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INVESTIGATING STORAGE DURATION AND PACKAGING MATERIALS ON QUALITY OF FRESH PALM OIL

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ABSTRACT

Red palm oil is a natural substance typically sourced from the fruit of the African oil palm tree (Elaeis guineensis). Quality deterioration of fresh palm oil was investigated at room temperature using two different containers namely opaque blue and transparent white containers covered with black polythene bag for storage duration of 12 weeks. The analyses carried out included free fatty acid, saponification value, carotene content, smoke, flash and melting points, viscosity, specific gravity, pH value and moisture content. The study revealed that there was an increase in the moisture content, free fatty acid value, Ph value, carotene content, melting point, flash point, smoke and saponification value of each sample of palm oil as storage time increases. The specific gravity decreased with increase in the storage duration. The result showed that palm oil should be used within few weeks once it has been processed and longer storage period should be avoided in order to maximize profit as it has been the usual practice of palm oil seller. This study will provide information on the effect of duration of storage, temperature and storage conditions on the quality of palm oil which will help the food processors palm and consumers to know the optimum storage period for their products.

Keywords: Effect, Storage duration, Packaging materials, Quality, Fresh palm oil

INTRODUCTION

Palm oil is a mixture of different fatty acids, saturated, unsaturated and polyunsaturated fatty acids, depending on the presence and number of double bonds or indeed the absence of it. However, it contains by higher proportion more of the saturated fatty acids (Minh, 2006). In terms of oil quality, the free fatty acid value of oil is an important quality parameter. Since fats and oils contain some level of free fatty acid, there will always be an increase in acidity with time during transport and storage (Chong, 2000). The nutritional value of fat depends, in some respects, on the amount of free fatty acid which develops (Edem, 2002). Similarly, because of the seasonal variation in availability and supply, bulk production and storage of the product is variously practiced during the peak season of production. Several tons of palm oil is therefore hoarded for quantum gains. Since in majority of the cases, this oil is improperly distilled, they would be expected to contain some degree of moisture and therefore, susceptible to oxidative and hydrolytic deterioration (Chong, 1991).

Nnadozie *et al.,* 1990 reported that palm oil has been used mainly for edible purposes; such as cooking oil especially along the coastal and forest regions of West Africa for many years. It is incorporated into blended oils, and a large variety of food products use red palm oil. It is used worldwide as cooking oil, in preparation of margarine , and also for non-edible purposes in soap and oleo chemical industries. Murthy *et al.,* 1996 reported that crude palm oil is rich in carotene, a precursor of vitamin A, and in vitamin E (an antioxidant). Red palm oil is one of the most stable vegetable oils; this fact can be attributed to the presence of natural antioxidants and to the balanced ratio of saturated to unsaturated fatty acids. The carotenoids (vitamin A), tocopherols (vitamin E) sterols, phosphatides, triterpenic, and aliphatic alcohols form the minor constituents of palm oil (Sambanthamurthi *et al.,* 2000). Crude palm oil contains tocopherols and tocotrienols in the range of 600-1000 ppm. In fact, no other vegetable oil has as much Vitamin E as compared to palm oil (Chow,1992). Refined palm oil retains about 50% of these products. Tocopherols (30%) and tocotrienols (70%) isomers are antioxidants and provide some natural oxidative protection to the oil (Sundram *et al..*,2002). The combined effects of the properties of the carotenoids, tocopherols, tocotrienols and the 50% unsaturation of the acids confer a higher oxidative stability and anti-carcinogenic activities to palm oil as compared to a lot of other vegetable oils (Mukherjee and Mitra, 2009). The low cholesterol level, together with the anti-thrombotic and anti-carcinogenic properties of some of the carotenoids, tocopherols, and tocotrienols present, add further to the nutritive value of palm oil and palm oil fractions (Theriault *et al.,* 1991). Nevertheless, palm oil, whether crude or refined is still susceptible to quality deteriorations. The quality of palm oil could be affected by improper post-harvest handling, processing and storage technique. The quality of palm oil is generally determined by the percentage of free fatty acid, moisture and dirt content. The produce is traditionally bought on a 5% free fatty acid basis with penalties for exceeding this figure (Juszczak and Forrtuna, 2004). However, in the real world of domestic and commercial food preparation and storage, they are exposed to oxygen, light and heat. Therefore, the objective of this research was to investigate the effect of storage duration and packaging materials on the quality of fresh palm oil.

$$Total\ carotenoids\ \left(\frac{mg}{kg}\right) = \frac{Abs * 454 * 22}{196 * L * W} \quad ....1$$

MATERIALS AND METHODS

Sample Preparation

The fresh palm oil was purchased from a food processor in Akure, Nigeria. The sample was divided into two after the initial analysis has been carried out. The palm fruit oil samples were stored at room temperature for a period of three months (twelve weeks). One of the samples was kept in a transparent white container and the other in an opaque blue container covered with black polythene bag.

Determination of nutritional qualities of palm oil

Determination of total carotenoids:

Palm oil sample of 2.5g was weighed into a conical flask, 30ml hexane, 20ml ethanol, 2 ml of 2% NaCl were added to the sample, and the solution was mixed and transferred into a separating funnel for about ten minutes to allow extraction of carotenoid. Total carotenoid was determined spectrometrically at 436 mm using the below relationship according to AOAC,1995 and Choo *et al*., 1993.

