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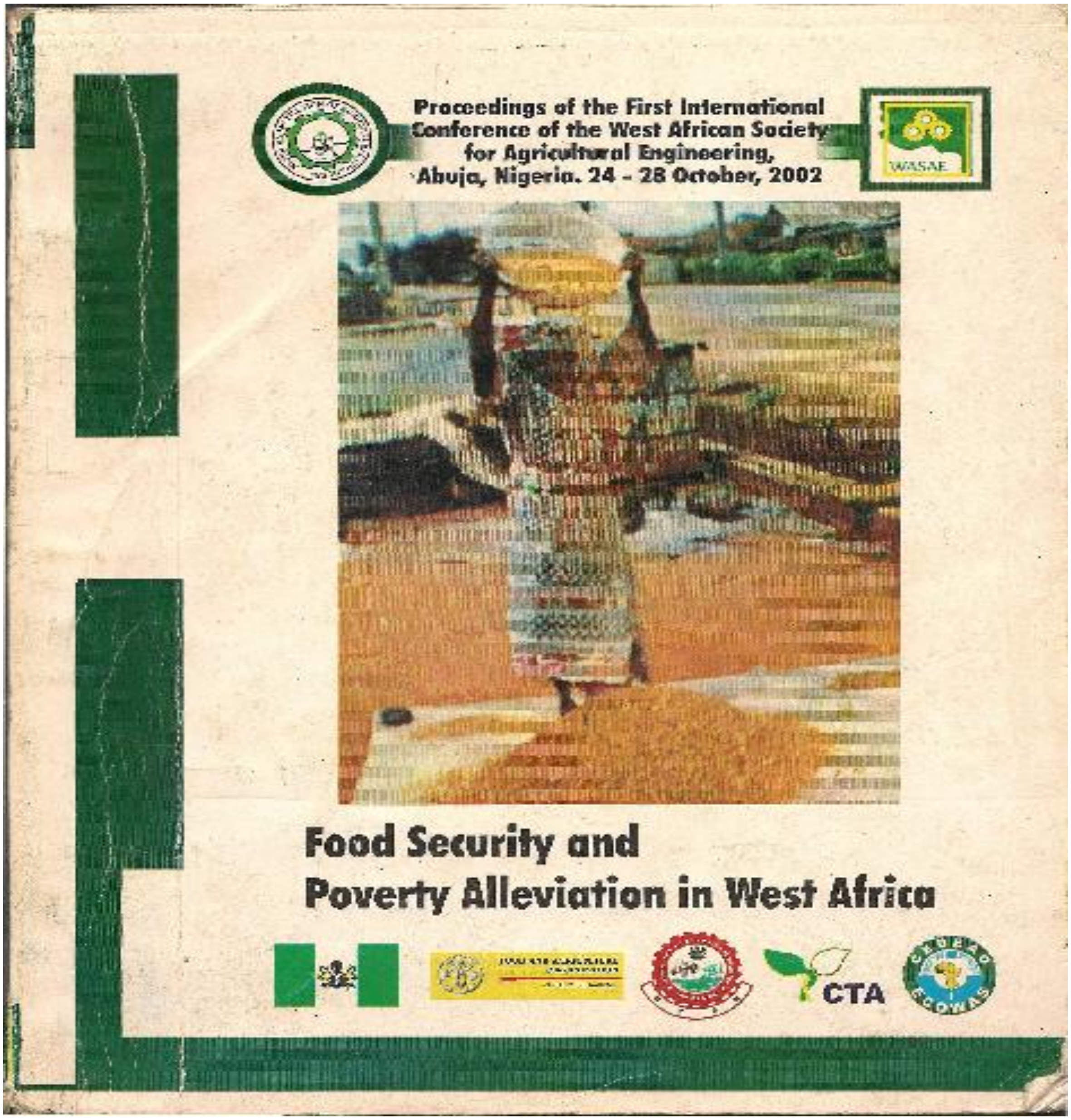

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APPROPRIATE TECHNOLOGY FOR THE CONVERSION OF CRUDE PALM OIL INTO REFINED PALM OLEIN

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ABSTRACT

In order to identify the appropriate technology for the conversion of crude palm oil into refined olein, four different methods of separation were adopted. These are the Direct Decanting (DRDC), Cold Treated Decanting (CLDC), Settled Discharged (STDG) and Mixed Instant Discharged (MIDG) methods. Twenty litres of freshly prepared raw palm oil were procured from a semi-mechanised palm oil processing centre at Erinmu in Oyo State. The separation of olein from crude palm oil and its refining were carried out in a specially designed set of equipment of 5litres / batch crude palm oil. This consists of settling and refining tanks mounted on wooden stands.

