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Variation of Refractive Index with Physical Properties of Groundnut oil

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ABSTRACT
The variation of some physical properties of groundnut oil with food solutes were investigated at room temperature, using standard laboratory experiments. These physical properties of groundnut oil were determined at room temperature 36 ^{o}C before and after heating up to 120 ^{o}C, and it was found that the physical properties remains the same. The solutes from the following food samples Irish potato, Sweet potato, Egg, Plantain, Beans and Yam were investigated. These solutes were made in paste form and equal amount of solute each of 100 gram was measured and fried in 200 mL of groundnut oil. The physical properties of the remaining groundnut oil after frying, each sample were determined. The result shows that the physical properties of groundnut oil increase or decrease as compared to their values measured in the absence of solutes. However, the variation of physical property is independent of the class of food solutes. From the observation, egg (highly protein) shows the highest increase in the values ofrefractive index т (1.79). Yam (carbohydrates) has the least increase in the value of т (1.478). The increase in л is due to the fact that the speed of light in groundnut oil with solute is less than that without solute or the angle of refraction in g/nut oil with solute is less than that without solute for the same given angle of incidence.
Key words: solute, physical properties, variations, angle of incidence and refractive index

I. INTRODUCTION

Generally, edible oils, for example, groundnut oil (organic compound) belongs to a homogenous series of fats and oil with similar chemical characteristics. The knowledge of the effect of impurity and other physical qualities of edible oils have both industrial and domestic applications and are useful as a prime index for quality control processes.

Refractive index is a phenomenon that plays a significant role in measuring the degree of bending of incident light in a medium. This index is the function of the molecular structure of oil and impurities or solute. The phenomenon help in detecting the adulteration of materials. That is its constant are similar due to minute/trace amount of impurities or solute often caused a measurable changes in refractive index of a pure material, which indicates a criteria for purity. It gives a gross information about the impurity, but it does not served to identify the impurity. Therefore, if we need quantitative information, measurement would have to be made at different wave lengths, though, it was not carried out in this work. Extreme variation of refractive index of fat/oil in general, depend on number of variables such as source, treatment, and age of the fat or oil.

Measurement of refractive index was carried out using Abbe Refractometer, with a precious ±0.0003, immersive or dipping refractometer with a precious ±0.00003, which require about15 mL of the sample and it is widely used to detect minute of impurities or to control the quality of product. Interferometer is used to measure the interference of gases or solution and its precious is ±0.000001.

The research on investigation of effect of concentration of solute introduced into a locally prepared groundnut oil from the following food samples; egg, red beans, yam, plantain, Irish potato and sweet potato on refractive index was carried out in Yola, North of Nigeria.

The main aim of this research, is to investigate how refractive index of groundnut oil can be altered by dissolved food solutes during frying process. This will no doubt, if properly incorporated will help in quality control in food industries.

II. METHODOLOGY

Source of groundnut oil and preparation of solutes

The locally produced groundnut oil was bought from Jimeta market, in Adamawa state - Nigeria. Groundnut oil is commonly used in cooking and frying. Its melting point ranges, from

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$0 - 3^0C$, and becomes very hot at temperature 175^0C - 200^0C. Above these temperature, it may likely decompose or ignite. Before measurement were made, the bulk oil was first sieved, and its refractive index ת of this fresh oil were determined. On heating the oil to 120^0C, it was allowed to cool to room temperature (36^0C), and its refractive index was also determined. It was observed that the physical properties before and after heating remain the same.

Measurement of refractive index of groundnut oil using Abbe Refractometer.

By using cotton wool soaked in an ethanol, the two lower prism of the refractometer was thoroughly washed. One or two drops of the groundnut oil were placed between the two prisms,then mounted on open slitof the powered refractometer, a ray of light from the sourceor lamp was now allowed to pass through the slit. By rotating the fine coarse adjusters, the criticalrays are centered in the eyepiece. The Amici Prism was turned in order to cause the division linebetween the light and dark regions to pass through the centered of the two cross wire or hair. Thenthe refractive index ת ofgroundnut oil was read from a scale through the other eyepiece andtemperature T was noted. The same procedures were repeated for the rest of the samples and therespective refractive index was noted in each case. The actual refractive index of g/nut oil wascalculated in each case using the equation $n = (T - 20)x0.0000087 + n_T$. All readings were taken at room temperature 36 ^oC.

III. RESULT

	Food solutes						
	A Fresh oil	B Oil + Egg	C Oil + plantain	D Oil + yam	E Oil + S.P	F Oil + I.P	G Oil + R.B
Refractive index, ת	1.469639	1.790059	1,711620	1.477567	1.606254	1.728613	1.682510

Table 1: Variation of refractive index with different contaminations of solutes

IV. DISCUSION

Refractive Index

Both experimental and theoretical values of refractive index of pure and adulterated g/nut oil were observed and tabulated as shown in table 1. Practically, the refractive index of pure groundnut oil was found to be 1.4696392, while theoretically, it was calculated as 1.5283092 using the relation

$$n = \sqrt{K} \quad (1)$$

K is obtained as

$$K = \frac{\varepsilon}{\varepsilon_o} \equiv \varepsilon_r \quad (2)$$

Where K is the dielectric constant of fresh groundnut oil, ε is the permittivity of the dielectric, ε_o is the permittivity of vacuum and ε_r is the relative permittivity. (Arthur, 1984).

