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PHYSICOCHEMICAL AND ELEMENTAL ASSESSMENT OF VEGETABLE OILS IN YENAGOA METROPOLIS, BAYELSA STATE, NIGERIA

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ABSTRACT

Background: Vegetable oils are very imperative component of several industrially manufactured products. They are utilized as lubricants, plasticizers, emulsifiers, surfactants, solvents, plastics, and resins, as well as in animal feed. The waste of vegetable oils has been refined to biodiesel that can be used as normal diesel fuel. Vegetable oils are edible and vital constituent of the human diet, serving as a good source of lipid, protein and fatty acids. **Objective:** The study aimed to determine some physicochemical parameters and elemental assessment of various brands of vegetable oils in markets within Yenagoa metropolis, Bayelsa State, Nigeria. **Method**: Ten samples of refined vegetable oils were obtained from different markets. They were tagged as samples A, C, D, G, H, I, J; from Opolo market, while samples B and E were obtained from Kpansia market and sample F was obtained from Market square shopping complex, Opolo, all in Yenagoa, Bayelsa State. The physicochemical analysis was determined using standard methods while elemental assessment was carried out using atomic absorption spectrophotometer. **Result**: The acidic content of the samples ranges from 0.7-26, revealing that majority of the oils must have undergone hydrolysis as they exceed the acid values of the reference standard of Arachis oil 0.5-0.8. Iodine values range from 3.14-7.04g I2 /100g, while peroxides values range from 2- 33 meq/kg. Also, the saponification values of the samples range from 7.01-183.03 mg/KOH. Heavy metals could be major contaminants in vegetable oils; mercury, lead, chromium, arsenic, cadmium, and selenium were examined and the results showed that the elements are within the acceptable limit as stated by the official standard. **Conclusion**: There was variation in the physicochemical properties of oils sold. The elemental assessment of the oils analyzed showed all samples were within acceptable standard limits; hence, are safe for human consumption.

KEYWORDS: Vegetable oil, heavy metals, physicochemical, Yenagoa, Spectrophotometry.

INTRODUCTION

Edible oils are part of essential household dietary requirements as well as startup materials for pharmaceutical products. Oil is a wellspring of energy, structural framework and could play an important role as a useful precursor for the biosynthesis of steroids in the body.[1,2] Vegetable oils play an important role and widely used lipid source for everyday dietary requirements. Its application for food purposes increases daily as they have been found to play a major role in human nutrition. Oils and fats have the highest energy in comparison to carbohydrates and proteins and are carriers for oil-soluble vitamins and fatty acids essential for health that are not manufactured by the human body.[3]

Rancidity occurs in oils due to poor storage which could lead to loss of its nutraceutical values.[4,5] Factors that can determine the rancidity and deterioration time of oils include moisture, air, microbes, anti-oxidant, and exposure to light.[6,7] In quality control, physicochemical parameters such as specific gravity (purity), acid value (free fatty acids formation because of hydrolysis), iodine value (degree of unsaturation), peroxide value (formation of primary oxidation products), are key parameters of interest because the shelf-life, quality and hence the economic value of oils depends on the physicochemical properties.[5,8] Rancidity of vegetable oils poses health risks including cancer and inflammatory diseases due to the production of harmful and reactive oxidative products.[5,9] In the course of the production of vegetable oils, are subjected to physical and chemical processes including refining, bleaching, and deodorization which inevitably make the oils come in contact with metallic surface areas, usually at high temperatures. The presence of these metals in oils has been reported to have deleterious effects on the flavor and oxidative stability of the oils. Metals that produce these effects are trace metals including Fe, Cu, Ca, Mg, Co, Cd, and Mn.[10] Other elements such as Cr, Cd, and Pb at certain levels are toxic.[11] The determination of nickel and copper concentrations in oils is important because of their use as hydrogenation catalysts.[1] Copper and iron are potential contaminants of oils arising from their use as processing equipment.[2,12] Trace elements play an essential role in the body system whereas, heavy metals are toxic could be harmful if consumed in excess.[13] Toxic levels of Pb could results in intellectual disability and behavioral problems in children.[14] The health and subsequent economic impacts of trace elements as well as heavy metals in food substances have resulted in increasing research for their determination.[2]

Vegetable oils are usually extracted from seeds of fruit plants. They are derived from many sources including groundnut, rapeseed, sunflower, mustard seed, corn, soya bean, castor bean amongst other fruit and seed-producing plants. Essentially, vegetable oils constitute triglycerides which primarily contain polyunsaturated and monounsaturated fatty acids.[15] However, after the extraction of the crude oil, it is then refined into a range of useful industrial and consumer products.

