

# Comparative Study of Oxidative Spoilage Effect on Margarine and Palm Oil Sold in Makurdi Benue State Nigeria

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## Abstract

Palm oil and Margarine are consumed in substantive quantities in various communities of Benue State Nigeria and so require attention especially in the areas of their handling and preservation . Palm oil is one of the few highly saturated vegetable fats and is semi-solid at room temperature. Like most plant-based products, palm oil contains very little cholesterol. Margarine is a manufactured, vegetable-oil-based substitute for butter **made** through a multi-step process whereby vegetable oils are extracted from corn, cottonseed, soybeans or safflower seeds. Their exposure to atmospheric conditions makes their wholesomeness a thing of concern especially their taste and colour. According to R. MacRae, R.K. Robinson, and M.J. Sadler (1993) as soon as a food, feed, or ingredient is manufactured, it begins to undergo a variety of chemical and physical changes. Oxidation of lipids is one common and frequently undesirable chemical change that may impact flavor, aroma, nutritional quality .Margarine also become rancid when exposed to air , heat , light and in some cases even the oxidized fats which interact with proteins and carbohydrates causing changes in texture. The peroxide value PV test is a usual test that measures the stability of various foods and so in 45 days margarine and palm oil were kept in a laboratory exposed atmosphere at an average temperature of 30°C and the measured peroxide value PV of margarine was an average of 0.346 meq/kg , while that of palm oil 0.186 meq/kg showing slower tendency of oxidative reactivity of palm oil and its stability on exposure compared to margarine .

**Keywords:** Oils, Volatiles, Peroxides, Saturation, Manufactured.

## 1. Introduction

Oil and fat products used for edible purposes are divided into two distinct classes: liquid oils, such as palm oil olive oil, peanut oil, soybean oil, sunflower oil; and plastic fats, such as lard, shortening, butter, and margarine. Fat is sometimes called nature's storehouse of energy because on a weight basis it contains more than twice as much energy as does carbohydrate or protein. It is probably as storehouses or depots of concentrated energy that fats appear in plant reproductive organs, such as pollen grains and seeds. It is this fat that humans recover from plants for use as food or in industry. The fat content of the nonreproductive tissue of plants is usually so low that recovery is impracticable. Yet much dietary fat comes from natural foodstuffs without being separated from the other plant materials with which it occurs. The proportion of fat in these foodstuffs varies from 0.1 percent in white potatoes to 70 percent in some nut kernels. The raw materials for the fat and oil industry are animal by-products from the slaughter of cattle, hogs, and sheep; fatty fish and marine mammals; a few fleshy fruits (palm and olive); and various oilseeds. Most oilseeds are grown specifically for processing to oils and protein meals, but several important vegetable oils are obtained from by-product raw materials. Cottonseed is a by-product of cotton grown for fibre, and corn oil is obtained from the corn germ that accumulates from the corn-milling industry, whose primary products are corn grits, starch, and syrup. Together with oils, fats comprise one of the three principal classes of foodstuffs, the others being proteins and carbohydrates. Nearly all cells contain these basic substances. The annual consumption of visible fats—such as lard, butter, shortening, or salad oils that have been separated from the original animal or plant source—ranges from 18 to 25 kilograms per person in various highly industrialized European countries to 23 kilograms per person in the United States. For the world as a whole, the average available supply is 10 kilograms per person; and in many areas of South America, Africa, and Southeast Asia, the annual consumption is 5 kilograms or less per person. Although natural fats consist primarily of glycerides, they contain many other lipids in minor quantities. Corn oil, for example, may contain glycerides plus phospholipids, glycolipids, phosphoinositides (phospholipids containing inositol), many isomers of sitosterol and stigmasterol (plant steroids), several tocopherols (vitamin E), vitamin A, waxes, unsaturated hydrocarbons such as squalene, and dozens of carotenoids and chlorophyll compounds, as well as many products of decomposition, hydrolysis, oxidation, and polymerization of any of the natural constituents. Fatty acids contribute from 94 to 96 percent of the total weight of various fats and oils. Because of their preponderant weight in the glyceride molecules and also because they comprise the reactive portion of the molecules, the fatty acids influence greatly both the physical and chemical character of glycerides. Fats vary widely in complexity; some contain only a few component acids, and at the other extreme more than 100 different fatty acids have been identified in butterfat, although many are present in only trace quantities. Most of the oils and fats are based on about a dozen fatty acids In considering the composition of a glyceride it is particularly important to distinguish between the saturated acids (acids containing only single bonds between carbon atoms, such as palmitic or stearic), with relatively high melting temperatures, and the unsaturated acids

