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Effect of Storage Temperature on the Development of Rancidity by selected Vegetables Oils sold in Jalingo Main market, Taraba State-Nigeria

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Abstract Five samples of groundnut oil were purchased from central market in Jalingo town. These were; labeled DVO, GVO, MVO, LVO and PVO. The samples were subjected to physicochemical analyses at varied temperatures of 283K, 293K, 303K, 313K and 323K. The results showed that as the temperature was increased the peroxide values, acid values and the iodine values of the various oils deteriorated. This is an indication that at higher temperatures vegetable oils become rancid. It is clear from this work that oil should be stored at cool temperatures, away from light and without exposure to oxygen.

Keywords Storage Temperature, Rancidity, Vegetables Oils

1. Introduction

Vegetable oils are obtained from oil containing seeds, fruits, or nuts by different pressing methods, solvent extraction or a combination of these. Crude oils obtained are subjected to a number of refining processes, both physical and chemical. These are detailed in various texts and articles [1]. There are numerous vegetable oils derived from various sources. These include the popular vegetable oils: the foremost oilseed oils - soybean, cotton seed, peanuts and sunflower oils; palm oil, palm kernel oil, coconut oil, castor oil, rapeseed oil and others. They also include the less commonly known oils such as rice bran oil, tiger nut oil, patua oil, kome oil, niger seed oil, piririma oil and numerous others. Their yields have different composition and by extension their physical and chemical properties determine their usefulness in various applications aside edible uses.

Also worthy of note is that coconut oil, which unlike most vegetable oils, is solid at room temperature due to its high proportion of saturated fatty acids (92%) particularly lauric acid. Due to its almost homogenous composition, coconut oil has a fairly sharp melting point [1].

The quality of any oil is indicated by some physico-chemical properties. The specific value of some of these properties provides an indication of both the nutritive and physical quality of the oil. These properties include iodine value, peroxide value, saponification value, unsaponifiable value, free fatty acid, colour and appearance etc. For example, oils with low melting point may readily go rancid due to the high level of unsaturation. Recently; palm oil has become the second most consumed oil all over the world as a result of its being rich in natural antioxidants, vitamins and exhibiting high oxidative stability with attendant long shelf life. However, its high melting point lowers the level of acceptance among some consumers. The exposure of oils to either a source of heat, light or moisture can alter some of the quality indicators. The extent of alteration depends on the duration of exposure, temperature and conditions of storage [2, 3].

The stability of oil to oxidation is an important indicator in determining oil quality and shelf-life [4]. Two common practices that render vegetable oils in most commercial centres prone to oxidative deterioration are packaging in transparent containers (plastic bottles and sachets) and displaying oils either under direct sunlight or artificial lights. Studies have shown that some vegetable oils available in the market do meet the recommended standards for edible oils. Considerable amount of attention has been given in recent years to test for the extent and nature of oil oxidation. Primary oxidation products are measured by peroxide value which is a value of the quantity of hydro-peroxides present in the oil [5]. It is usually expressed in milli-equivalent of oxygen per kg of oil. The secondary oxidation products are assessed by measuring the Para or p-anisidine value. The p-anisidine value measures mainly the amount of alpha-beta unsaturated aldehydes (2-alkanals) and ketones present in the oil. The primary oxidation products (peroxide and hydro peroxides) are unstable and gives very little off-flavor, but the secondary oxidation products (aldehyde and ketones) give undesirable off-flavor to the oil and cannot be completely removed on refining [5]. Some of the oxygenated decomposition products are implicated in degenerative diseases such as aging, membrane damage, heart disease and cancer; as a result the study of lipid oxidation has received great attention recently[6]. The sources and characteristics of a good number of edible oils are not known. It is therefore, very important that the quality and oxidative stabilities of commercially available vegetable oils be examined to ascertain their suitability for consumption. In the light of the aforementioned therefore, we undertook this research to investigate the effects of temperature on the development of rancidity by some commercial vegetable oils sold in Jalingo Main market, Taraba State.

2. Materials and Methods

2.1. Materials

All chemicals used were of analytical grade and were products of British Drug Houses (BDH) Chemicals Ltd, Poole England unless otherwise stated. Samples of groundnut oil were purchased from central market in Jalingo town and labeled as DVO, GVO, MVO, LVO and PVO for the purpose of the analysis.

2.2. Methods

Some portions of these oils were heated to 303K, 313K and 323K, respectively over stove flame. Other portions were cooled to 283K and 293K, respectively in a refrigerator. The peroxide values of the various oil samples were determined immediately at various treated temperature as described by the AOCS method [7]. The iodine value was determined by AOACS 2000 and I.S.I method. Acid value was determined as described by (AOAC method and ISO 1996) [8].

