Chemistry of Refining

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ABSTRACT

Processing practices are reviewed, discussing the chemistry involved. Refining is a process of purification. Both the individual unit operations and the whole integrated process are considered. Efficiency of the physical and the alkaline refining procedures as practiced in Malaysia are compared. Palm oil is unique in being a fruit flesh oil and not a seed oil. The crude oil is produced at the oil mill by cooking, pressing and clarification. Quality of the crude affects the efficiency of refining, and thus the quality of the fully processed product. Moreover, after fractionation problems can arise in refining of crude stearin. Recent research into the nature of the minor and trace constituents of crude palm oil is described. Their partition during fractionation and removal during the purification process of refining are important. Some chemical artifacts that can be formed during processing are discussed. Certain findings of the research laboratory are confirmed by actual commercial operations. Unique product specifications mean that both feedstock quality and refinery operation need to be controlled. Efficient optimization of processing requires a better understanding of the chemistry involved. Alternative purification procedures specifically relevant to palm oil are being investigated in the laboratory.

INTRODUCTION

Refining of palm oil is an industry that has developed extensively in Malaysia only within the last decade, mainly because of government support for expansion of downstream processing to yield added-value products. Nowadays nearly all the palm oil exported is processed, whereas previously the crude oil had been traded worldwide. A comprehensive review of the Malaysian palm oil industry for 1983 has been published by the Palm Oil Registration and Licensing Authority (PORLA) (1).

Refineries established in Malaysia to process palm oil have been purchased from overseas suppliers mainly on a turnkey basis. Several of the manufacturers described their processing plants in 1976 at an International Symposium on Palm Oil Processing and Marketing organized by the Incorporated Society of Planters (ISP) in Kuala Lumpur (2). The first physical refining plant became operational in Malaysia in 1975 (3,4).

Extensive reviews of the refining process have been published in Malaysia (5,6), while at the last AOCS World Conference on Oilseed and Edible Oil Processing held in the Hague in October 1982 papers were presented on aspects of palm oil processing (7,8), and on palm kernel and coconut (9). The present paper on aspects of the chemistry of refining considers only palm oil, with emphasis on the industry in Malaysia.

Local refineries have the advantage of only processing one type of feedstock. Moreover, this has less chance of deterioration than when the crude was shipped around the world (10). Nevertheless, the quality of the crude feedstock is still crucial in determining the quality of the product of refining (11). Physical refining was originally introduced because it has a lower loss factor associated with the removal of free fatty acids (FFA) and because the environmental pollution problem associated with the splitting of soap-stock does not arise. With a reasonable quality crude, both physical and chemical refining can produce a good quality processed palm oil. Alkali refining, however, is more tolerant of variations in the quality of the feedstock.

Future developments of the refining process are diverse and potentially extensive. Both physical and chemical refining will be, and indeed already are being, optimized for palm oil processing. Eventually there will be a rationalization between the purification done at the oil mill and that at the refinery. Thus, crude palm oil as we know it will disappear from an integrated industry in Malaysia. Even an alternative refining process based on extraction for deacidification and purification could develop. Research into the chemistry of palm oil is showing how this might be achieved.

PROCESSED PALM OIL QUALITY

The general specifications of Malaysian processed palm oil are based on those agreed upon by the Technical Committee of the Palm Oil Refiners Association of Malaysia (PORAM) (12). For both physically and chemically refined palm oil these are free fatty acid (FFA as palmitic acid) 0.1% max., moisture and impurities (M&I) 0.1% max., iodine value (IV Wijs) 50-55, slip melting point (MPt) 33-39 C, and red color (5.25 in Lovibond cell) either 3 max. or 6 max. The same analyses with appropriate values also apply to processed olein and stearin. These then are the basic specifications for trading contracts.

In addition to the above, there are two other types of chemical data which form part of quality assurance. The first type may be described as identity characteristics, while the second determines the extent of deterioration and contamination. Both types are affected by the efficiency of the refining process, and also can be included in the trading contract rather than relying just on good merchantable quality (GMQ).

