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RANCIDITY PROFILE OF PALM OIL, PALM KERNEL OIL AND COCONUT OIL AT TWO SELECTED TERTIARY MARKETS IN ACCRA

BY

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SUMMARY

There are many problems associated with handling and keeping of unrefined cooking oils on the Ghanaian markets. These problems affect the general quality of the products. Some of these problems are development of foul smell and undesirable taste. It is believed that these are caused mainly by inappropriate handling practices during the sale of the oil.

A survey was therefore conducted at two tertiary markets to determine the extent of rancidity associated with three cooking oils sold at these markets. The oils studied were palm oil, palm kernel oil and coconut oil. The rancidity profile was monitored by determining the peroxide and free fatty acid values of the oils.

The results obtained indicate that palm oil in all cases show the highest tendency to go rancid as shown by the observed high peroxide values and high free fatty acid contents of palm oil from the two markets. This could be attributed to the processing procedures and the keeping conditions.

The coconut and palm kernel oils have relatively low tendencies to show any sign of rancidity by looking at their peroxide values and low free fatty acid values and thus have higher quality.

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1.0 INTRODUCTION

One of the most important constituents of all food materials is a fraction called lipid. They serve as a rich source of energy; yielding approximately 9kilocalories per gram and also serve as carriers of the fat-soluble vitamins A, D, E and K while certain components themselves (linoleic, linolenic, and arachidonic acids) are essential components in all diets (Ihekoronye and Ngoddy, 1985).

Oils /fats play a distinctive role in the natural flavour of a wide variety of food commodities, and degradation products of oils/fats are the cause of many major off-flavours in foods.

Oils and fats are subject to a kind of spoilage known as rancidity. Rancidity is the condition in which an off-flavour has been developed in edible oils or fats, or oil-containing food products; it is caused by oxidative deterioration and hydrolysis of the triglycerides. Primary oxidation products are odourless and tasteless but certain secondary decomposition products have particularly potent off-flavours and are detected by the palate at extremely low concentrations (Shewfelt et. al, 1993)

In spite of its importance in nutrition, the vegetable oil industry in Ghana has not been well developed. This is attributed to a number of reasons. Key among these is the low level of technologies used in the production and processing of these cooking oils. This has resulted in poor returns for oil-producing farmers and non-optimal use of oil-bearing crops in Ghana.

An earlier market survey on constraints facing cooking oil sellers in some markets established that the deterioration parameters such as development of smell in palm oil usually starts after one month handling and storage by market women. (Baidoo and Johnson, 2001)

To attend to the problem a search was made to identify the rancidity status of the oils selected from two markets over a period of time using the free fatty acid content and the peroxide value of the oils as indices to rancidity.

The objective of this work is to assess the quality and purity of the cooking oils on our markets.

2.0 BACKGROUND OF FAT/OIL STORAGE

Fats and oils undergo changes during storage, which results in the production of an unpleasant taste and odour, commonly referred to as rancidity. Rancidity is brought about by the action of air (oxidative rancidity) or by microorganisms (ketonic rancidity) and enzymes (lipolysis). Oxidative rancidity is accelerated by light and heat, moisture and presence of traces of certain metals (e.g. copper, nickel, iron).

It is now generally accepted that oxygen is taken up by the fat/oil with the formation of compounds, which react as peroxides. In general the greater the degree of unsaturation in the fat/oil, the greater the liability of the fat to oxidative rancidity. When the concentration of peroxides reach a certain level, complex chemical changes occur and volatile products are formed which are mainly responsible for the rancid taste and odour.

With most crude fats/oils, the free fatty acidity increases during storage as a result of breakdown of the triglycerides but with refined oils particularly, the free fatty acid figure is not necessarily related to the extent to which rancidity has progressed. On the other hand although the "peroxides" are possibly not directly responsible for the taste and odour of rancid fats, the concentration of them as represented by the peroxide value is often useful for assessing the extent to which spoilage had advanced.

