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Physical and chemical characteristics of refined vegetable oils from rubber seed (*Hevea brasiliensis*) and bread-fruit (*Artocarpus altilis*)

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Abstract. Crude vegetable oil obtained by solvent extraction from rubber seed (*Hevea brasiliensis*) and breadfruit (*Artocarpus altilis*) were subjected to alkali refining (neutralisation), degumming and bleaching. At each stage of refining, the crude and the refined oil were analysed for their physical and chemical characteristics notably specific gravity, moisture and volatile matter content, saponification, iodine values, peroxide value, unsaponifiable matter, fatty acids and free fatty acids. Results showed an improvement in the quality of the oil after refining. Refining decreased the free fatty acids and peroxide value, which are some of the characteristics that determine stability. There was a very slight decrease in saponification value and unsaponifiables matter after refining. Refining did not have much effect on the fatty acid composition except slight non-consistent decreases in saturated and unsaturated fatty acids. There was no decrease in iodine value.

Introduction

Vegetable oil is becoming scarce and expensive in Nigeria. An attempt is being made to exploit some low priced seeds as sources of vegetable oil. Rubber seeds are not currently in use and they are abundant and wasted. Bread fruits are also abundant and the oils are not in use. The aim of this study was to assess the effect of refining on the physical and chemical characteristics of the oil. These unconventional oils are being explored for their potential use as domestic cooking oil and perhaps for industrial purposes. The oils will invariabley be subjected to refining to serve these purposes. The term 'refined' as referred to in this paper includes alkali refining (neutralization), degumming and bleaching.

Materials and methods

The rubber seeds (*Hevea brasiliensis*) and the breadfruits (*Artocarpus altilis*) were picked fresh from the plantations. They were dehulled and ground to pass through a 40 mesh sieve (aperture size 0.42 mm). Oil was extracted from the samples with petroleum ether (40–60 ° Bp) under reflux for 8 h.

The specific gravity, moisture and volatile matter content of the oil samples were determined by the AOAC method [2]. The ash content,

saponification value, Wij's iodine value, peroxide value, free fatty acids, and unsaponifiable matter were determined by the British Standard Institution (BSI) methods [3]. Fatty acids were determined after methylation as described by Achinewhu [1] with a Pye 104 gas chromatography.

Results and discussion

Table 1a and b shows the physical and chemical characteristics of the crude and refined oil from the test samples. There was a decrease in the ash content, free fatty acids and peroxide value when the oils were refined. There were slight decreases in saponification value, unsaponifiables and in moisture and volatile matter content of the refined oils. Refining did not have any effect on the iodine value of the oils. Table 2a and b shows the fatty acid composition of the crude and refined oils. There were slight but inconsistent decreases in both the saturated and unsaturated fatty acids. Similar inconsistent decreases were noticed with the total saturated and unsaturated fatty acids. Certain factors are important when considering the quality of a given oil. Such factors as the stability of oil to oxidative rancidity are determined by the free fatty acids, peroxide value, moisture and volatile matter content. Other factors like the nutritional factors especially the amount of polyunsaturated fatty acids, the chemical characteristics like the iodine value the saponification value and the unsaponifiables are also important in determining the quality of oil. One of the aims of refining oil is to remove some

Table 1a. Some physical and chemical characteristics of crude and refined breadfruit oils (means ± SE of six determinations)

Characteristics	Oil samples			
	Crude	Degummed	Alkali refined	Bleached
Moisture and volatile matter (% dry wt)	0.52 ± 0.002	0.48 ± 0.001	0.48 ± 0.001	0.45 ± 0.001
Ash content (% dry matter)	0.273 ± 0.0003	0.098 ± 0.00018	0.086 ± 0.0006	0.066 ± 0.0003
Free fatty and (% Oleic)	2.86 ± 0.01	2.13 ± 0.03	1.53 ± 0.05	1.55 ± 0.01
Saponification value (mgKoH/g sample)	223.3 ± 5.2	220.8 ± 6.5	221.2 ± 6.3	221.1 ± 5.8
Unsaponifiable matter (% by wt)	1.99 ± 0.003	1.77 ± 0.007	1.87 ± 0.003	1.73 ± 0.005
Iodine value (Wijis 30 min)	37.15 ± 2.3	37.12 ± 1.9	37.00 ± 2.5	37.01 ± 3.1
Peroxide value (mEq/Kg sample)	1.8 ± 0.0008	1.02 ± 0.003	0.54 ± 0.001	0.51 ± 0.0006
Specific Gravity	0.81 ± 0.0001	0.81 ± 0.0001	0.80 ± 0.0002	0.81 ± 0.0002

Table 1b. Some physical and chemical characteristics of crude and refined rubber seed oils (means ± SE of six determinations)

Characteristics	Oil samples			
	Crude	Degummed	Alkali refined	Bleached
Moisture and volatile matter (% dry matter)	0.48 ± 0.001	0.45 ± 0.001	0.42 ± 0.001	0.42 ± 0.001
Ash content (% dry matter)	0.156 ± 0.001	0.023 ± 0.0003	0.025 ± 0.0001	0.018 ± 0.0001
Free fatty acid (% Oleic)	2.82 ± 0.04	2.05 ± 0.05	1.22 ± 0.03	1.03 ± 0.01
Saponification value (mgKoH/g sample)	198.8 ± 4.8	195.3 ± 5.4	196.8 ± 4.6	196.3 ± 4.8
Unsaponifiable matter (% by wt)	1.36 ± 0.01	1.12 ± 0.003	1.13 ± 0.005	1.18 ± 0.002
Iodine value (Wij's 30 min)	82.5 ± 3.5	82.3 ± 4.1	82.8 ± 3.8	81.5 ± 4.2
Peroxide value (mEq/Kg sample)	2.5 ± 0.006	1.2 ± 0.003	0.62 ± 0.0003	0.53 ± 0.0001
Specific Gravity	0.83 ± 0.0001	0.81 ± 0.0003	0.83 ± 0.0003	0.81 ± 0.0003

