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Adulteration Detection in Some Edible Oil Products in Nigeria

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Abstract: *Viscosity is an important property of edible oil products either pure or adulterated. Edible oil products such as palm oil, palm kernel oil, coconut oil, vegetable oil and groundnut oil were used for the analysis. The percentages by volume of pure to adulterated oil samples were 70%:30%. The degree of sensitivity varies depending on the type of the adulterated samples introduced into a given pure sample. Mostly, sensitivity variation occurred from 30% of the adulterated. The analysis was to detect the adulteration in edible oil products; this was done by using their viscosity to detect the variation in the viscosities and densities of pure to adulterated oil products. The result indicates that the detection rate is very negligible.*

Keywords: *Adulteration, Density, Edible oil, and Viscosity.*

1. Introduction

Food adulteration, the act of adding or mixing something inferior, harmful, useless and unnecessary substance to food; and food item may be considered as adulterated if its nature and quality are not up to the standard, (Bell and Gillatt, 2004). Adulteration of fats and oils is easy and cannot be easily detected except with careful analysis, (Elbashbeshy and Ibrahim, 1993).

Recently, because of the discovery of synthetic colours and flavours, any fat can be made to look like ghee and customers may easily be cheated. Til oil and coconut oil are often mixed with groundnut or cottonseed oil as the latter are cheaper. Mixing of palm oil with soybean oil is a common practice among dishonest trader for more profits, which will cause a change in it viscosity. In the drying oil industries, the process of heat-bodying, blowing and other methods for modifying oils, cause large changes in viscosity.

Determination of viscosity in these cases provides an excellent test for process control, (Etuk, *et al*, 2000). Viscosity is a measure of the combined effects of adhesion and cohesion of a fluid's molecules, which manifest itself as an internal force resisting the flow of the fluid, (Ekpe and Essien, 1999; Abbot, 1967). Fluids with high internal resistance to flow are said to be viscous and will not pour or spread as easily as fluids of lesser viscosity, (Neikon and Parker, 1982). Although all real fluids resist any force tending to cause one layer to move over another, the resistance is offered only while the movement is taking place, (Bernard and Ward-Smith, 1998). The fluid will flow over the boundary in such a way that the particles immediately in contact with the boundary have the same velocity as the boundary, while successive layers of fluid parallel to the boundary move with increasing velocities, (Douglas, *et al*, 2001).

In many cases, the rate or degree of a reaction or the indication of the end point of a chemical process can be obtained by viscosity measurement, (Igwe and Odeh, 2000). Where viscosity can be related to another variable such as concentration, density or colour, it can be used as an indirect measurement of these variables, which are difficult to obtain in the more conventional manner, (Serway, 1985). Viscosity depends on molecular size, length in particular forces as well as temperature. Adulterated edible oils are found to cause damage to the sellers that did not known even the consumers (Ekpe and Essien, 1999). Good edible oil at every pure form is often free from any mixture with oil by roadside oil dealers in order to increase the quantity and maximize profit. This action by the dealers results in the oil product being adulterated from its original properties.

Nevertheless, ensuring the authenticity in edible oil products has been a problem for millennia, edible oil fraud usually involves misleading the purchaser as to the true nature, substance or quality of the oil demanded, this edible oil standards and labeling are breached. The offence is in the form of adulteration which generally involves the dilution of pure edible oil with less expensive one. Cheaper oil (adulterated) may also be represented as if it were some oil of grater (pure) oil quality, (FAO, 2004). Historically, detecting such fraud has been difficult because of the small database establishing appropriate purity criteria for authentic edible oils and fats, (Nair, 2004).

2. Theory

In the very viscous liquid under test, the small balls fall with a constant (terminal) velocity (Ette 1994). According to Stoke's law, such a sphere of radius r falling in a viscous liquid of viscosity coefficient η with a terminal velocity V, is acted on by a viscous drag force F, given by:

$$F = 6\pi\eta vr \qquad 1$$

In a steady state, F will equal the net downward force;

$$6\pi\eta vr = \frac{2}{9} gr^2 \frac{(\rho-\sigma)}{\eta} \text{ (Ette 1994)} \qquad 2$$