Another important factor is the iodine content of oils, as iodine is very essential in thyroid functions and necessary for the development of vital body tissues and organs, especially in children.[16] Vegetable oils commonly sold in markets are fortified with chemical substances including vitamins in a bid to improve their physical and chemical characters. Thus, it is deemed important to characterize these various oils since they are produced in batches and by different companies to ascertain whether they conform to global standards, health risks involved in their consumption, and the use of such oils for the production of other commercial consumer products such as pharmaceuticals and cosmetics. The study would serve as a scaffold for further researches on commercial vegetable oils and regulatory agencies to identify vegetable oils that are unsafe for human use.

The importance of using the appropriate oil for the production of consumer products cannot be overemphasized, like product quality, which may negatively affect the consumer's health. It is expected that consumer products like vegetable oils are manufactured following standard operating procedures to ensure quality and safety.[17] It is, therefore, necessary to ascertain the quality of vegetable oils present in the Nigerian market periodically as widespread distribution and consumption of these oils that are unsafe for human consumption could result in poor health and economic sabotage. This research aims to determine some physicochemical properties and elemental assessment of various brands of vegetable oils sold in markets within Yenagoa metropolis, Bayelsa State, Nigeria.

MATERIALS AND METHODS

2.1 Reagents and Chemicals

All the reagents used for the experiments were bought from reputable companies and of analytical grade.

2.2 Instrumentation

Analytical balance (Ohaus), Agilent technologies 200 Series AA, Viscometer NDJ-5S, Abbe refractometer were used.

2.3 Samples

Ten (10) different samples of refined vegetable oils were obtained from different markets within the Yenagoa metropolis. Samples A, C, D, G, H, I, J were obtained from the Opolo market. Samples B and E were obtained from the Kpansia market whereas sample F was obtained from Market square shopping complex, Opolo all in Yenagoa, Bayelsa State.

2.4 Physicochemical Analysis

The physicochemical analysis was carried out according to standard procedures.[18,19,20,21]

2.5 Elemental Analysis

Elemental analysis of the oils was determined using Atomic Absorption Spectrophotometer (AAS) Agilent technologies 200 Series AA.

RESULTS AND DISCUSSION

Table 1: Physicochemical Parameters of oil analyzed.

S/N	Sample	RD	RI	AV	PV	IV	SV	EV
1	A	0.9205±0.001	1.4542±0.002	1.3±0.4	2.0±0.4	4.41±0.2	72.93±4.0	71.63±2.5
2	B	0.9136±0.001	1.4533±0.001	8.1±0.6	14.0±1.1	3.14±0.2	177.42±1.2	169.3±0.8
3	C	0.9185±0.002	1.4658±0.001	3.4±0.1	13.5±2.1	8.0±0.5	46.34±0.6	42.94±0.3
4	D	0.9113±0.001	1.4600±0.001	1.5±0.8	18.5±0.7	8.25±2.0	133.24±0.6	131.7±0.2
5	E	0.9203±0.003	1.4547±0.002	26±1.6	6.0±0.4	4.28±1.2	183.03±0.5	157±1.3
6	F	0.9187±0.001	1.4698±0.002	0.7±0.1	33.0±7.8	9.0±0.1	73.63±1.0	72.9±0.3
7	G	0.9190±0.001	1.4668±0.001	1.0±0.4	25.3±0.4	9.0±0.4	162.6±1.0	161.6±0.4
8	H	0.9149±0.003	1.4603±0.002	1.0±0.2	9.3±1.1	6.3±0.5	7.01±0.4	6.01±0.6
9	I	0.9138±0.002	1.4612±0.002	1.5±0.02	2.5±1.4	7.0±0.3	57.2±1.4	55.7±1.2
10	J	0.9140±0.003	1.4617±0.002	5.0±0.2	9.0±0.7	7.0±1.0	40.0±2.3	35.0±1.8