(acids with one or more pairs of carbon atoms joined by double bonds, such as oleic or linoleic), which are low melting and chemically much more reactive. Maria Carrel AmeilaCarelli (2010)

## 2.0 Fats and Oils

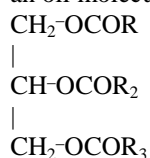
Fats and oils are defined as triglycerols of long chain fatty acids .in other words ,fats and oils are water soluble , non-volatile and greasy substances of plant and animal origin, predominantly of low fatty esters derived from the single trihydric alcohol,  $\text{CH}_2\text{OH}-\text{CHOH}-\text{CH}_2\text{OH}$  and are collectively known as triglycerides.

Thos triglycerides that are generally liquid at room temperature are known as oils, mainly from plants, while those that are solid at room temperature are called fats.

In generally are triglycerides of saturated fatty acid wit 12 or more

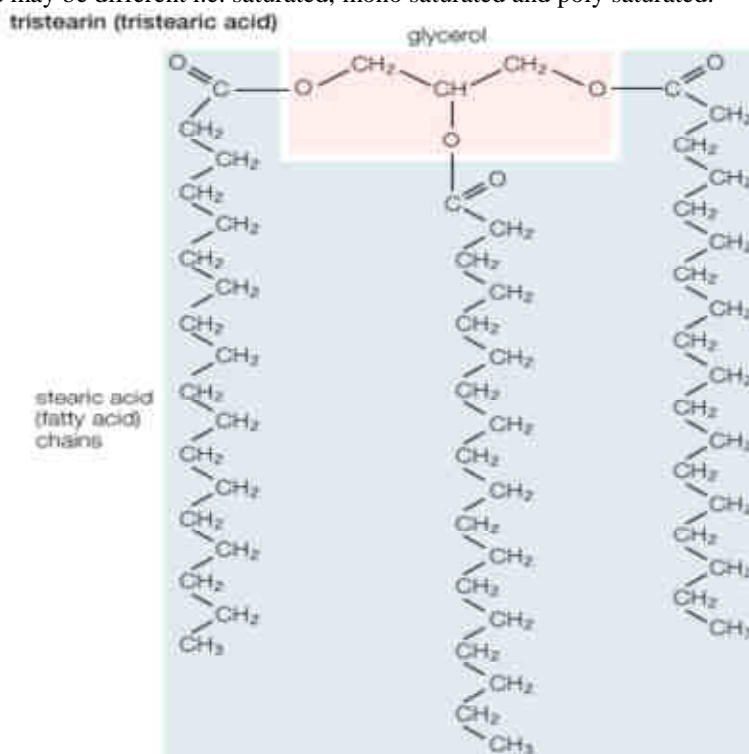
### 2.1 Structure of an oil molecule

The oil molecule has triglycerides as the general structure, below is the present atom of the general structure of an oil molecule

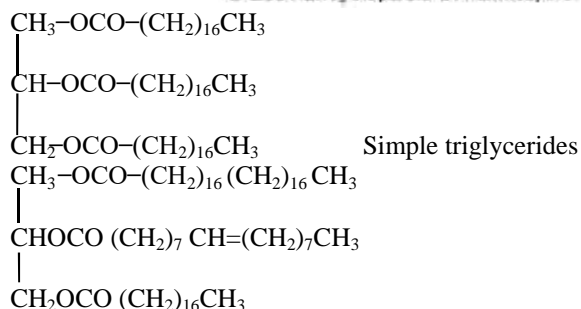


STRUCTURE OF OIL

$\text{R}_1\text{R}_2\text{R}_3$  stands for hydrocarbon chain of the fatty acid which may be the same given a simple triglyceride example, tristearin, a mixed triglyceride. On the other hand is one in which the fatty acid may be different i.e. in which the fatty acid may be different i.e. saturated, mono saturated and poly saturated.

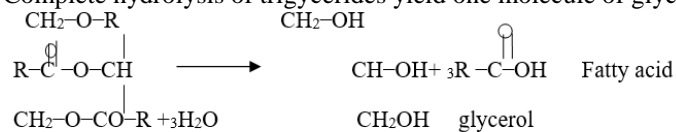


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Triglycerides contain approximately 95% acid and 5% glycerol combine as ester since fatty acids constitute greater part of the glyceride molecule and are also the reactive portion. The physical and chemical properties of their fatty acid component

Complete hydrolysis of triglycerides yield one molecule of glycerol and three molecules of fatty acids



A triglyceride

## 2.2 Major components of vegetable oil

Fatty acids constitute from 94-96% of the total weight of various oil and fats .fatty acids are mono basic organic acids having the general formular RCOOH where R represents an alkyl group btw 12-22 carbon atom

Various fatty acid occur in living tissue usually in the form of glycosides in the oils. fatty acids obtained from oils may be saturated.