The equation of motion is therefore;

$$mg - V - U = Ma \qquad 3$$

$$\therefore Mg - V - U = Ma = F \qquad 4a$$

$$\text{Also, } 6\pi\eta vr = Ma = F \qquad 4b$$

$$\text{Hence, } 6\pi\eta vr = M\frac{(V-U)}{t} = F \qquad 5$$

Therefore $F = 6\pi\eta vr = Mg$

But, $v = {}^{L}/{}_{t}$

By making η the subject of formula, we have

$$\eta = \frac{Mg}{6\pi vr} = \frac{Mg}{6\pi {}^{L}/{}_{tr}} = \frac{Mg}{\frac{6\pi Lr}{t}} = \frac{Mg*t}{6\pi Lr}$$

$$\eta = \frac{mgt}{6\pi Lr} \qquad 6$$

Hence, η is the viscosity, M is the mass of oil sample, g is the gravitational force, L is the distant between point A and B, r is the radius of each of the ball bearing; it is the mean time taken for each of the ball to fall and $v = {}^{L}/{}_{t}$ is the average terminal velocity of the bearing in the liquid. But, at a certain stage the ball ceases to accelerate, but moves with uniformed velocity, which is called terminal speed. The viscous force V is proportional to velocity v; $V = kv$ where K is constant, (Serway, 1985).

As the ball bearing accelerates the speed increase and so does the viscous force *"V"*, unit a point is reached were the viscous drag equals the downward force. At this stage r acceleration "a" $= 0$ so that the above equation becomes:

$$Mg - V - U = 0 \text{ or } V = Mg - U \qquad 7$$

3. Materilas and Methods

Samples and Sampling

Pure samples of edible oil products comprising palm kernel oil were obtained from Otuku Palm Kernel Company Uyo, vegetable oil and groundnut oil were obtained from Uyo main market, while coconut oil and palm oil was where obtained from extraction industries at Ikot Ekpene and Abak respectively. These samples, which were collected was stored in a container in its pure state; where subsequently transported in carefully sealed, clean, and well labeled sample bottles to the laboratory for the adulteration tests and measurement adulteration tests and measurement of some physical parameters.

Determination of Viscosity Using Stoke's Law:

This involves the steps in determination and measurement of viscosity of pure and adulterated oil sample by Stoke's law.

The measuring cylinder was set up as shown in figure 1; The measuring cylinder was filled with different oil samples and a fixed point "A" were made bellow the top of liquid and another mark was made at the bottom "B" of the cylinder. The distant L between the A and B were measured to be 100.00cm. The ball-bearing were gently drop into the cylinder starting from the smallest of the largest, and time of fall of the ball-bearings were taken between the fixed point A and B. The diameters of the different ball-bearing were measured five times with the micrometer screw gauge and average diameter was determined. The process was repeated for four different ball-bearing with different oil samples pure and adulterated. The temperature of each of the oil samples was taken.

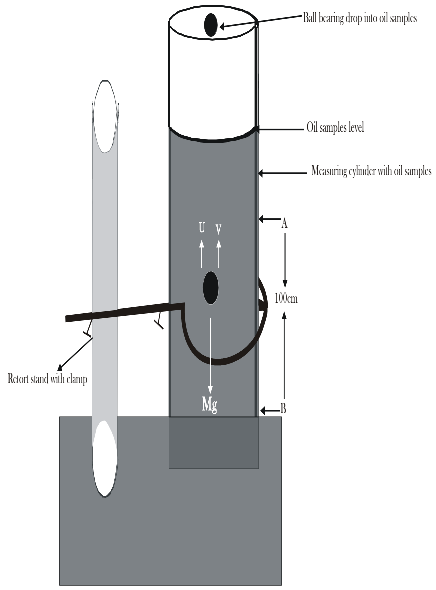

Figure 1. *The experimental setup for the determination of viscosity.*

Determination of Relative Density:

The laboratory determination of the relative densities of the edible oil products was carried out using a 50ml density bottle which had been carefully cleaned (using soap solution) and dried (Umoren, 2004). The process was repeated for pure and adulterated oil samples at 70%:30% which is equivalent to 500ml volume ratio. The pure oil sample was then adulterated with some quantity of each oil sample introduced into it in steps of 10%, but at 30% they was a variation.

4. Results and Discussion

The results of the diameter measurements of the ball bearing shown in table 1 and time of descent of spheres (ball bearing) shown in table 2 and 3 were used in determination/calculation of the viscosity of pure and adulterated oil sample, the procedure was repeated for all samples.