The identity characteristics of Malaysian palm oil have been the subject of several extensive surveys which have established the ranges of such parameters as fatty acid and triglyceride compositions, iodine value, slip melting point, cloud point and solid fat content at various temperatures. Relative density, refractive index, saponification value and unsaponifiable matter have also been measured (13,14,15).

Aspects of deterioration and contamination of most common concern are measures of oxidation such as peroxide value (PV meq/kg) and anisidine value (AV), and for contamination, levels of phosphorus (P ppm), iron (FE ppm) and copper (Cu ppm).

Certain of these parameters have been included in the Malaysia standards promulgated by the Standards and Industrial Research Institute of Malaysia (SIRIM) for palm oil, stearin and olein (16).

However, it is more useful to discuss what may be regarded as the typical analysis of a physically refined palm oil as produced at the refinery. Such a product requires both a crude of good quality and an efficient pretreatment stage during refining. Table I shows not only the analysis of the processed palm oil exdeodorizer, but also of the degummed and bleached oil and the acceptable range in the quality of the crude feedstock. Note that all the parameters quoted relate to aspects of deterioration and none to identity characteristics. With such values at production, the purchaser should receive the oil in sound condition if codes of good practice have been observed during storage and transportation (17-20).

The most likely changes are an increase in PV and in FFA because of oxidation and hydrolysis. Increase in Fe levels is a sure sign of contamination by corrosion. A maximum of 0.05% FFA ex-deodorizer gives reasonable assurance that the product will arrive within specification. Recently it has been reported that a maximum of 4 ppm P

TABLE I

Typical Analysis of Palm Oil During the Process of Physical Refining

	Crude palm oil (range)	Degummed and bleached	Refined, bleached and deodorized
FFA (%)	2-5	2-5	0.05
M&I (%)	0.15-0.3	0.02	0.02
Red color (5.25 in. Lovibond)	orange red	orange red	2.5
PV (meq/kg)	1-5	0	0
AV	2-6	2-6	1-3
Carotene (ppm)	500-700	–	–
DOBI	2-3.5	–	–
Phosphorus (ppm)	10-20	4	4
Fe (ppm)	4-10	0.15	0.15
Cu (ppm)	0.05	0.05	0.05
Tocopherol (ppm)	600-1000	–	–
Diglycerides (%)	2-6	–	–

is also a prerequisite of minimal hydrolysis during shipment (21,8). Low oxidation values and minimal metal contamination are necessary for good oxidative, flavor and color stability not only of the oil itself but of edible products made from it. If addition of antioxidant is permitted then a mixture of TBHQ and citric acid has been found to be the most beneficial. Citric acid addition, which is regarded as routine in most countries, is little practiced in Malaysia. The most dramatic benefit, however, is obtained if the processed oil is packaged at the refinery in Malaysia and is delivered in this packaged form to the overseas customer. Access to air and moisture is minimal and contamination during handling is avoided. Whether in containers, drums or cartons such storage and transportation provides the best assurance for maintenance of quality, at however additional cost.

CRUDE PALM OIL QUALITY

Important aspects of the quality of the crude feedstock have to be considered in that they affect the refining process. There are two types of factors: those that cause losses during the refining process and those that cause difficulty in producing a product of good quality.

The contractual specification currently extant in Malaysia is for a crude palm oil with a maximum 5% FFA and a M&I not exceeding 0.5%. The SIRIM Malaysian Standard for oil of 5% FFA max. quotes 0.25% M&I max. Special Grade is also defined with 2.5% FFA max., 0.25% M&I max. and additionally PV 3 max. and AV 4 max. (16). Table II presents the house specifications for four grades of crude palm oil currently offered in the product guide of a major plantation company. Apart from the loss factor type specifications of FFA, M&I, the other parameters are relevant to oxidation characteristics and a bleachability test. This then identifies the traditionally accepted difficulty factors. The major problem in the refining of palm oil has been one of bleachability during processing and to a very much lesser extent the oxidative and flavor stability of the product.