Saturated fatty acids as in palmitic acid or unsaturated having one double bond attached as oleic and two as linoleic etc. the type and proportions of the different fatty acids present in oil have a major influence on the physical , chemical, and nutritional properties of theoil. Oils have significant place in human nutrition and the essential fatty acids derived from oil are required by the body as a vehicle for conveying vitamins.

no. of C=C bonds(Taylor 1969). The presence of unsaturated fatty acids residue in vegetable oil, may be accessed from the physical nature of the oil, those with high percentage of unsaturated residue like oleic and linoleic have low melting point, where as those with high percentage of saturated residue have very high melting point. In other words, the more the number of double bonds present in the chain, the lower is its melting point and vice versa.

Figure 1. The most frequently occurring common saturated and unsaturated fatty acids in vegetable oils .Showing the structure of some common fatty acids in vegetable oil.

SN	Acids	Common names	Bond	No. of carbon	Structure	Melting point
1	saturated	Lauric acid	0	12	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>10</sub> COOH	14
2		Mystic acid	0	14	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>12</sub> COOH	54
3		Palmitic	0	16	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>14</sub> COOH	63
4		Stearic acid	0	18	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CH=CH(CH <sub>2</sub> ) <sub>7</sub> COOH	10
5	unsaturated	Oleic	1	18	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CH=CH(CH <sub>2</sub> ) <sub>7</sub> COOH	13
6		linoleic	2	18	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>4</sub> CH=(CH <sub>2</sub> )CH=CH(CH <sub>2</sub> ) <sub>7</sub> COOH	-5
7		Linolenic	3	18	CH <sub>3</sub> (CH <sub>2</sub> )CH=CH(CH <sub>2</sub> )CH=(CH <sub>2</sub> ) <sub>7</sub> COOH	-7

The poly unsaturated fatty acids namely linolenic and arachidonic fatty acids are considered as essential fatty acid because of their necessity for growth and the occurrence of syndromes attributed to their deficiency. Adequate intake of essential fatty acid deficiency syndrome which can occur both in infant and adult alike.(sailer Berg,1974).

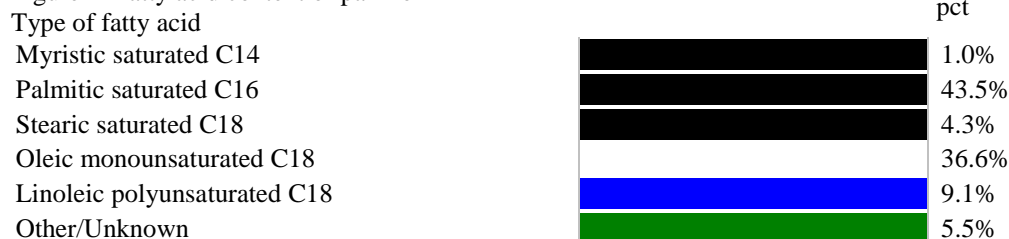
## 3.0 Palm Oil

The African palm tree gives a high yield of oil per year than any other oil seed and also produces two distinctive vegetable oils. Palm oil is derived from the fleshy mesocarp of the fruit and palm kernel oil from the seed (kernel). The oil palm is a native of west Africa where it grows wild in coastal areas.

Palm oil is yellow to orange red in color and is derived from the fleshy pulp of the fruit which contains 45-55% oil. The deep orange is due to the presence of large quantities of carotene, particularly β-carotene, the precursor of vitamin A. It is more or less solid at room temperature. The fatty acid composition of palm oil is;- myristic acid 1.0-2.5%, palmitic 32-43%, oleic acid 40-53% and linolenic acid 2-11%. Palm oil has long been an important food in west Africa and is extensively used for edible purpose even today. A large proportion of the oil is also consumed in the manufacture of soaps, candles, lubricants and in tin-plating industry. sometimes it is used as fuel for internal combustion engines .Since the mid-1990s, red palm oil has been cold-pressed and bottled for use as cooking oil, and blended into mayonnaise and salad oil. Along with coconut oil, palm oil is one of the few highly saturated vegetable fats and is semi-solid at room temperature. Like most plant-based products, palm oil contains very little cholesterol. Obahiagbon, F.I. (2012). Palm oil, like all fats, is composed of fatty acids,