Keys: Relative Density **(**RD), Refractive Index (R I), Acid Value (A.V) Peroxide Value (P.V), Iodine Value (I.V), Saponification Value (SV), Ester Value (EV) Mean±SD

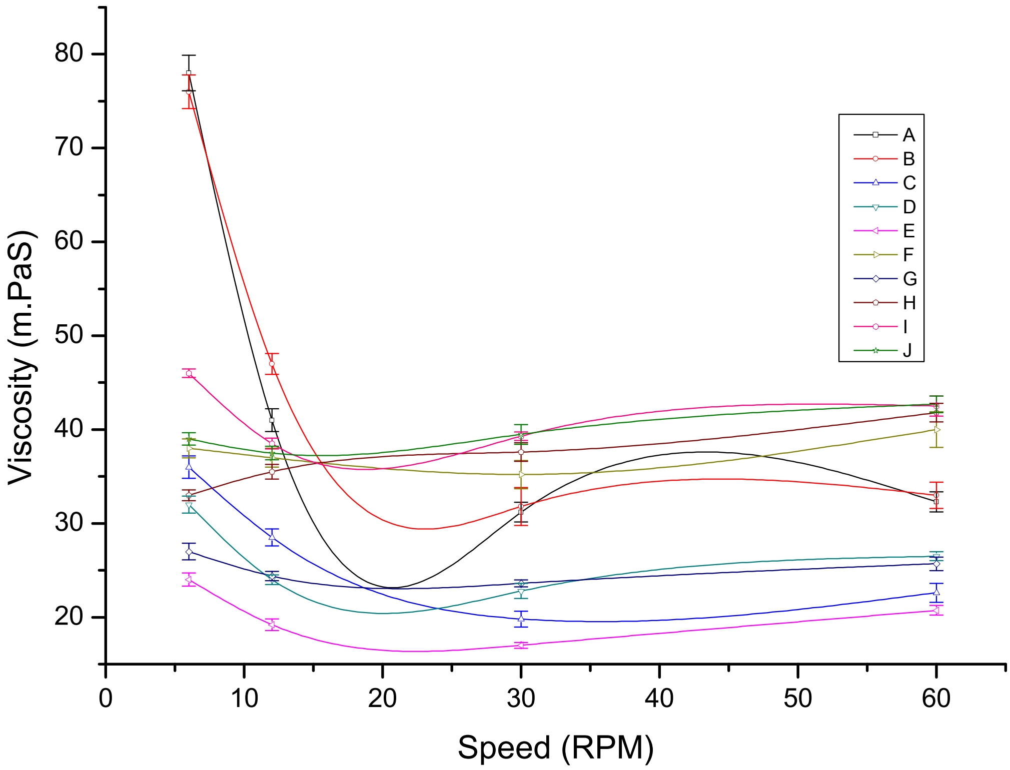

Figure 1: Viscosity variation of the various samples of vegetable oils in m.PaS.

Table 2: Quantitative amounts of various elements contained in the various samples of vegetable oils.

S/N	Parameter (mg/L)	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	Sample G	Sample H	Sample I	Sample J
1	Sodium	56.608	71.082	116.411	108.400	32.875	137.479	118.527	154.000	210.065	119.630
2	Potassium	7.131	12.949	0.005	0.002	3.049	0.003	0.027	0.002	0.012	0.004
3	Magnesium	27.835	14.225	102.073	99.047	20.904	63.918	45.928	72.000	59.193	33.510
4	Calcium	10.211	9.288	41.847	37.920	13.194	30.387	25.823	42.019	22.613	19.125
5	Phosphorus	0.005	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	<0.001	<0.001	<0.001
6	Manganese	0.161	0.191	0.325	0.152	0.098	0.462	0.271	0.099	0.106	0.088
7	Chromium	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	<0.001	<0.001	<0.001
8	Zinc	5.918	8.019	17.692	13.821	3.901	22.009	15.921	9.289	15.039	19.372
9	Iron	34.629	21.475	66.827	45.980	21.106	100.87	22.511	19.403	45.531	85.329
10	Lead	0.009	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
11	Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
12	Boron	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
13	Cadmium	0.079	<0.001	<0.001	<0.001	0.083	<0.001	<0.001	<0.001	<0.001	<0.001
14	Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
15	Copper	0.140	0.085	0.819	0.050	1.831	0.029	0.103	0.342	0.100	0.111
16	Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