2.2.1. Determination of peroxide value

Oxidation, and the formation of peroxides, occur during oil extraction and processing and can continue after bottling and during storage. Peroxides are intermediate oxidation products of oil which lead to the formation of a complex mixture of volatile compounds such as aldehydes, ketones, hydrocarbons, alcohols and esters responsible for the deterioration of olive flavours. Peroxides have been shown to occur when oil is exposed to oxygen and/or light, particularly at elevated temperatures.

Procedure

5.00g of sample was weighed into 250 mL glass stoppered Erlenmeyer flask.30 mL of acetic acid - chloroform solution (2:1) were introduced and Swirled until the sample was completely dissolved and carefully warmed on a hot plate.1mL potassium iodide solution was added stopped and swirled for 1min, immediately 30 mL of distilled water was added stoppered and shaken vigorously to liberate the iodine from the chloroform layer. The solution initially was a light amber colour; 1 mL of starch solution was added as indicator and titrated until the blue gray colour disappeared in the aqueous (upper) layer.

$$Peroxide\ value = \frac{(S-B)\times N\ thiosulp\ hate \times 100}{Weight\ of\ sample} \quad (1)$$

where, S is titration value of sample, B is titration value of blank.

2.2.2. Determination of iodine value

Iodine value (IV) measures the degree of unsaturation in the vegetable oil. It will determine the stability of oils to oxidation, and allows the overall unsaturation of the fat to be determined qualitatively (AOACS, 2000)[9].

Procedure

3.17g of oil was weighed into conical flask (For an expected iodine value of 10meq/kg). 10mL of chloroform was added and warmed slightly and then cooled for 10min. 25mL wij's solution was added in the same flask and shaken vigorously. The flask was allowed to stand for half an hour in dark place. 10mL KI solution was added and titrated against 0.1N sodium thiosulphate solution until the appearance of the yellow colour. 1mL of starch solution was added and titrated against the sodium thiosulphate solution from the burette. The end point was indicated by the disappearance of the blue colour. The procedure was repeated without the oil sample for the blank titration. The IV was calculated as follows:

$$IV = \frac{(V_1 - V_2) \times N \times 126.9}{W} \quad (2)$$

Where V_1 is the quantity of sodium thiosulphate used for blank; V_2 is the quantity of sodium thiosulphate used for sample; N is normality of the thiosulphate solution and W is the weight of the oil sample and 126.9 is the molecular weight of iodine (AOACS 2000 and I.S.I method) [9].

2.2.3. Determinations of acid value

The acid value is the number of milligram of KOH or NaOH required toneutralize the free fatty acid present in one gram of fat. It is a relative measure of rancidity as free fatty acid are normally formed during decomposition of oil glycerides.

Procedure

A solution of 25mL each of diethyl ether and ethanol was prepared and 10g of the sample oil (for expected acid value of 1 to 4) was added, and the mixture was digested in a water bath for ten minutes. It was then titrated still hot with 0.1M of NaOH solution until the pink colour faded. Under the same conditions, a blank titration was conducted (AOAC method and ISO 1996) [8]. Acid value is determined as follows:

$$AV = \frac{titre\ \ value \times N \times 56.1}{Weight\ of\ \ sample} \quad (3)$$

3. Results and Discussion

3.1 Result

Table 1: Effect of Storage temperature on peroxide value of some commercial vegetable oils

Vegetable oil	**Peroxide Value**				
	283K	**293K**	**303K**	**313K**	**323K**
GVO	7.20	8.00	10.20	11.00	12.00
LVO	5.00	5.60	6.00	6.80	8.00
PVO	8.00	9.20	10.40	11.30	13.00
DKVO	5.00	6.00	8.00	8.40	8.00
MVO	6.00	7.80	8.40	9.20	9.00

Each value is a result of triplicate readings

The effect of storage temperature on the peroxide value (PV) of some of the commercial vegetable oils sold in Jalingo town, Taraba State are presented in Table 1. The GVO and PVO had higher initial values than other vegetable oils.

A.O.A.C and Pearson suggested a PV value of below 10 meq/kg as the rancid tolerance limit for fresh oil. Rancid taste begins to be noticeable when the PV value is above 20 meq/kg. This value has been as a standard for many processing industries.