esterified with glycerol. Palm oil has an especially high concentration of saturated fat, specifically, of the 16-carbon saturated fatty acid palmitic acid, to which it gives its name. Monounsaturated oleic acid is also a major constituent of palm oil. Unrefined palm oil is a large natural source of tocotrienol, part of the vitamin E family. Comparison to trans fats In response to negative reports on palm oil many food manufacturers transitioned to using hydrogenated vegetable oils in their products, which have also come under scrutiny for the impact these oils have on health. A 2006 study supported by the National Institutes of Health and the USDA Agricultural Research Service concluded that palm oil is not a safe substitute for partially hydrogenated fats (trans fats) in the food industry, because palm oil results in adverse changes in the blood concentrations of LDL cholesterol and apolipoprotein B just as trans fat does. Rosalie Marion Bliss (2009)

Figure 2 Fatty acid content of palm oil

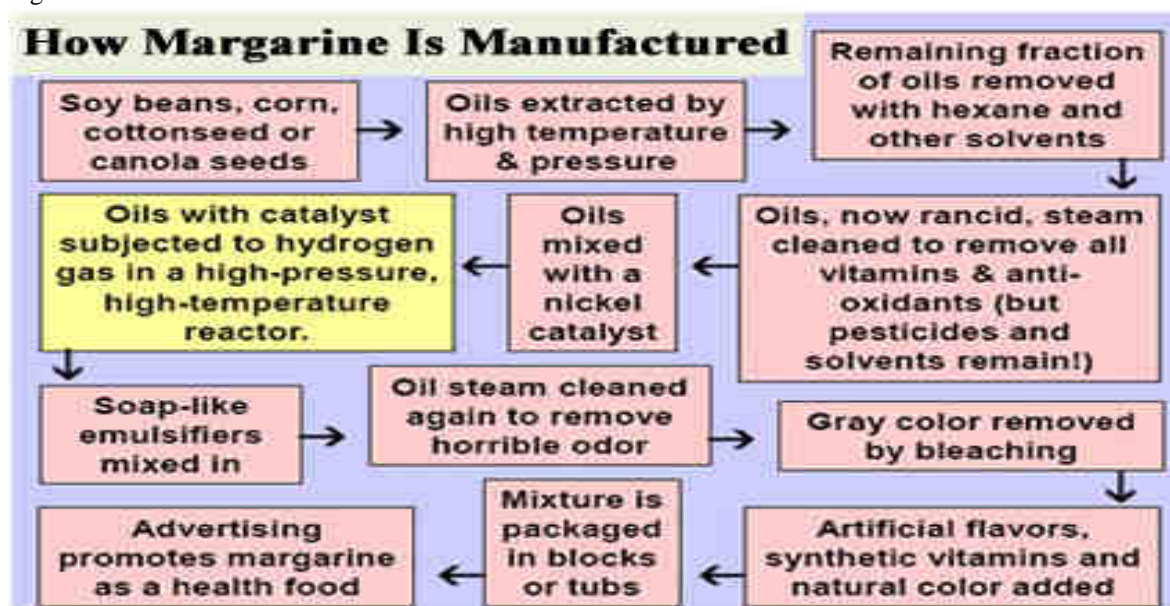


*black*: Saturated; *grey*: Monounsaturated; *blue*: Polyunsaturated Poku, Kwasi (2002).

#### 4.0 Margarine

Margarine was invented by the French chemist Mège-Mouriès, who in 1869 won a prize offered by Napoleon III for a satisfactory butter substitute. The modern hydrogenation process had its origin in research in the late 19th century that led to the establishment of the vegetable-oil-shortening industry and a variety of industrial applications. It is a manufactured, vegetable-oil-based substitute for butter made through a multi-step process whereby vegetable oils are extracted from corn, cottonseed, soybeans or safflower seeds. Hexane, an organic compound commonly used as a solvent, is used in the extraction process, the oil is then steam cleaned to remove most impurities but the steam also destroys vitamins and antioxidants in the process hydrogen gas is bubbled through liquid oil in the presence of a catalyst (usually nickel) this forces unsaturated fatty acids to become saturated and solid. The more complete the hydrogenation process, the firmer the finished product. Margarine undergoes partial hydrogenation, to make it semi-solid. Partial hydrogenation produces a lumpy grey grease and results in the formation of trans-fats. Emulsifiers are added to remove lumps and bleach to remove the grey color. A second steam cleaning removes chemical odors. Synthetic vitamins, artificial colors and a natural yellow color are added. The final product is packaged as a healthy alternative to butter. Most fats, even after refining, have characteristic flavours and odours, and vegetable fats especially have a relatively strong taste that is foreign to that of butter. The deodorization process consists of blowing steam through heated fat held under a high vacuum. Small quantities of volatile components, responsible for tastes and odours, distill, leaving a neutral, virtually odourless fat that is suitable for the manufacture of bland shortening or delicately flavoured margarine. Originally, deodorization was a batch process, but increasingly, continuous systems are being used in which hot fat flows through an evacuated column countercurrent to the upward passage of steam. In Europe, a deodorization temperature of 175°–205° C is common, but in the United States, higher temperatures of 235°–250° C are usually employed. About 0.01 percent of citric acid is commonly added to deodorized oils to inactivate trace-metal contaminants such as soluble iron or copper compounds that otherwise would promote oxidation and the development of rancidity.