The most widely accepted tenet of the production of good quality crude palm oil is that the freshly harvested ripe fruit bunch must be handled with care and sterilized as soon as possible. Overripe or damaged fruit yields crude with higher levels of FFA, without however any evidence of oxidative changes due to enzymes. This is in contrast to oilseeds where lipoxygenase activity is associated with lipase action. Recent investigations into some autolytic changes occurring in palm fruit flesh or mesocarp have shown phospholipase (22), and polyphenol-oxidase (personal communication, Azis Ariffin, PORIM) activities. Moreover, the different biochemical compositions of a fruit flesh from a seed must result in impurities of a unique nature in crude palm oil. Thus the removal of such impurities during pretreatment at the refinery may require a different process. For example, pectin, which forms the intercellular cement of the fruit tissue (23), could assist in the colloidal dispersion of impurities. And indeed a process for purifying crude palm oil by treatment with pectinase enzyme has been patented (24).

Phosphorus Compounds

Gums and phosphatides are often synonymous in the refiner's vocabulary. However, the phosphorus content of crude palm oil is quite variable both in amount and in properties. Whereas normally in the range of 10 to 20 ppm, values less than 5 ppm have been observed for Lotox-type oils and exceeding 30 ppm for crudes of high acidity. Indeed a rough correlation has been reported between the level of phosphorus and the acidity (25,26). Only between 10 and 30% of the phosphorus occurs as a phosphatide. The major amount has been described as inorganic (22), but it has unique nonpolar properties. The exact nature of the dispersion of phosphorus containing impurities is still the subject of investigation at PORIM. Their removal is a necessary requirement of the refining process. In the fractionation of crude palm oil the phosphorus concentrates in the stearin and may well show a three-fold increase from the original level in the crude. Neither routine analysis of phosphorus in crudes nor the optimization of pretreatment in refining for its removal is current practice.

TABLE II

Supply House Specifications for Crude Palm Oil

	Grade			
	SQ	Lotox	Standard	Contractual
FFA (%)	2.5	2.5	3.5	5.0
M (%)	0.2	0.2	0.2	basis pure
I (%)	0.02	0.02	0.02	basis pure
max. PV (meq/kg)	3	3	5	–
max. AV	4	3.5	–	–
Carotene (ppm)	–	600-700	–	–
max. Fe (ppm)	4	4	5	–
max. Cu (ppm)	0.02	0.2	0.2	–
Hobum thermal bleach color (1 in. Lovibond)	1 red 10 yellow	1 red 10 yellow	– –	– –

Trace Metals

By contrast, contamination with trace metals, particularly iron, arises because of mechanical wear and corrosion at the oil mill. Use of stainless steel and of magnetic traps can greatly reduce the level (27). On the other hand, oil recovered from effluent treatment is particularly rich in iron contamination. Again during fractionation iron concentrates in the stearin.

Oxidative Deterioration

The products resulting from oxidation have long been recognized as the most important factor causing problems of bleachability during refining. This arises because of bad practices at the oil mill or during the subsequent storage and transport. Such deterioration occurs to a lesser extent when the crude is refined in Malaysia than when it was transported overseas. Peroxide and anisidine values have been the parameters used in the past to monitor such changes. However, a reinvestigation of this problem at PORIM showed that iron-catalyzed oxidation which caused extensive destruction of carotenoids and tocopherols was particularly detrimental (28). A new simple analytical method was proposed as a relevant Deterioration of Bleachability Index (DOBI) (29,30). The procedure is a spectrophotometric assay of the crude palm oil dissolved in a hydrocarbon solvent. Measurements of absorbance are made at the two wavelengths of 446 nm and 269 nm, corrected only for the solvent blank. The DOBI is then defined as the ratio of the absorbance at 446 nm divided by that at 269 nm. This ratio has been observed to have a value between 3 and 4 for the best grades of crude palm oil, while oils with a value between 2 and 3 also yield an acceptable color for the refined product. However, sludge oils and those recovered from spent bleaching earth have values less than 1 and cnnot be bleached during processing, and, therefore, should be regarded as technical and not edible crudes. Many companies have now found the DOBI assay useful and are incorporating it into their quality control specifications. However, an appropriate test is still required for the level of other types of impurities which can cause difficulties during processing.