2.1 ANALYSIS AND TESTING OF FATS AND OILS

The analysis and testing of oils and fats is needed for an assessment of quality and purity as well as for their identification. A number of physical and chemical parameters have been established for these purposes. Although some of them are empirical, others are quite specific measurements of the characteristics of the oils/fats. Those most commonly used to establish identity are saponification value, iodine value, refractive index and the Reichert-Polenske-Kirschner values. Other constants have special significance for certain oils such as the hydroxyl value for castor oils and Ever's test for groundnut oil.

Colour reactions can also give a useful guidance in identifying an oil but measurements of melting points of oils/fats are debatable. Other data are determined on the oil in order to assess quality. Of these, the free fatty acid content, peroxide value, benzidine or anisidine value, moisture, impurities and unsaponifiable matter, all help to give an adequate measurement of the quality of the material.

Oils and fats are natural products and are therefore subject to some variation in composition so that the constants fall within a range. Even so from time to time oils become available which have constants outside the normal range. The variations in composition are dependent on a number of factors. Vegetable oils vary according to the botanical variety, climatic conditions, soil composition, rainfall and temperature. Similarly, animal fats vary according to the breed of the animal, climatic conditions, and type of feed.

The acid value is a measure of the amount of free fatty acid present in a fat/oil. Some of the deterioration that take place during storage of either the raw material from which the fat/oil is obtained, or in the fat/oil itself after isolation (extraction), results in hydrolysis of triglycerides to yield free fatty acid.

The peroxide value is usually used as an indicator of deterioration by rancidity of fats/oil. As oxidation takes place the double bonds in the unsaturated fatty acids are attacked forming peroxides. These break down to produce secondary oxidation products, which indicate rancidity. The peroxide value can therefore be used to estimate oxidation, but as the compound formed is unstable and oxidation proceeds further.

2.2 FACTORS CAUSING OIL/FAT DETERIORATION

When oils/fats are oxidized the unsaturated fatty acids react, resulting in rancidity. The most common mechanism of oxidation is a free radical chain reaction. This process is retarded by the presence of anti-oxidants such as tocopherols and tocotrienols and accelerated by pro-oxidants such as trace metals and heat. The primary products of oxidation are hydro-

peroxides; these then decompose into secondary oxidation products such as aldehydes and ketones causing the off-flavours.

The factors that largely determine the quality and storability of oils/fats are the content of free fatty acids, contamination of the oil with water and other impurities and bleachability. The presence of water and other foreign contaminants encourages high rates of free fatty acid formation through the activities of lipolytic enzymes (lipases).

The fatty acids in palm oil may be formed by autocatalytic action, by the action of lipolytic enzyme lipase from the palm fruit, or by microbial lipases. The formation of free fatty acids is mainly caused by the action of lipase before processing. Palm fruits and copra contain lipase, which can only effect the breakdown of fats into fatty acids and glycerol when the cells of the fruit has been damaged. The fat is protected from the lipase in the fruit by the membranes of the vacuoles, which can be ruptured either mechanically or by low temperature. The enzyme lipase, is completely inactivated at high temperatures i.e. temperatures above 55°C .The rate of free fatty acid formation in palm fruits following crushing is fast and reaches its peak in 30-60 minutes. (Desasis, 1955).

Locin and Jacobsberg (1963) showed that after destruction of enzymes, oil in storage could deteriorate through autocatalytic hydrolysis. The fatty acids already present in small quantities, act as catalysts in the reaction between the triglycerides and water.

For the production of oil low in free fatty acids, rupturing of the fruits ought to be avoided and to provide an oil which will maintain a low free fatty acid content during storage, the final processing ought to be geared primarily to reducing the water content to less than 0.1 per cent, since below this value little auto catalytic hydrolysis is likely to occur.

Apart from moisture content and rupturing of raw materials, a rise in fatty acid content during storage of oil/fat has been found to be due to the action of heat–resistant lipases undestroyed by drying or high temperatures.

3.0 MATERIALS AND METHODS

Samples of red palm oil, palm kernel oil and coconut oil were collected from two selected markets in Accra (31st December and Mallam Atta) at random and parameters of peroxide value and free fatty acid content measured for six consecutive weeks to obtain a profile of rancidity indices of the oils. Altogether 20 samples of each oil were analysed.