Figure 3



### 5.0 Rancidity

Rancidity refers to the spoilage of a food in such a way that it becomes undesirable (and usually unsafe) for consumption. When people say that a food has "gone bad," it is rancid and can change the odors or flavors of a food in such a way that it becomes very unpleasant to smell or taste. Oils can be especially susceptible to rancidity because their chemistry can make them exceptionally susceptible to oxygen damage. When food scientists talk about rancidity, they are often talking about a specific type of rancidity involving oxygen damage to foods, and this type of rancidity is called "oxidative rancidity." During the process of oxidative rancidity, oxygen molecules interact with the structure of the oil and damage its natural structure in a way that can change its odor, its taste, and its safety for consumption

### 5.1 Autoxidation

The unsaturated fatty acids present in the lipids of many foods are susceptible to chemical breakdown when exposed to oxygen. The oxidation of unsaturated fatty acids is autocatalytic; that is, it proceeds by a free-radical chain reaction. Free radicals contain an unpaired electron (represented by a dot in the molecular formula) and, therefore, are highly reactive chemical molecules. In addition to promoting rancidity, the free radicals and peroxides produced in these reactions may have other negative effects, such as the bleaching of food colour and the destruction of vitamins A, C, and E. This type of deterioration is prevalent in fried snacks, nuts, cooking oils, and margarine. An example of autoxidation that is of great commercial concern is the one leading to the rancidity of fats, oils, and fatty foods. The use of antioxidants for food is closely regulated in most countries. Specific limitations are normally imposed on the type and quantity of antioxidants that may be used. The propagation of further oxidation by lipid oxidation products gives rise to the term "auto-oxidation" that is often used to refer to this process. In the final, termination phase of lipid oxidation, relatively unreactive compounds are formed including hydrocarbons, aldehydes, and ketones.

### 5.2 Antioxidation

The oxidation of food products involves the addition of an oxygen atom to or the removal of a hydrogen atom from the different chemical molecules found in food. Two principal types of oxidation that contribute to food deterioration are autoxidation of unsaturated fatty acids (*i.e.*, those containing one or more double bonds between the carbon atoms of the hydrocarbon chain) and enzyme-catalyzed oxidation. The autoxidation of unsaturated fatty acids involves a reaction between the carbon-carbon double bonds and molecular oxygen ( $O_2$ ). The products of autoxidation, called free radicals, are highly reactive, producing compounds that cause the off-flavours and off-odours characteristic of oxidative rancidity. Antioxidants that react with the free radicals (called free radical scavengers) can slow the rate of autoxidation. These antioxidants include the naturally occurring tocopherols (vitamin E derivatives) and the synthetic compounds butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tertiary butylhydroquinone (TBHQ). Specific enzymes may also carry out the oxidation of many food molecules. The products of these oxidation reactions may lead to quality changes in the food. For example, enzymes called phenolases catalyze the oxidation of certain molecules (*e.g.*, the amino



acid tyrosine) when fruits and vegetables, such as apples, bananas, and potatoes, are cut or bruised. The product of these oxidation reactions, collectively known as enzymatic browning, is a dark pigment called melanin. They are often used as preservatives in fat-containing foods to delay the onset or slow the development of rancidity due to oxidation. Natural antioxidants include polyphenols (for instance flavonoids), ascorbic acid (vitamin C) and tocopherols (vitamin E). Synthetic antioxidants include butylatedhydroxyanisole (BHA), butylatedhydroxytoluene (BHT), TBHQ, propyl gallate and ethoxyquin. The natural antioxidants tend to be short-lived, so synthetic antioxidants are used when a longer shelf-life is preferred. The effectiveness of water-soluble antioxidants is limited in preventing direct oxidation within fats, but is valuable in intercepting free radicals that travel through the aqueous parts of foods. A combination of water-soluble and fat-soluble antioxidants is ideal, usually in the ratio of fat to water.