The result of the analysis of olein produced from all the four methods showed that the CLDC method gave the best-refined olein of 0.08 free fatty acid with bright and sparkling red colour.

Based on this choice of the CLDC method of separation, a-120litres/batch low temperature non bleaching (LTNB) palm oil refining plant which consists of a pre-crystalliser-separator and deodouriser (PSD); a palm oil neutraliser-clarifier (PNC) and an ice water generating heat exchanger (ICWGHE) was developed.

Keywords: Olein, refining, separator, neutraliser, deodouriser.

INTRODUCTION

Palm oil is obtained from the ripe fruits of palm tree (*Elaeis guineensis*). The tree bears fruit in bunches with each bunch bearing up to 200 fruits. Each fruit contains one seed enclosed in a stony endocarp, oval in shape but varying in size and colour depending on variety (Raj., 1992). The two common varieties in West Africa are Dura - with thick shelled and large kernel, and Tenera - with thin shelled and small kernel fruit (Raids, 1995).

Traditional processing of palm fruit is commonly carried out by women. The methods of extraction are generally divided into two types - the hard oil and soft oil process. In the hard oil process also known as fermentation process, the bunches are covered with water in a special container and allowed to ferment for several days through the action of fungi, yeast as well as enzymes in the fruit. The process is inefficient in terms of oil yield, only about 20-30% of the oil present is recovered. The oil has a higher value of free fatty acid (FFA), between 10-20% thus limiting its use to soap production. The soft oil process involves boiling the fruit after separating it from the bunch. This process yields oil with a lower FFA content, which is acceptable for food use (UNIFEM, 1987).

The red palm oil is one of the richest plant sources of carotene with concentration of about 500 – 700ppm. It is used in domestic cooking. It can also be employed in making margarine, soap, lubricants, candles and skin creams. Upon storage at ambient temperature, the red oil starts to separate into two phases, a lower solid phase (stearin) and a top liquid phase (olein). With time a single solid phase finally emerges (Nnadozie et al., 1989). Before use, therefore, the congealed oil must be melted. However, reheating the oil will limit the packaging materials for the crude palm oil to metal cans and glass bottles.

According to Tandy (1984) and Siew et al. (1985) one of the major inconveniences encountered during frying with the Nigerian crude palm oil is that the oil smokes very rapidly, and this smoke has an extremely choking effect within the vicinity of the frying perimeter.

Tan et al., 1985 stated that separating the Nigerian crude palm oil into olein and stearin would eliminate its congealing tendencies, greatly facilitate the ease with which the oil is used when needed, expand the scope of packaging materials used for storage purposes and considerably raise the smoke point of the oil.

However, the current practice is to bleach the separated and refined palm olein in order to obtain golden yellow oil that can replace vegetable oil such as groundnut and cottonseed oil (Eteng, 1999 and Akinuli, 2000). This act destroys almost all the carotene, which are vitamin A precursors. Therefore, the objective of this research work is to identify the appropriate method of producing refined palm olein without removing its red colour.

MATERIALS AND METHODS

The unit operations developed in the FIIRO's laboratory (Figure 1) was transferred to the development of a set of model handling equipment for 5litres per batch of palm oil. It consists of separation and refining plastic tanks. Both tanks have taps at the bottom and are mounted on wooden stands. Other materials such as plastic containers, enamel pot and sieves were used in the processing of the oil. The design of the mixer/reactor is presented below.