Table 2a. Fatty acid composition of crude and refined breadfruit oils (means ± SE of six determinations)

Fatty acids (% total oil)	Oil samples			
	Crude	Degummed	Alkali refined	Bleached
Saturated				
14:0 Myristic	0.22 ± 0.0003	0.23 ± 0.0001	0.22 ± 0.0001	0.20 ± 0.0002
16:0 Palmitic	19.1 ± 1.6	18.6 ± 1.3	18.9 ± 1.4	19.3 ± 1.8
17:0 Margaric	1.2 ± 0.003	1.4 ± 0.005	1.02 ± 0.008	1.16 ± 0.005
18:0 Stearic	17.8 ± 1.3	17.5 ± 1.5	17.7 ± 1.8	17.3 ± 1.5
22:0 Behenic	0.93 ± 0.008	0.86 ± 0.006	0.93 ± 0.008	0.95 ± 0.006
Total saturation	39.25 ± 2.9	38.59 ± 2.8	38.77 ± 3.2	38.91 ± 3.3
Unsaturated				
18:1 Oleic	24.52 ± 2.1	24.3 ± 1.8	24.3 ± 2.5	24.5 ± 2.9
18:2 linoleic	30.5 ± 2.8	29.8 ± 2.3	29.5 ± 2.8	30.4 ± 2.5
18:3 Linolenic	2.4 ± 0.06	2.2 ± 0.08	2.3 ± 0.03	2.3 ± 0.05
20:1 Gadoleic	0.13 ± 0.0001	0.13 ± 0.0001	0.13 ± 0.0003	0.15 ± 0.0001
22:1 Erucic	0.44 ± 0.0003	0.45 ± 0.0005	0.42 ± 0.0008	0.38 ± 0.0005
Beyond 22:1	2.4 ± 0.06	2.2 ± 0.05	2.1 ± 0.05	2.2 ± 0.08
Total unsaturated	60.37 ± 5.0	59.08 ± 4.2	58.75 ± 5.3	59.93 ± 5.5

Table 2b. Fatty acid composition of crude and refined rubber seed oils (means ± SE of six determinations)

Fatty acids (% total oil)	Oil samples			
	Crude	Degummed	Alkali refined	Bleached
Saturated				
14:0 Myristic	0.15 ± 0.0001	0.15 ± 0.0001	1.13 ± 0.0001	0.15 ± 0.0002
16:0 Palmitic	8.68 ± 0.9	8.35 ± 1.2	8.35 ± 0.6	8.58 ± 0.9
17:0 Margaric	0.07	0.05	0.06	0.03
18:0 Stearic	9.85 ± 1.3	9.51 ± 1.5	9.66 ± 1.3	9.82 ± 1.7
22:0 Behenic	0.09	0.09	0.06	0.08
Total Saturated	18.75 ± 2.2	18.14 ± 2.7	18.26 ± 1.9	18.66 ± 2.6
Unsaturated				
18:1 Oleic	23.34 ± 2.6	23.61 ± 1.9	23.16 ± 2.3	22.86 ± 2.1
18:2 linoleic	37.07 ± 2.3	36.91 ± 2.6	36.82 ± 2.8	37.00 ± 2.6
18:3 linolenic	20.35 ± 1.8	20.20 ± 1.6	20.11 ± 2.1	19.65 ± 1.5
Total Unsaturated	80.76 ± 6.7	80.72 ± 6.1	80.09 ± 7.2	79.51 ± 6.2

undesirable substances that may have adverse effects on the oil. Toxic components may also be reduced by refining.

In the present study, refining affected the factors of stability as reflected in the decrease of some of those characteristics that affect stability. Refining decreased free fatty acids, peroxide value, and moisture and volatile matter content. The lower they are, the less readily an oil is susceptible to oxidative deterioration [5]. Ojeh [5] showed similar decreases in free fatty acids, peroxide value and moisture and volatile matter after refining cashew kernal oil. He concluded that a more stable oil was obtained upon refining. Similarly, Jaward et al. [4] showed that physically refined soyabean oil had very low levels of free fatty acids and good oxidation stability. There was a very slight but in-consistent decrease in saturated and unsaturated fatty acids on refining. This was in variance with the finding of Ojeh [5] who showed a slight increase in total unsaturated fatty acids and a slight decrease in total saturated fatty acids.

The two oil samples are very high in unsaturated fatty acids especially linoleic acid which is an essential fatty acid. Linoleic acid alone formed about 37% and 30% of the total oil in rubber seed and breadfruit oils, respectively. The extracted refined oil could be used as a linoleic acid-rich oil or could be hydrogenated and used in the industry as edible oil in margarine or for cosmetics or paints. Further research is on to test the possible uses of these oils.

Crude vegtable oils extracted from rubber seed (*Hevea brasiliensis*) and breadfruit (*Artocarpus altilis*) were refined by degumming, bleaching and alkali refining and analysed for their physical and chemical characteristics. There was an improvement in the quality of the oils after refining, demonstrated by a decrease in those characteristics that determine stability notably

free fatty acids and peroxide value. Refining did not have much effect on the iodine value and the fatty acid composition.

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