Antioxidants that inhibit enzyme-catalyzed oxidation include agents that bind free oxygen (*i.e.*, reducing agents), such as ascorbic acid (vitamin C), and agents that inactivate the enzymes, such as citric acid and sulfites.

### 5.3 Health risks associated with trans fat

Concern over the health impacts of trans fats first emerged in the 1940s, and by the late 1950s scientists had demonstrated a clear link between the intake of saturated fat and heart disease. However, this link was contested by subsequent studies, which found that the consumption of fats was healthy. Confusion over which types of fat were healthy and which types were unhealthy resulted in numerous lengthy studies designed to identify the physiological effects of each type of fat. In the late 1980s, an association between high intake of saturated fat and increased risk of heart disease was firmly established. As a result, the consumption of trans fats soared, since they were used in favour of all products containing saturated fats, including lard and tallow. However, in the 1990s, evidence emerged indicating that trans fats carried a higher risk for heart disease than saturated fats.

The consumption of trans fats causes an increase in levels of low-densitylipoprotein (LDL) cholesterol. Increased LDL levels result in the accumulation of fat in blood vessels, which can lead to atherosclerosis, heart disease, and stroke. Trans fats also lower levels of high-density lipoprotein (HDL) cholesterol, which plays an important role in transporting cholesterol from cells and blood vessels to the liver, where cholesterol is metabolized for excretion. Levels of HDL are inversely correlated with the risk of heart disease, and therefore the depletion of HDL by trans fats increases the risk of cardiovascular disease. In addition, trans fats are associated with an increased risk of type II (adult-onset) diabetes mellitus Ascherio, A., Katan, M.B., Stampfer, M. (1999):

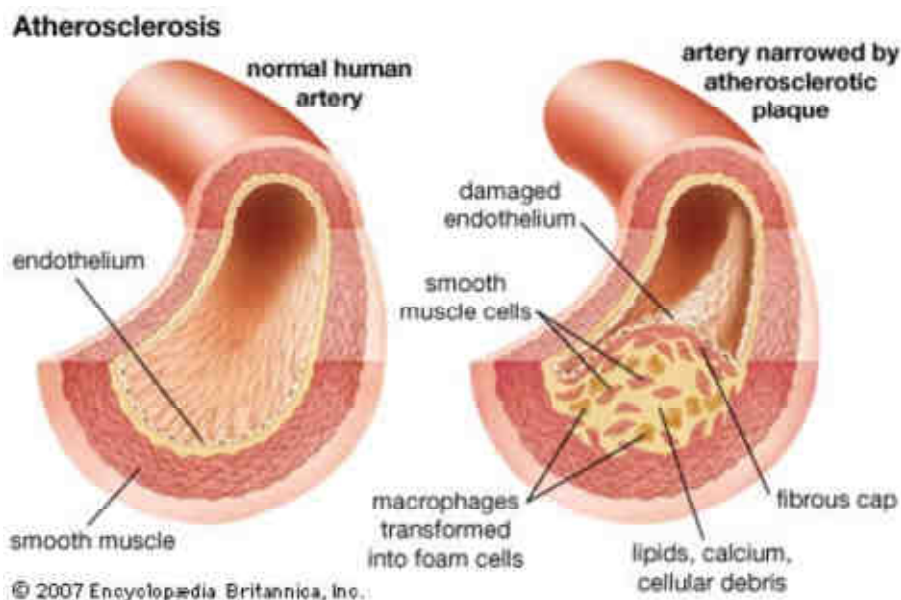


Figure 3 Cross-sectional diagrams of human blood vessels showing a normal, healthy artery and a narrowed artery.

## 6.0 Analysis

### 6.1 Peroxide Value

The peroxide value test is a commonly requested test used to measure the stability of various food products including pet foods, feeds, and human foods. The peroxide value is a commonly used indicator of the shelf life of a product because an elevated peroxide value will accompany disagreeable odors.