As shown in table 1, solute of samples B – G shows an increase in refractive index of groundnut oil. The increase may be as a result of solutes/impurities introduced during frying process which may tends to lower the speed of light when passing through this medium. Previous work on refractive index explained that, the faster the speed of light in a given medium, the lesser is the index of refraction, whereas the lower the speed, the greater will be its index of refraction. Contaminant that resulted from frying of egg in a given sample of g/nut oil shows the highest value of refractive index, followed by contaminant that resulted from frying of Irish potato, plantain and red beans, while those of yam and sweet potato shows the lowest refractive index which were much closer to that of unadulterated ground nut oil. This implies that solutes from these samples (sweet potato and yam) did not introduced much solutes to the groundnut oil during frying (Nelkon, 1991)

In general, the higher the concentration of solute in a liquid medium, the higher will be the refractive index of the given medium, whereas, the lower the concentration, the lower will be its index of refraction (Sybil, 1983).

Asiedu in (1989), observed refractive index of pure groundnut oil within the range of 1.4697 – 1.4719, while Pearson's in his own observation ranges from 1.460 – 1.465. From these results of these previous researchers, it can be seen that the experimental result obtained in this research were in fairly agreement with these results.

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Refractive index as observed affects the physical properties of groundnut oil. The phenomenon shows an increase in value of index in the presence of solutes. It was observed from previous study that the denser the medium, the greater the index of refraction, because it will tends to attenuate the speed of light in the medium and also the angle of refraction. Therefore the solutes from these food samples introduced into the oil during frying have characteristic properties of causing the medium to become denser than its normal medium. Though the density of the medium depends on each particular food solutes added to it. The denser the medium, the less is the speed of light in that medium, hence the greater is the index of refraction. Likewise also the angle of refraction, if the angle of refraction, r is less than the angle of incidence i, then ת become greater.

V. CONCLUSION

Effect of solutes on refractive index of groundnut oil was found to vary independent of the class of food items. However, it was found that, presence of food samples, generally increase the refractive index ת of groundnut oil. The general increase in ת may be attributed to the fact that the oil becomes denser as food particles were added to it, hence reduces the speed of light and additional of polarization to added food molecules. These variations may advance application in the study of quality control of groundnut oil in food industries. For example, emulsion needs to be stable when they are part of food product, if top quality is to be achieved.

VI. RECOMMENDATION

Any researcher that has interest in this work should try the following method:

1. Vary the masses of the food sample (in paste form) and fry each in the same volume of groundnut oil
2. Vary the volume of oil and keep mass constant for each sample
3. Try finding out the chemical composition of groundnut oil before and after frying to check whether variation in physical properties is due to contamination rather than the solutes.

Abbe refractometer to determined ת of groundnut oil.

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APPENDIX

Table 1: Food composition of some local food (100 g).
Courtesy: Brain Fox A. (1984). Nigeria Institute of Food Science and Technology

Sample	Egg			Irish potato	Yam	Sweet potato	Plant ain	Red Beans	
	whole	white	Yolk					Red	cooked
Water (%)	73.7	87.6	51.1	75	75.5	70.6	66.4	10.4	69.0
Protein (g)	12.6	10.9	16.0	3.2	2.1	1.7	1.1	10.4	69.0
Carbohydrate (g)	0.9	0.8	0.6	17-43	23.2	26.3	31.2	22.4	7.7
Calcium (mg)	54	9	141	7	20	32	7	60.6	21.4
Phosphorus (mg)	205	15	596	53	69	47	30	110	37.8
Iron (mg)	2.3	0.1	5.5	0.6	0.6	0.7	0.7	406	140
Sodium (mg)	122	146	52	3	--	1.4	5.0	6.9	2.4
Potassium (mg)	129	407	98	407	600	280	385	10	3

Table 2: Refractive Index of some Fat/oil

Fat/Oil (Plants)	Refractive Index	Temperature T (^{o}C)
Babasse oil	1.4430	60
Castor oil	1.4770	50

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Cocoa butter	1.4568	50
Coconut oil	1.4493	50
Corn oil	1.4734	50
Cotton oil	1.4735	50
Lin seed oil	1.4782	25
Mustared oil	1.4750	50
Nemm oil	1.4615	
Niger-seed oil	1.4710	50
Olive oil	1.4679	50
Palm oil	1.4578	50
Palm kernel oil	1.4569	50
Peanut oil	1.4691	50
Soyabean	1.4729	50
Sunflower-seed oil	1.4694	50