3.1 Parameters determined

The parameters determined were free fatty acid content and peroxide value of the oils.

3.2 Free fatty acid content of oils

The acidity of a fat/oil is normally a measure of the extent to which hydrolysis has liberated the fatty acids from their ester linkage with their parent glyceride molecule and for this reason it is quoted as free fatty acids per cent (%FFA). This method of expression gives the refiner an immediate estimate of the amount of oil that will be lost when a batch is neutralized to remove these free fatty acids. Unfortunately, however, calculation of %FFA entails an assumption of the molecular weight of the free fatty acids.

The appropriate molecular weight for the calculation can usually be derived without difficulty, and there is a convention that the FFA of lauric oils is expressed as lauric acid (mol.wt 200), of palm oil as palmitic acid (mol.wt. 256) and of most other oils as oleic acid (mol.wt 282).

Occasionally, a blend of oils may be involved and it may not be clear which molecular weight to take for the calculation.

The determination of FFA is carried out by dissolving a weighted amount of the fat in hot neutralized 95% ethanol and titrating with sodium hydroxide using phenolphthalein. (AACC, 1982)

3.3 Peroxide Value of oils

The most common cause of oil deterioration is rancidity -- the most common cause of rancidity being oxidation. It is generally accepted that the first product of oxidation of an oil is a hydro-peroxide. The usual method of assessment is by determination of peroxide value, which involves the measurement of iodine, produced from potassium iodide by the peroxides present in the oil and is reported in units of milli-equivalents of oxygen per kilogram.

The peroxide value (PV) is a good guide to the quality of a fat/oil and freshly refined oil should have a PV of less than 1 unit. Oils that have been stored for some period of time after refining may be found to have PVs of up to 10 units before undue flavour problems are encountered. This is due to the fact that the peroxides themselves have no flavour; they do however decompose into aldehydes and ketones, many of which have pronounced off-flavours (Rossel, 1987).

4.0 RESULTS AND DISCUSSION

4.1 Free fatty acid content of the oils

Figures 1 and 2 show graphs of the free fatty acid (FFA) content of the oils from the two markets. It indicates that all the oils do not show any sign of rancidity (rancid oil/fat have FFA of 10% and above) but the FFA values of the oils from Mallam Atta market were higher than those from the 31st December market as indicated by the range of values, which is FFA of 1.0%-6.0% for oils from the 31st December market and 1.0%-9.0% for Mallam Atta market.

The graphs also indicate that of the three oils, palm oil has the highest free fatty acid content and this is shown in weeks 2,3,4 and 5 in Mallam Atta market as shown in figure 1 and weeks 1and 4 in 31st December market, shown in figure 2.

The results from the Mallam Atta market indicate that palm oil has the highest average content of free fatty acids, followed by coconut oil and palm kernel oil. (Figure 3, page 10).

The order of quality with respect to free fatty acid content at the 31st December market is as follows: coconut oil> palm oil> palm kernel oil.

It is also clear that apart from coconut oil, the average FFA of all the oils is comparably higher in Mallam Atta market and could be due to the fact that the 31st December market being a bigger and a more popular market has a lot of competitors selling oils and thus relatively low quality oil is not found.

4.2 Peroxide value of the oils

In general the oils under study did not show signs of rancidity by looking at the peroxide values (PVs). This is because the PVs obtained from the study are below that observed before the onset of rancidity. (Peroxide value of 10 for fresh oils)

Figures 4 and 5 indicate the peroxide values of the oils from the Mallam Atta market and the 31st December market. In all cases from the two markets, palm oil shows the highest peroxide value. This may be attributed to its high content of unsaturated fatty acids.

The mean peroxide values for palm oil at the Mallam Atta and the 31st December market are 6.14 and 6.02 respectively. The PVs of palm kernel oil at the 31st December market are lower than those obtained from the Mallam Atta market. This is shown by the mean PVs. For coconut oil, the mean PV at Mallam Atta market was 2.52 while that of the 31st December market is 1.8 That of palm kernel oil at Mallam Atta market is 2.07 whilst that of the 31st December market is1.87 as shown in Table 1 (page 11).