The peroxide value method is referenced in both the American Oil's Chemist Society (AOCS) and the

Association of Analytical Chemists (AOAC) as methods 965.33 (AOAC) or Cd-8b (AOCS). The method is carried out by dissolving the oil sample in a solvent and potassium iodide and then titrating with sodium thiosulfate and using starch as an indicator. The theory and science behind the test involves lipid oil (chemistry) because the peroxide formation occurs in these materials. The test itself indicates its scope is applicable to all normal fats and oils and that the method is highly empirical and any variation in the test procedure may result in erratic results. Also, the test measure substances that are assumed to be peroxides or other similar products of food oxidation. Fat oxidation is a normal process that occurs when normal fats or oils are exposed to air (oxygen), sunlight, or elevated temperature. These factors cause chemical reactions in the fats, which include breaking fatty acids from glycerin or the addition of oxygen to unsaturated fatty acids, and the formation of peroxide is a natural reaction that occurs. The more oxygen (air), heat, or sunlight that is present, the greater the rate of peroxide

formation. Also, the type, form, and amount of fat (oils) is also critical. The process of peroxide formation in foods can be controlled by adding antioxidants that react with free radicals and slow down auto-oxidation or the natural formation of peroxides. Fereidoon Shahidi, Ying Zhong 2005

### 6.2 Moisture and dirt

For routine purposes, moisture can be determined by loss of weight at 105 °C. This can conveniently be estimated by heating a sample in a fat porcelain dish over a small flame using a very short thermometer to stir and to indicate the temperature. This gives total volatile matter and moisture can be determined more accurately by the Karl Fisher method. Dirt is determined by filtration of a hot dry sample of the oil through a dry filter paper and weighing the residue after fatty matter has been removed with a solvent as petroleum ether, 40 °C–60 °C

### 6.3 Titter

Dry fatty acids are first prepared from the fat, the liquid fatty acids are cooled under standardized conditions and the titer of the sample is the highest temperature reached when a rise occurs due to the latent heat of solidification, it is thus a measure of fatty acids.

### 6.4 Free fatty acids

Estimation of free fatty acids content of a fat can be expressed in terms of NaOH% or it can be converted to percentage of a notional fatty acid. For many fats, FFA as oleic equals FFA as NaOH  $\times 282$  or  $\text{Na} \times 9.10$ . In terms of palm oil, it is sometimes expressed in terms of palmitic acid (factor 6.45). FFA content can also be expressed in terms of mg KOH required to neutralize the FFA in one gram of fat. This figure is known as acid value (AV), or acid number.

### 6.5 Reagents

Acetic acid - chloroform solvent mixture (3:2), mix 3 cm<sup>3</sup> of glacial acetic acid with 2 cm<sup>3</sup> of chloroform. Freshly prepared saturated KI solution 0.01M Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> Standardized against 0.01M K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. Starch solution = 1%

### 6.6 Procedure

A.O.A.C 17<sup>th</sup> ed., 2000, official method 965.33 was used in the determination of Peroxide Value of Oils. All samples were exposed in the same environment for 45 days. Peroxide Value was measured at 15 days interval 5g ( $\pm 50$ mg) sample was weighed into a 250ml stoppered conical flask. 30ml solvent mixture was added and stirred to dissolve. 1ml KI solution was added with a Mohr pipette. After 5 minutes in dark with occasional shaking, 30 ml of H<sub>2</sub>O was added and slowly titrated the liberated iodine with standard 0.01M Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution, with vigorous shaking until yellow colour was almost gone. Using a dropping pipette, 1mL starch solution was added as indicator and titration continued, shaking vigorously to release all I<sub>2</sub> from CHCl<sub>3</sub> layer until blue colour disappeared. Note: Triplicate analysis was performed and a blank determination was also conducted.

### 6.7 Calculations

Peroxide value expressed as milli equivalent of peroxide oxygen per kg sample meq/kg:

PV =  $\frac{\text{Titre} \times 0.01M \text{ Na}_2\text{S}_2\text{O}_3 \times 100}{\text{Weight of sample}}$

Where: Titre = mL of sodium thiosulphate used (blank corrected)

### 7.0 Results

Sample Name: Blue Band margarine Sample Code = BB

D/4	BB <sub>1</sub> = 5.001	vol of Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	= 2.60
	BB <sub>2</sub> = 5.010		= 2.60
	BB <sub>3</sub> = 5.008		= 2.70

$$\begin{aligned}\bar{X} &= 5.006\text{g} & \bar{X} &= 2.633\text{ml} \\ \text{Titre} &= (2.633 - 0.50)\text{ml} = 2.133\text{ml}. \\ \text{PV} &= 0.426 \pm\end{aligned}$$