Table 1. *Shown Diameter reading of the ball-bearing (Steel ball).*

S/N	DIAMETER (mm)					MEAN (mm)	RADIUS r
1	d1	d2	d3	d4	d5	d	$r = \frac{d}{2}$
1	4.35	4.34	4.33	4.34	4.34	4.34	2.17
2	4.67	4.66	4.66	4.67	4.67	4.66	2.33
3	8.15	8.16	8.17	8.16	8.15	8.15	4.07
4	9.39	9.38	9.38	9.38	9.38	9.38	4.67
5	9.89	9.90	9.88	9.89	9.87	9.88	4.94

Table 2. *Indicating time of descent of spheres (steel ball) in groundnut oil.*

S/N	TIME (S)						MEAN T (S)
	T1	T2	T3	T4	T5	T6	
1	2.38	2.61	2.41	2.46	2.34	2.41	2.43
2	1.94	1.84	1.89	1.96	1.87	1.91	1.90
3	1.28	1.29	1.36	1.21	1.24	1.35	1.28
4	1.18	1.12	1.19	1.13	1.18	1.13	1.15
5	1.22	1.28	1.14	1.19	1.11	1.25	1.19

Table 3. *Indicating time of descent of spheres (steel ball) in vegetable oil and coconut oil*.

S/N	TIME (S)						MEAN T (S)
	T1	T2	T3	T4	T5	T6	
1	2.39	2.40	2.33	2.34	2.34	2.20	2.33
2	1.85	1.91	1.85	1.89	1.77	1.85	1.85
3	1.12	1.12	1.10	1.14	1.13	1.14	1.12
4	1.01	1.00	1.02	1.01	1.02	1.01	1.01
5	1.05	1.07	1.03	1.03	1.08	1.04	1.05

From table 2 and 3 the result shows that there are no much differences in the time of descent in both pure and adulterated edible oil samples. Table 4 shows the results of the measurements of relative densities of both pure and adulterated edible oil samples.

Table 4. *Showing the relative densities of pure and mixed (adulterated) oil samples.*

Pure Oil	Relative Density (g/cm^3)	Adulterated Oil	Relative Density (g/cm^3)
Palm oil	0.469	Palm oil and palm kernel oil	0.473
Palm kernel oil	0.471	Vegetable oil and palm kernel	0.472
Groundnut oil	0.470	Vegetable oil and coconut oil	0.472
Vegetable oil	0.467	Vegetable oil and coconut oil	0.474
Coconut oil	0.472	Coconut oil and groundnut oil	0.475

Also, the result obtained indicates no significant differences in the relative densities of both pure and adulterated edible oil samples. The results of the viscosity determination of pure and adulterated oil sample.

Table 5. *Showing the Viscosities of pure and adulterated (mixed) oil sample*.

Pure	(kg/m-s))	Adulterated	(kg/(m-s))
Groundnut oil	13.0663	Vegetable oil and coconut oil	14.9119
Crude palm kernel oil	12.8583	Vegetable oil and groundnut oil	13.1004
Vegetable oil	14.7668	Groundnut oil and coconut oil	12.4232
Palm oil	12.3901	Palm oil and crude palm kernel oil	11.5274
Coconut oil	12.3884	Vegetable oil and crude palm kernel oil	12.2266

The result shows, very negligible difference between the pure and adulterated oil samples as indicating in the table.

5. Conclusion

According to (Nair, 2004), adulteration has been taking place for some time but it has become rampant following the steep rise in the prices of edible oil; detection becomes difficult when materials like liquid paraffin are mixed in edible oil.

When compared the density of pure and adulterated oil samples, it was observed that the range is very close to each other; also the viscosity of pure and adulterated edible oil sample, almost have the same viscosities. Hence, adulterations are very negligible. The effect of temperature on the viscosity of the liquid is necessary, because, cohesive force between molecules of a liquid decrease with increasing temperature and the viscosity will decrease. Since, the determination of viscosity and density of oil samples proved that the adulteration detection in some edible oil product is negligible, which conforms to the work of other researchers using other methods of detection. Also, consumers and traders of edible oil products should be alert on this issue of adulteration and report same to law enforcement agent.

6. Recommendation

Since detection in edible oil products is negligible, the consumers should prefer branded edible oil on the belief that its manufacturers would not resort to adulteration. Governments should initiate suitable steps to detect and prevent adulteration in edible oil products.

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