REFINING PRACTICES

Before discussing the chemistry involved, a description of physical refining as practiced in Malaysia identifies the unit operations. First the crude feedstock is subjected to pretreatment and then to deodorization and deacidification. The pretreatment comprises a degumming step and an earth bleaching step which together remove certain nonvolatile impurities by filtration. Volatile and thermally labile components are removed during the conditions of steam distillation under vacuum, which originally gave the process its name of steam refining.

Crude palm oil is first mixed with about 0.1% of concentrated phosphoric acid. After holding, about 1 to 2% activated bleaching earth is added under vacuum and at a temperature of 80 to 130 C. After a suitable contact time the spent earth is removed by filtration. This degummed and bleached oil is first deaerated before steam stripping under a vacuum of 2 to 6 mm Hg at a temperature between 240 and 270 C. Careful cooling and a polishing filter then yields the refined, bleached and deodorized product (RBDPO) (5,12).

As refining is a process of purification, the chemistry of the unit operations must be understood before they can be optimized. Curiously, during degumming nothing is removed, and reduction of color is unimportant during earth bleaching. Nevertheless, efficient pretreatment is vital to successful physical refining (31,32).

The initial treatment with phosphoric acid should be thought of as a conditioning treatment assisting the subsequent removal of insolubilized impurities at the time of earth filtration. The color of a good quality crude palm oil is visually dominated by its carotenoid content. This also is true of the partially earth-bleached product (30). Now carotenoids are known to be efficiently thermally bleached under the conditions of deacidification and deodorization. Thus the important action of earth bleaching, which is one of adsorptive cleansing, is not seen until the color and quality of the fully refined product. The color of palm oil after earth bleaching alone is unimportant and, for example in the case of a heavily oxidized crude, may be completely misleading (33).

This means that adsorptive cleansing has to be described in chemical terms so that an optimum performance for an adsorptive clay may be defined (34). Unfortunately, while many refiners have long recognized the phenomena, several recent research papers even published in the JAOCS have been predominantly concerned with the removal of carotenoids by the earth bleaching process (35-38). Current refinery practice in Malaysia is to reduce the color roughly to one half by earth bleaching.

Adsorptive cleansing as a result of pretreatment must reduce the trace metal content, particularly iron and copper (39). It must reduce phosphorus compounds to an acceptable level of less than 5 ppm. This is the residual level not only arising from the crude, but also after removing the heavy load of phosphorus just added in degumming using 0.1% phosphoric acid. Oxidation products in the oil should also be reduced. Bleaching does mean reduction of those pigments or color-precursors which would remain after deodorization. We are beginning to require not just a specification of adsorptive cleansing but also a specification of important impurities in crude palm oil which require to be removed (34).

Little need be said about the process of deodorization and deacidification, as the process is well described in terms of its physical chemistry. However, the mechanisms of thermal and steam mediated reactions have been little investigated. Both peroxides and carotenoids are sufficiently thermally labile to be completely destroyed under the conditions of steam refining. However, not all the decomposition products are volatile. Thus, peroxides yield an increase in the anisidine value on thermal decomposition in the deodorization process.

Deleterious chemical reactions affecting the quality of the processed oil are to be avoided. They can arise as a result of abuse at both the earth bleaching and the deodorization stages. Activated earth or thermal catalysis are involved. The most dangerous is oxidation due to access of air. Isomerization of tocopherols (40) during earth bleaching, and of unsaturated fatty acids and glycerides under too severe conditions of temperature and time in the deodorizer (8) have been reported. Unique to the refining of palm oil is the reaction that takes place between phosphoric acid "slip" (past the bleaching earth) and diglycerides in the deodorizer, resulting in esterification (personal communication, Siew Wai Lin, PORIM).

Novel Chemical Refining

Chemical refining, where neutralization with alkali is used after phosphoric acid mediated gum conditioning, is still a considerable though small proportion of the Malaysian refining capacity. With the removal of fatty acid in the soap stock comes a considerable extent of removal of the impurities necessary to process palm oil. The buildup of these impurities in the soap stock has been described (41).