Coconut oil shows the least values of PVs in the two markets. This could be due to its high content of saturated fatty acids which delays rancidity.

Fig.1 Free fatty acid content of oils; Mallam Atta market

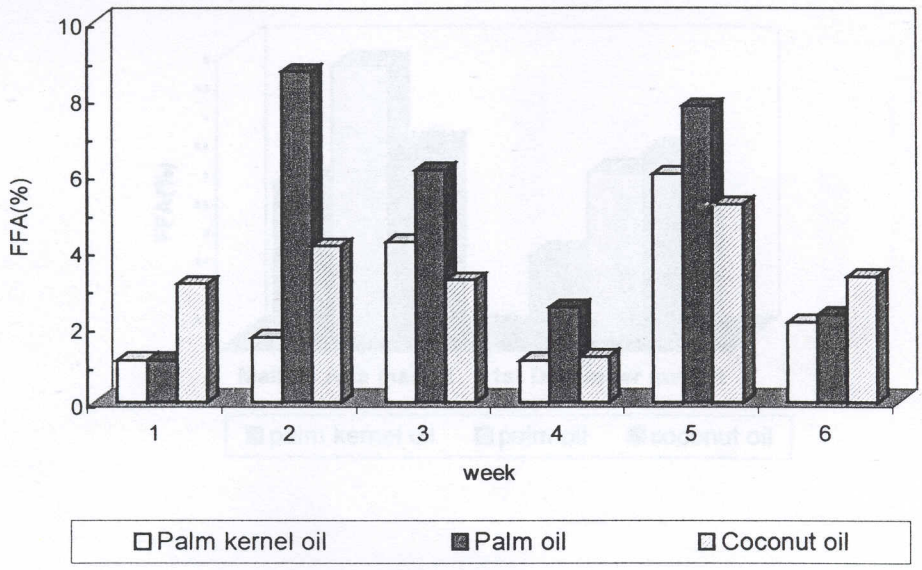

Fig.2 Free fatty acid content of oils; 31st December market.