DISCUSSION

Following the physicochemical analysis of the oils, the relative density of the experimental oils ranges 0.911 - 0.921, indicating that water is denser than the oils; the oils are within an acceptable range for mineral and vegetable oils of 0.840 – 0.960. The Refractive indices of the samples range from 1.4542-1.4698 as shown in Table 1. This implies that the values obtained are in line with standard values for vegetable oils. Viscosity which measures the internal frictions of the oil molecules, as well as its ability to resist flow, depends on the nature of the triglyceride and chemical constituent present in the oils. The viscosities of the oils at 6, 12, 30, and 60 rpm exhibited a non-newtonian flow pattern due to similar chemical characteristics of the oils shown in Figure 1 above. Viscosity is related to the chemical properties of substances the more viscous oil is better its use as a lubricant. Oils with low viscosity indicate they are light and probably highly unsaturated.[20,21]

The acidic content of the samples ranges from 0.7-26. This reveals that the majority of the oils must have undergone hydrolysis as they exceed the acid values of the reference standard of Arachis oil 0.5-0.8.[21] Sample

E showed a high level of acid value similar to beeswax with an acid value of 26. High acid value shows that Sample B and E are unsuitable in cooking, however, they could be used for the preparation of cosmetics such as liquid soap and shampoos.[22]

Iodine value is an indication of the level of unsaturation in a molecule. The high iodine values suggest that the oils contained high-level unsaturated fatty acids and it varies for different oily samples.[22] The iodine values obtained from the samples range from 3.14-7.04g I_2 /100g. The experimental iodine values when compared to standard reference values of fixed oils such as; Arachis oil, 88-98, olive oil 79-88, and coconut oil 6-11g I_2/100g which showed that Arachis and olive oils have high iodine value than the oily samples, this implies a high level of saturated fatty acid. A high iodine value is an indication of the decline instability and susceptibility to oxidative rancidity.[22] It can be deduced that most of these oils are hydrogenated oils to reduced oxidation. The peroxide value of fats and oils is a useful indicator of spoilage. The peroxides values of the test samples range from 2- 33 meq/kg. These samples showed varying values with regards to the recommended standard of 10meq/kg for oils; however, the experimental values of sample F peroxide value are above the standard recommended by the Standard Organization of Nigeria and Nigerian Industrial Standards for edible oils which is an indication of rancidity.[23] Sample A, E, H, I, and J showed peroxide values that comply with the recommended standards.[18] The oxidation of fats and oils is undesirable due to off-flavors, toxins, and the loss of fat-soluble vitamins.[21]

Saponification values of the samples range from 7.01-183.03 mg/KOH. This showed that all the samples did not conform to the standard saponification value stated by International Codex for edible oils, 196-205mg/KOH. This implies that oils with high saponification value will be valuable in the soap-making industries.[24]

Heavy metals could be major contaminants in vegetable oils, which may be introduced in course of production were examined to determine their concentration. These metals include; Mercury, Lead, Chromium, Arsenic, Cadmium, and Selenium were examined and results displayed in Table 3 showed these elements are within the acceptable limit as stated by the official standard; Other metals which could be potentially toxic had an insignificant concentration that is not harmful as confirmed with reference standard this implies that oily samples are free from the toxic effect of these elements.[25]

4.2 CONCLUSION

The results obtained from the experiment showed there is variation in the physicochemical properties of oils sold in markets. These variations could be due to different manufacturers, sources of raw materials, production procedures. Also, variations may arise within different batches of products. The elemental assessment of the oils analyzed showed that the samples were within acceptable standards with regards to their elemental concentrations and are safe for human consumption.

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