TABLE III

Analysis of Palm Oil During a Process of Chemical Refining Without Earth Bleaching

	Crude palm oil	Degummed and neutralized	Degummed neutralized and deodorized
FFA (%)	2.56	0.06	0.03
M (%)	0.08	0.01	0.01
I (%)	0.03	0.02	0.003
Red color (5.25 in. Lovibond)	orange red	orange red	1.0
Carotene (ppm)	580	579	0
DOBI	3.1	–	–
Phosphorus (ppm)	16	3	4
Tocopherol (ppm)	733	679	566
Induction period (hr at 100 C)	49	34	44

However, an efficient alkali refining plant, in this case using Westfalia equipment, has been found to purify crude palm oil so efficiently that it can be deodorized directly.

Normally, chemical refining includes a stage of earth bleaching between the neutralization and the deodorization steps. For palm oil, between 1 and 2% acid activated clay is used. If the crude palm oil feedstock is of bad quality, higher levels of the earth are required. Even then it is not possible to produce a fully refined product with the lowest color specification.

This background, therefore, emphasizes the uniqueness of a factory where alkali refining without earth bleaching has been in operation for the last four years producing many thousands of tons of good quality processed palm oil. Table III shows some analytical data for this neutralized and deodorized product, and the crude and the neutralized oil from which it was made. Of note is the cleansing action of neutralization in reducing the phosphorus level, for example. However, no bleaching takes place until the thermal bleaching of the carotenoids in the deodorizer operated at 240 to 260 C. As no distillative deacidification is required, a shorter treatment time is used resulting in reduced loss of tocopherols. The final product possesses good oxidative stability as measured by its induction period at 100 C, and an exceptional low color of 1 red, 10 yellow as measured in a 5.25 in. Lovibond cell.

LABORATORY STUDIES

A prerequisite for the study of the refining process in the laboratory is a procedure which simulates the industrial process and yields comparable results. It would appear that the most significant factors to be investigated relate to the problem of bleachability of palm oil, particularly during physical refining.

Many bleachability tests have been proposed and often abandoned because they were either not reproducible or because they did not correlate with the results at the factory. Ideally a laboratory test should allow the investigation of three factors. Of prime importance is the assessment of crude oil quality. An additional benefit attaches to an evaluation of the behavior of various bleaching earths. Lastly, an investigation of various degumming treatments should be possible.

The method of test now widely adopted in Malaysia was originally developed in the late 1970's by the Seed Crushers and Oil Processors Association of the United Kingdom (SCOPA). The method is based on the concept that to correlate with bleaching at the refinery, a laboratory test must measure the extent of thermal bleaching after an earth bleach treatment. Also, an initial conditioning with acid is needed to mimic pretreatment as practiced in the physical refining of palm oil. The SCOPA Palm Bleachability Test was developed as a result of collaborative trials between laboratories with the objective of establishing the procedure giving the most reproducible results for the evaluation of crude palm oil quality.

The procedure of the SCOPA Palm Bleachability Test is summarized below. An initial "degumming" of a 100 g sample of the crude palm oil under test is achieved by mixing with 0.5 ml of a 20% aqueous solution of citric acid at 90 C for 10 minutes. Then at 105 C, earth bleaching is simulated by treatment with 2 g Tonsil Standard FF bleaching earth for 15 minutes. Both these steps of pretreatment are done under a nitrogen blanket. After filtering, 90 g of this earth-bleached oil is further heat-bleached at 260 C for 20 minutes under vacuum (1 to 3 mm Hg). With the vacuum still applied, the oil is cooled to 60 C and the final color measured in a 5.25 in. Lovibond cell.

This procedure has been reproducible within the error of measurement of the Lovibond color. Its critical step is the thermal bleach where contact with air must be excluded. The main modifications that have been made are changes in the type and amount of bleaching earth and also the use of phosphoric acid to replace the citric acid.

