. 0.1% max. 56 min. 24 max.
6. Neutralized & Bleached Palm Olein	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.25% max. 0.1% max. 56 min. 24 max. 20 Red max.
7. Refined, bleached & Deodorized (RBD)/Neutralized, Bleached & Deodorized (NBD) Palm Olein	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.1% max. 0.1% max. 56 min. 24 max. 3 or 6 Red max.

8. **Double Fractionated Palm Olein**	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.1% max. 0.1% max. 60 min. 19 max. 3 Red max.
9. **Crude Palm Stearin**	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25)	5.0% max. 0.25% max. 48 max. 44 min.
10. **Neutralized Palm Stearin**	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25)	0.25% max. 0.15% max. 48 max. 44 min.
11. **Neutralized & Bleached Palm Stearin**	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.25%max. 0.15% max. 48 max. 44 min. 20 Red max.
12. **Refined, Bleached & Deodorized (RBD)/Neutralized, Bleached & Deodorized (NBD) Palm Stearin**	* FFA (As Palmitic) M&I I.V. (Wijs) + M. Pt degrees C (AOCS Cc 3 – 25) # Colour ($5\frac{1}{4}$" Lovibond cell)	0.2% max. 0.15% max. 48 max. 44 min. 3 or 6 Red max.
13. **Palm Acid Oil**	Total Fatty Matter M&I * FFA (As Palmitic)	95% min. (basis 97%) 3% max. 50% min.
14. **Palm Fatty Acid Distillate**	Saponifiable Matter M&I * FFA (As Palmitic)	95% min. (basis 97%) 1% max. 70% min.

\+ : Slip Point, Softening Point or Rising Point
* : Molecular Weight of Palmitic Acid is taken as 256
\# : Colour measurement based on Tintometer Model 'E' AF 900 and Model 'D' AF 702.
: Specifications are shipped quality final
: For double fractionated palm olein, specifications can be adjusted if required for selected customers' specifications.

APPENDIX II

SPECIFICATIONS FOR PALM KERNEL PRODUCTS

1. Crude Palm Kernel Oil	A. FFA (as lauric)	5.0% max
	B. Moisture and Insolubles	0.5% max
	C. Iodine Value (Wijs)	19 max at time of shipment
2. Crude Palm Kernel Olein	A. FFA (as lauric)	5.0% max
	B. Moisture and Insolubles	0.5% max
	C. Iodine Value (Wijs)	25 max
	D. Cloud Point	8°C max
3. Crude Palm Kernel Stearin	A. FFA (as lauric)	5.0% max
	B. Moisture and Insolubles	0.5% max
	C. Iodine Value (Wijs)	9 max
4. RBD Palm Kernel Oil	A. FFA (as lauric)	0.1% max
	B. Moisture and Insolubles	0.1% max
	C. Iodine Value (Wijs)	16.2 – 19.2
	D. Lovibond colour ($5\frac{1}{4}$")	Red 2 max
	E. Taste	Bland
5. RBD Palm Kernel Olein	A. FFA (as lauric)	0.1%
	B. Moisture and Insolubles	0.1%
	C. Lovibond colour ($5\frac{1}{4}$")	Red 1.5 max
	D. Iodine value (Wijs)	25 max
	E. Cloud Point	8°C max
6. RBD Palm Kernel Stearin	A. FFA (as lauric)	0.1% max
	B. Moisture and Insolubles	0.1% max
	C. Lovibond colour ($5\frac{1}{4}$")	Red 1.5 max
	D. Iodine value (Wijs)	9 max
7. Palm Kernel Expeller	Fair Average Quality	
	A. Profat	22% min
	B. Moisture	12% max
8. Palm Kernel Extraction Pellets	Fair Average Quality	
	A. Profat	16% min
	B. Moisture	14% max