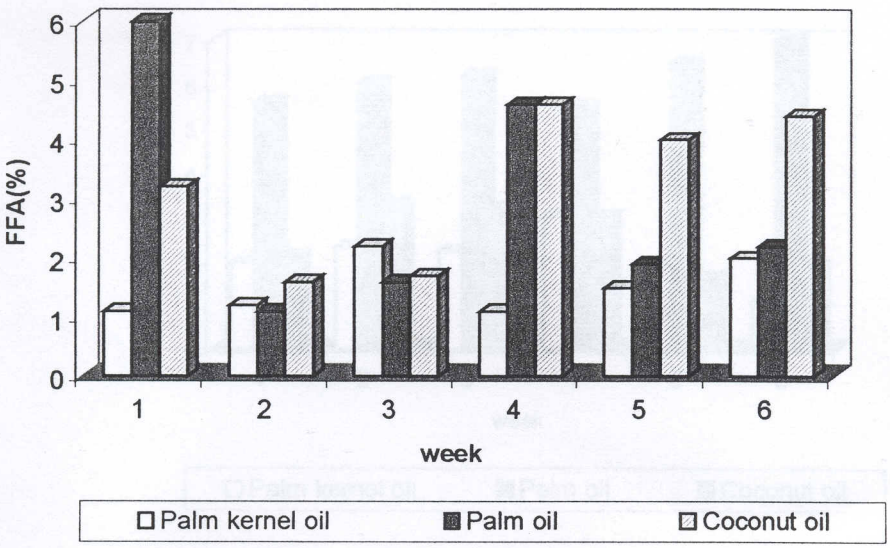

Fig. 3 **Mean %FFA of oils from the two markets**

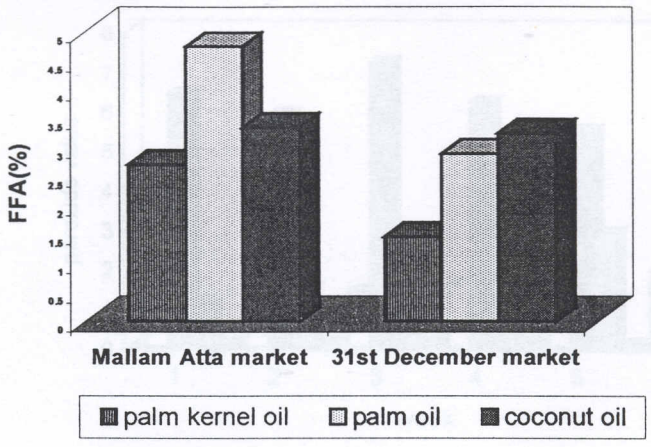

Fig.4 Peroxide values of oils from Mallam Atta market

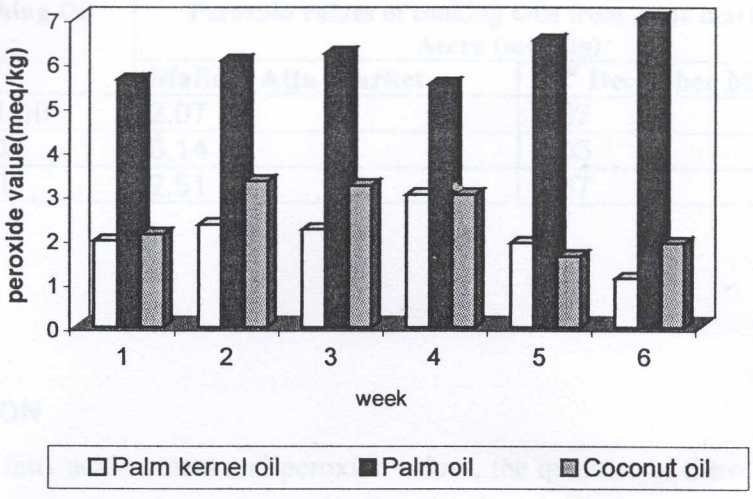

Fig. 5 Peroxide values of oils from 31st December Market

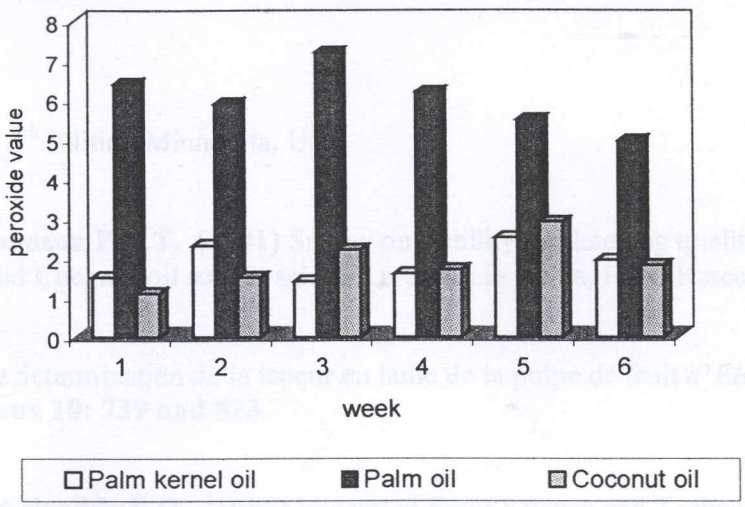

Table 1: Mean peroxide values of oils from the two markets

Type of cooking Oil	Peroxide values of cooking Oils from some markets in Accra (meq/kg)	
	Mallam Atta Market	31st December Market
Palm kernel Oil	2.07	1.87
Red Palm Oil	6.14	6.03
Coconut Oil	2.51	1.87

5.0 CONCLUSION

With respect to free fatty acid content and peroxide values, the qualities of the oils under this study from the two markets showed values that were not close to onset of rancidity. The free fatty acid contents and the peroxide values obtained were quite high but not to the point of the onset of rancidity where the foul smell start to develop.

Coconut oil and palm kernel oils had reasonably low free fatty acid contents and peroxide values than palm oil from the two markets.

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