The laboratory studies that have been made mainly at PORIM using the SCOPA Palm Bleachability Test have investigated several aspects of refining. A study in 1980 relating the bleachability of a crude palm oil to the extent and nature of its oxidation led to the proposal of the DOBI assay. An investigation contrasting the color after the earth bleaching step with that after the thermal bleach showed that there was no correlation. Bleaching of the dominant carotenoid color by the earth is unimportant compared to its adsorptive cleansing function. It was useful to monitor phosphorus and iron removal during the test, and to study the efficacy of different bleaching earths. As is usual in studies of adsorption isotherms, the effect of different levels of earth were investigated. The dominant finding is that the activity is dependent on the quality of the crude.

Malaysia has no clay deposits of the montmorillonite type, which can be activated by treatment with acid into an expanded lattice bleaching earth. It does have considerable deposits of kaolin. This mineral is mined and processed for other industries but has been rejected for palm oil processing as it has little bleaching activity for β-carotene (42). However, it was possible to show using the SCOPA test that kaolin has the desirable property of performing adsorptive cleansing, yet has little catalytic activity associated with acid activation. PORIM is now sponsoring further research at the Universiti Sains Malaysia into optimization of kaolin performance for palm oil processing. Mineralogical studies accompany functional investigations.

TABLE IV

Effect of Liquid Extraction on Color after Thermal Bleach "Break" Test

	5.25 Lovibond color		
	Red	Yellow	Blue
(CPO control)[a]	7.3	75	7
Alcohol alone[a]	5.0	50	3
Water alone	4.8	48	–
Alcohol after water	3.7	37	–
Water after alcohol	3.8	38	–
Citric acid after alcohol	4.2	42	–
1N Bicarbonate after alcohol	3.3	33	–
1N Carbonate after alcohol	2.2	22	–
5N Sodium hydroxide after alcohol	1.6	16	–
0.3N Sodium hydroxide after alcohol	1.8	18	–

[a] Very cloudy and filtered before measurement.

Liquid Extraction

In the present practice of pretreatment, the phosphoric acid added first has to be removed by the bleaching earth. It has been suggested that the addition of calcium carbonate would aid in its removal by forming insoluble calcium phosphate. Laboratory investigations of various time/temperature treatments failed to show any significant activity. However, water washing after the phosphoric acid treatment was effective in removing the added acid. The phosphorus and iron content of the oil is reduced to a variable extent, depending on the experimental conditions. Nonetheless, the capacity of the bleaching earth for adsorptive cleansing is improved. Alternative degumming procedures are still under investigation, including treatment with water and steam. A most dramatic benefit of such an extraction of crude palm oil with water before refining has been a considerable reduction in darkening when heated at frying temperatures (43). The nature of the impurities which can be extracted or precipitated by such treatments is under investigation. An understanding of the physical chemistry of their dispersion in crude palm oil is needed before we can optimize pretreatment.

An alternative procedure for the refining of crude palm oil is based on removal of impurities by liquid-liquid extraction. It has long been known that free fatty acids for example can be extracted by alcoholic solvents. Studies of the rate of continuous extraction by recycling an aqueous alcohol azeotrope now showed a rapid improvement in bleachability accompanies the reduction in titratable acidity. Partition studies relative to the rate of weight loss confirmed that while phospholipids are readily extracted, the so-called inorganic phosphorus behaves in a nonpolar manner like the carotenoids and remains in the raffinate. Unique to this purification process is reduction of diglyceride content which accompanies the deacidification.

While for a normal crude palm oil such extraction resulted in the lowest color achievable in the SCOPA bleachability test, difficult samples such as certain stearins required a further washing of the raffinate. Here, dilute alkali has been found to be most effective particularly in reducing phosphorus and iron content to very low levels. Also under investigation is the use of sodium borohydride during such treatments to chemically reduce the level of oxidation products, particularly the anisidine value. This reagent has been used in analytically (29), and has been proposed as an additive during refining (44).