Capacity of the Mixer

Based on the FIIRO developed laboratory process (Olayanju et al., 1999), 100ml of crude olein gave 84ml of refined olein. Therefore, by adopting an output of 2litres per batch of refined olein, (100/84) x 2000 i.e. 2.38 litres of crude olein shall be put in the reactor. Similarly, the required quantity of water for the washing of refined olein shall be (340/85) x 2380 = 9.52litres. To reduce the size of the mixer, thus saving cost, the washing of the olein is to be done twice, therefore, the required quantity of water is 4.8litres. The design volume, V_d of the reactor = (2.38 + 4.8) = 7.18L.

The ratio of the design volume (V_d) and the actual volume (V_a) of the reactor is equivalent to the vortex clearance or fillage coefficient. It is given as 0.7 for simple liquid mixing (Mubeen, 1998). Therefore, $(V_d/V_a) = 0.7$, hence, $V_a = 7.18/0.7 = 10.2$litres. The actual capacity of the reactor is taken to be 10litres.

Design of Impeller

For simple impeller design, d = 0.66D and h = 0.5D (Mubeen, 1998.). If D is chosen to be 0.25m, then d = 0.66 (0.25) =0.165m and h = 0.5 (0.25) = 0.125m where, D = Diameter of the reactor, (m); d = diameter of impeller (m) and h = height of impeller from the base of the reactor (m). The volume of reactor, Va = 10L = 0.01m^3. Therefore, the height of reactor,

$$H = \frac{4V}{D^2} = \frac{4 \times 0.01}{3.142 \times (0.25)^2} = 0.2037m$$

Fractionation of Palm Oil

Twenty litres of palm oil which has just been produced was procured in 4(5litres each) plastic kegs from a semi-mechanised palm oil processing centre at Erunmu, near Ibadan in Oyo State. Four different methods were adopted for the separation (fractionation) of the crude palm oil into olein and stearin. These were Direct Decanting (DRDC); Cold Treated Decanting (CLDC); Settled Discharged (STDG) and Mixed Instant Discharged (MIDG) methods. The fractionation procedures are as follows (Fig. 1).

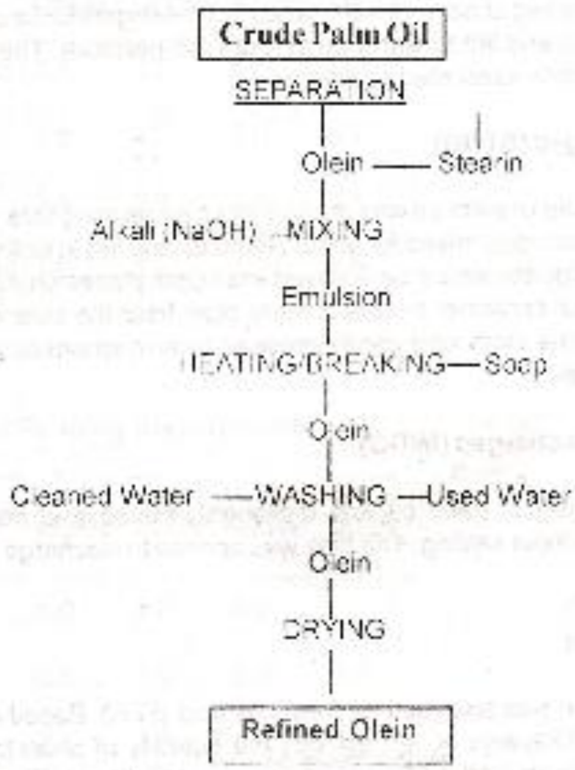

Fig.1: **Flow Diagram for the Laboratory Process**

Decanting (DRDC)

The first 5 litres keg of palm oil was left to settle under gravity. The settling time was noted. The upper liquid portion, the olein, was separated from the semi- solid portion, the stearin, by sieving through a sieve lined with filter cloth and placed on a container to collect the olein while the stearin remained on the cloth. This was repeated three times and the mean values are given in Table 1.

Cold Treated Decanting (CLDC)

The second 5litres keg of palm oil was placed in the refrigerator for cold treatment. It was brought out and left to warm up at room temperature. The liquid and the semi liquid were then separated by sieving.