The result obtained from this study showed that at the time of the analysis, GVO and PVO were on the process of becoming rancid because they were above the limit of fresh oil. Temperature exerts great effect on the peroxide

value of GVO and PVO basically at all temperatures but more as the temperature increases from 303K to 323K.The peroxide value of LVO, DKVO and MVO vegetable oils were below the rancid tolerance limit. Despite the increase in the PV at high temperatures, the value did not exceed the maximum level of 10 Meq/kg set by the Codex Alimentarius Commission [9]. The increase in PV is, however, not acceptable since this is a reflection of deteriorating oil quality. Apart from harmful effect to human health, peroxide value also has effect on the quality of biodiesel derived from vegetable oils.

Table 2: Effect of storage temperature on Iodine value of some commercial vegetable oils.

Vegetable oil	**Iodine Value (mg/3.17g of sample)**				
	283K	**293K**	**303K**	**313K**	**323K**
GVO	6.00	5.80	5.60	5.40	5.20
LVO	6.20	6.00	5.80	5.60	5.20
PVO	6.80	6.60	6.50	6.30	6.00
KVO	5.20	5.20	5.10	5.00	4.80
MVO	5.40	5.20	5.14	5.10	5.00

Each value is a result of triplicate readings

The rate of formation of peroxide by the vegetable oils was related to the degree of unsaturation of the fatty acid in the vegetable oil. The iodine value of GVO, LVO, PVO, DKVO and MVO as in Table 2, hence it is used as a measure of the degree of unsaturation of the fat stability and resistances to oxidation. Data given in Table (2) illustrate change in iodine value (IV) of vegetable oil with temperate. It could be noticed that the IV decreased gradually in all oil samples. The decrease in IV of the oil samples during storage could be attributed to the formation of new fatty acids which differ in their degree of unsaturation or to the distribution of double bonds saturation of the fatty acids during the production of hydro peroxides and intermediate compounds. Such results are in reasonable agreement with those reported by Iskander, *et al* [10]. Also; results presented in Table (2) showed that the decrease in the IV was accompanied by the decrease in linoleic acid content. The same trend was found for sunflower seed oil reported by Iskander *et al*. (2010). [10] A higher IV number indicates more double bonds in the sample and therefore that greater care will be needed to slow down oxidation. IV is not a measure of quality but is an indicator of oil composition.

Table 3: Effect of storage temperature on acid value of some commercial vegetable oils

Vegetable oil	**Acid Value (mgNaOH/g)**				
	283K	**293K**	**303K**	**313K**	**323K**
GVO	0.40	0.80	1.60	1.80	2.00
LVO	0.60	0.80	1.20	1.40	1.60
PVO	0.80	1.20	1.50	1.60	2.20
KVO	0.40	0.80	1.00	1.20	1.40
MVO	0.60	0.70	1.20	1.60	2.00

Each value is a result of triplicate readings

The AV for PVO was observed to value at higher temperatures, the values obtained in this increase from 0.8 at 283K to 2.2 mg KOH/g at 323K. This work lies within the codex of 0.6 and 10 mg KOH/g [11]

MVO and PVO as declared on their label as refine palm olein oil. Hence the group is low in unsaturated fatty acid. This is indicated by the low iodine value for PVO and MVO these contributed to the stability of the LVO and KVO at the various temperature studies. The GVO, LVO and KVO Were more stable at the various temperature than the PVO this was associated with the degree of unsaturation as depicted by their iodine value (Table 2) while LVO belong to the oleic group (34.40 %) with one unsaturated double bond. GVO is in the linolic group with two unsaturated double bonds which constitute 85% of the total soya bean oil contains high level of unsaturated fatty

acid. The Linoleic and linolenic.78% which predominant in soya beans oil contain three double bonds while linolenic 53.25 contains two double bond as in LVO.

The acid values of the oils were low value varying from 1.0 mg/g in KVO to 2.0 mg/g. These result shows that the oil can be used for edibility purpose. Some of the deterioration that occurs during the storage of either the raw materials from which oil is produced or in the oil itself could lead to the hydrolysis of triglyceride by lipid to yield free fatty acid. Acid value is a measure amount of free fatty acid in oil hence its measures the level of hydrolytic rancidity in oils.

4. Conclusion

This study confirmed that all the studied oils were of good quality and it also under scored the importance of proper storage in maintaining the quality of vegetable oil. It built on evidence that high storage temperature has a detrimental effect on the quality of vegetable oil. It is clear from this work that oil should be stored at cool temperatures, away from light and without exposure to oxygen. This should be the case not just in the short term, but throughout the life of the oil which includes during the transport, storage and marketing of the oil as well as when the oil has reached its final destination – that is when it is with the consumer. Vegetable oil sold in open market should be stored in cool and dark places. At home, the refrigerator is possibly recommended.

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