An interesting insight into the effect of different washing treatments on removal of impurities is obtained by the use of a modified SCOPA test with the earth bleaching and filtering stages omitted. The assay may be described as a thermal bleach break type test in the presence of citric acid. Results obtained from various treatments are shown in Table IV. By applying the washing techniques to the raffinate it was possible to eliminate the effect of free fatty acid and partial glyceride levels. Also, such a test does not indicate what can be removed by traditional pretreatment. Thus, the full SCOPA bleachability test gave for the good quality crude palm oil, with an acidity of 2.7%, a 1.3 red and 13 yellow. The same color was obtained for the water-washed sample. However, the raffinate yielded 0.7 red, 9 yellow, which same color was found for the alkali-washed raffinate. Thus the definitive improvement in bleachability is between the crude and the raffinate.

By contrast Table IV shows that an aqueous wash greatly reduced break color, and of all the treatments those with sodium hydroxide were the most effective. These samples also had the lowest phosphorus and iron levels. Thus a distinction appears between impurity level and bleachability. Nevertheless, the most reliable refining process is the one which can best tolerate variations in the quality of the crude feedstock.

FUTURE DEVELOPMENTS

In this competitive industry new developments will be exploited if of financial benefit. Either processing must become cheaper or the product a better value. Chemical understanding only makes processes feasible. Developments appear possible in more efficient removal of impurities by either improved coagulation and precipitation by clays activated for adsorptive cleansing, or by the techniques of liquid extraction (45). As well as improving unit operations, the overall processing benefits must be considered. Ideally the palm oil mill, refinery and the oleochemical industry should become more integrated.

ACKNOWLEDGMENTS

The author is indebted to his colleagues in research and friends in the industry for useful briefings, and to PORIM for the award of a senior research fellowship which made this study possible.

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The Function of Bleaching Earths in the Processing of Palm, Palm Kernel and Coconut Oils

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ABSTRACT

The results presented in the literature, which attempt to elucidate the mechanisms by which triglyceride oils are bleached by earths, are reviewed. The impact of this work and how the mechanistic proposals affect changes in oil properties are considered, with particular emphasis on the needs of the palm oil processor. Important properties include color, metals and phosphorus content and oxidative stability of the oil.

Investigations made in our own laboratories have been aimed at elucidating the effect of varying physical and chemical properties of the bleaching earth on the quality of bleached and deodorized oils. Techniques used in this work are pore-size distribution, surface area, scanning and transmission electron microscopy and a variety of chemical and X-ray analysis methods.

The ability to vary such parameters in montmorillonite clays by alteration of process conditions to give materials with specific performance characteristics is demonstrated.

Comparisons are made between acid-activated montmorillonites and other clay types.

INTRODUCTION

The use of acid activated montmorillonites in the physical and chemical refining of palm, palm kernel and coconut oils is a widely accepted process (1,2). In this paper, we appraise the current state of knowledge of the way in which bleaching earths function.

Investigations carried out in our own laboratories have been aimed at elucidating the effect of varying physical and chemical properties of the bleaching earth on the quality of bleached and deodorized oils. By comparison with other possible materials we intend to demonstrate the unique properties acid activated montmorillonites have for this application.

Although of general relevance to the processing of virtually all triglyceride oils, particular reference is made to the physical refining of palm oil products.

EXPERIMENTAL PROCEDURE

Bleach Test

Evaluation of bleaching earths was made using a modified version of the SCOPA test. Palm oil samples were subjected to degumming, earth bleaching and heat bleaching. The conditions used in each stage are given in Table I. The test procedure was done in stirred glass flasks, with a nitrogen purge during stages 1 and 2 and a vacuum during stage 3. The bleached oils were filtered before and after stage 3.

We have found this test procedure to give results comparable to laboratory steam deodorization, particularly when ranking a series of bleaching earths for performance by measuring heat bleached color. For simplicity, we refer in the following tables to these colors as deodorized colors. One reservation we have for this test method is that in the absence of steam, peroxide values of zero are not obtained. The method does have advantages in ease of operation when testing a large number of earth or oil samples. We find no improvement in final color by inclusion of steam.

Heat bleached colors were measured in 5¼" cells using a Lovibond Tintometer.