Settled Discharged (STDG)

The third 5litres keg of palm oil was poured into a separating tank with tap at the bottom. It was thoroughly mixed for about 2minutes and left to settle. The tap was opened to discharge the stearin on a sieved lined cloth placed on a big funnel over a plastic cylindrical container to collect more olein from the stearin. The stearin was wrapped in the cloth and gently pressed in a mechanical plate press to collect excess olein.

Mixed Instant Discharged (MIDG)

The last 5litres keg of palm oil was thoroughly mixed and poured into the separation tank without settling. The tank was opened to discharge the separated palm olein.

Refining of Olein

The collected olein was analysed for free fatty acid (FFA). Based on the results obtained before (Olayanju et al., op. cit.) the quantity of alkali to be used for refining the olein to lower the FFA was determined (Table 2). The olein and the alkali (NaOH) were mixed together in the refining tank. The emulsion formed was heated, the olein was separated, washed in clean water and dried.

Tables 3 shows the free fatty acid (expressed as percentage palmitic) composition of the raw and the treated oil.

RESULTS AND DISCUSSION

Analysis of the results (Tables 1 - 3) shows that separation methods CLDC followed by STDG gave the best refined olein which were sparkling clear and bright red. The DRDC and MIDG have some precipitates which were later separated and bulked together. Further treatment removed the precipitates but the oil became lighter in colour and was not as clear as the initial portion.

Table1: **Fractionation of Palm Oil into Olein and Tearin.**

Method	DRDC	CLDC	STDG	MIDG
Pre-Separation Time (days)	4.0	4.0	4.0	—
Separation Time (hours)	2.5	4.5	9.0	4.5
Volume of Olein (litres)	3.4	3.8	3.8	4.1
Volume of Hard Stearin (litres)	1.6	1.0	1.0	0.9

Table 2: **Olein Refining Requirements**

Method	DRDC	CLDC	STDG	MIDG
Initial FFA of Clear Olein	4.0	4.0	4.0	
Volume of Olein (litres)	2.5	4.5	9.0	4.5
Volume of Alkali (litres)	3.4	3.8	3.8	4.1
Volume of Refined Olein (l)	1.6	1.0	1.0	0.9

Table 3: **Characteristics of Raw and Refined Palm Olein**

Parameter	Acid Value	FFA (%)
Raw Palm Olein (DRDC)	11.51	5.25
Raw Palm Olein (CLDC)	11.58	5.37
Raw Palm Olein (STDG)	11.72	5.37
Raw Palm Olein (MIDG)	11.76	5.44
Refined Palm Olein	0.19	0.08
Refined Palm Olein	0.73	0.33

FIIRO industrial process technology is therefore based on the cold treatment method because of higher yield of olein, shorter separation time and lower residual FFA content. It is called Low Temperature Non Bleaching (LTNB) process.

It is an integration of 3 main equipment. These are the pre-crystalliser and separator (PCS); the palm oil neutraliser and clarifier (PNC); and the ice water generating heat exchanger (ICWGHE). These are linked with process plant facilities/utilities supply system like pumps, exhaust fan, raw material, final and intermediate product tanks and piping network.

The plant is designed for the production of palm olein, vegetable oil and industrial grade stearin from red palm oil. Depending on the use of stearin, it can be bleached or its red colour retained. Therefore, the following processes were adopted as the basis of appropriate technology development:

- Methodical separation of olein and stearin substrates with concurrent precrystallation by cold treatment and inert gas agitation.
- Neutralisation of FFA in olein or stearin substrates separately allowing for clear-cut separation of olein processing from stearin processing.
- Deodorization and drying of oil substrates using desiccating agents (like silica gel, kieselghur or magnesium anhydrous sulphate) at low temperature under a slight pressure depression of about 5-25mm of mercury that is achievable with an exhaust fan.
- Economical and simpler generation of cold brine solution (CBS) using ice-water-salt full mix mass/heat exchanger instead of the usually expensive industrial cryogenic system.

CONCLUSION

Successful transfer of this industrial prototype plant in the palm oil producing regions of the country, will not only give added value to our palm oil export but also allow for local sourcing of intermediate raw materials for our food, pharmaceutical and lubricant industries. The developments of down stream industries like production of fatty acids food colours, vitamin concentrate alongside local technology advancement will be greatly stimulated.

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