#### Blue Band

$$\begin{aligned}\text{BB}_1 &= 4.98\text{g} = 2.30\text{ml} \\ \text{BB}_2 &= 4.976\text{g} = 2.20\text{ml} \\ \text{BB}_3 &= 5.001\text{g} = 2.20\text{ml} \\ \bar{X} &= 4.988\text{g} = 2.23\text{ml} \\ \text{Titre} &= (2.53 - 0.50)\text{ml} = 1.73\text{ml} \\ \text{PV} &= 0.346 \pm\end{aligned}$$

#### Sample Name: Palm oil

$$\begin{aligned}\text{Sample Code} &= \text{PM}, & \text{vol of Na}_2\text{S}_2\text{O}_3 & \text{ used} \\ \text{D/4} & \text{PM}_1 = 5.001 & & = 1.60 \\ & \text{PM}_2 = 5.001 & & = 1.60 \\ & \text{PM}_3 = 5.032 & & = 1.50 \\ \bar{X} &= 5.011\text{g} & \bar{X} &= 1.567\text{ml} \\ \text{Titre} &= (1.567 - 0.50)\text{ml} = 1.067\text{ml}.\end{aligned}$$

$$\text{PV} = 0.213 \bar{X} = 5.006\text{g}$$

#### 1. palm Oil

$$\begin{aligned}\text{PM}_1 &= 5.001\text{g} = 1.40\text{ml} \\ \text{PM}_2 &= 5.001\text{g} = 1.50\text{ml} \\ \text{PM}_3 &= 5.025\text{g} = 1.40\text{ml} \\ \bar{X} &= 5.009\text{g} = 1.433\text{ml} \\ \text{Titre} &= (1.433 - 0.50)\text{ml} = 0.933\text{ml} \\ \text{PV} &= 0.186 \pm \text{meq/kg}\end{aligned}$$

### 8.0 Discussion

Volume of  $\text{Na}_2\text{S}_2\text{O}_3$  used shows an average ( $\bar{X}$ ) = 1.567ml in palm oil and  $\bar{X}$  = 2.633ml in margarine. The peroxide value PV of margarine is 0.346meq/kg average while that of palm oil is  $0.186 \pm$  meq/kg average. That shows the slower tendency of oxidative reactivity of palm oil on exposure to atmospheric conditions to as much as 45 days. While margarine is produced from vegetable oils almost artificially, palm oil remains almost naturally with many stabilizing components within. It will therefore not be out place to take longer for palm oil to spoil. Nevertheless some degree of spoilage is recorded in both samples. Palm oil is prepared and kept for usage under prevailing atmospheric conditions while margarine is necessarily refrigerated for preservation for a longer shelf life. The chemical composition of an oil is also a key factor in the risk of rancidity. Here the basic principles involve saturated and unsaturated fat. The more saturated fat contained in an oil, the less susceptible it is to rancidity. The greater the amount of unsaturated fat in an oil, the more likely it is to become rancid.

### 9.0 Conclusion

Early in the lipid oxidation process, peroxides and hydroperoxides are the predominate reaction products. These reaction products continue to increase until storage conditions change, one or more initiators is depleted, available oxygen is consumed. Increased peroxide and hydroperoxide concentrations will initiate a series of reactions that eventually lead to increasing concentrations of aldehydes, ketones, hydrocarbons, and other termination phase products. The consequence of all of these changing concentrations is that any attempt to evaluate the rancidity of a product will likely be taking aim at a moving target. Peroxide values could be low because minimal oxidation has occurred or because peroxide concentrations have begun to decrease. Low aldehyde concentrations may be the result of limited oxidation or the aldehydes may have volatilized. It is generally not possible to predict the best indicator of lipid oxidation and any attempt to characterize rancidity of a product will likely require multiple tests. Appropriate control samples are also helpful when historical values are unavailable. And finally, while a variety of chemical tests can objectively quantify various lipid oxidation products, subjective sensory evaluations may be the key to understanding the data. Ultimately, correlation to sensory testing is the basis for determining which chemical tests are appropriate for measuring lipid oxidation in any product. When oil is to be bottled the bottles to be filled should be immaculately clean and free of any trace of droplets or bubbles. If they have held oil previously, they should be rinsed several times with boiling water and then should be left open to dry thoroughly. Before pouring fresh oil in, put your nose right up against the dry, empty bottle and sniff hard several times; if there is any hint of a musty, rancid odor, you can be sure the fresh oil will be spoiled within a few days, especially if kept at room temperature. Recognizing rancidity is not the cure, of course, but as more people realize it is a flaw, their demands for freshness may be answered.



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