Where L = cell length (1cm); W = weight of sample and Abs = absorbed value

Determination of the free fatty acid value

The free fatty acid value was determined by using the following equation as recommended by AOAC (1995). 25ml of ethanol and diethyl ether was mixed with 1g or 2 grams of sample. The mixture is heated lightly after which 1 or 2 drops of phenolphthalein was added to act as an indicator. The mixture is then titrated against 0.1mol of potassium hydroxide and this gives a faint pink colour which must persist for about 30 seconds before taking the readings. The volume of the potassium hydroxide must be checked before and after titration to give the initial and final value. The equation for the free fatty acid value determination through this test is given below:

$$FFA = \frac{Acid\ value}{2} \ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$Acid\ value = \frac{Titre\ value * 0.1m\ (KOH) * 56.00}{Weight\ of\ sample} \ldots 3$$

Where 56.00 is a standard value

Determination of physicochemical qualities of palm oil

Determination of pH

pH is the standard measure of how acidic or alkaline a solution is. The pH of the palm oil was determined using a digital pH meter as recommended by AOAC (1995).

Moisture content:

The moisture content (MC) was determined by using the following equation as recommended by AOAC (1995).

$$MC\% = \frac{weight\ of\ wet\ sample - weight\ of\ dried\ sample}{mass\ of\ wet\ sample} \ldots 4$$

Determination of flash, smoke and melting point:

The smoke point is the temperature at which the oil is decomposed and where possibly toxicological relevant compounds are found. Considerably, above the smoke point is the flash point, the point at which the vapours from the oil can first ignite when mixed with air (Markley and Che-man, 1940).

Determination of saponification value:

The saponification value was determined by using the following equation as recommended by Shikha (2011).

$$Moles = \frac{mass\ of\ oil}{Relative\ atomic\ mass} \ldots\ldots 5$$

Determination of flow qualities of palm oil

Determination of viscosity of the palm oil

Viscosity was determined using a digital viscometer with spindle one at four different rotational speeds. The four different rotational speeds used were 6, 12, 30 and 60 rpm.

Determination of the specific gravity of the palm oil:

Specific gravity was determined using the specific gravity bottle and it was obtained using the below equation according to AOAC (1995).

$$Specific\ gravity = \frac{wieght\ of\ sample}{weight\ of\ water} \ldots\ldots 6$$

Statistical analysis: Excel window 2010 version was used to analyze the data generated from this study.

RESULTS AND DISCUSSIONS

Effect of storage duration and packaging materials on total carotenoids of palm oil

Figure 1 shows that the concentration of total carotenoids decreased significantly with time because high temperature accelerates reactions. This reaction occurred more slowly at room temperature which was why the rate of decrease was slow. The carotene content values obtained were far above the recommended carotene content values recommended by SON and NIS (500-2000mg\kg) which shows a good quality palm

oil. Also, the decrease in the carotene content value throughout the storage duration does not have significant effect on the oil quality or cause any reduction on its value.

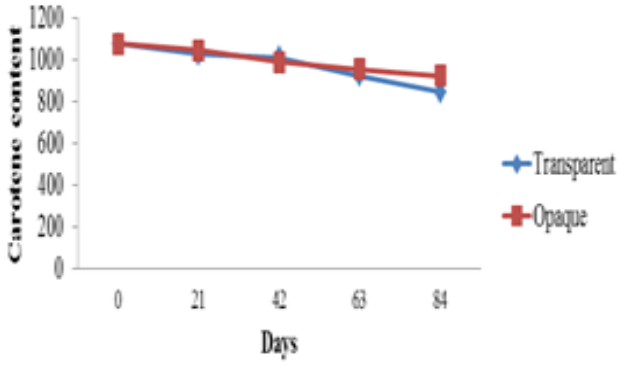

Figure 1: Effect of storage duration and packaging materials on the carotene content of fresh palm oil.

Effect of storage duration and packaging materials on the free fatty acid value of palm oil

Figure 2 revealed that the free fatty acid value of palm oil increased with time irrespective of the storage container except that the increment was more rapid in the transparent container compared to the opaque container. In both samples, the free fatty acid at day 21 was less than the maximum recommended value of free fatty acid of palm oil which is 5.00 with good quality which means that at day 21, the palm oil was still able to preserve its quality.

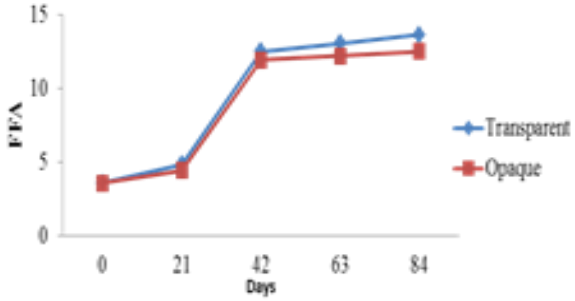

Figure 2: Storage duration and packaging materials on the Free Fatty Acid of fresh palm oil

Effect of storage duration and packaging materials on the pH of the fresh palm oil

Figure 3 showed the effect of storage duration and the conditions of storage on the pH value of the fresh palm oil. The initial pH value of the fresh palm oil on day 0 was 5.20 which shows that it is slightly acidic, it was observed that the pH increased with time in both samples and this is because of the deterioration of the fresh palm oil since most bacteria grow best around pH values of 6.50-7.00 even though some thrive in acidic conditions. It was also reported that there is a significant decrease in acids in liquid foods with storage time (Bawa *et al.*, 1987). At day 21, the pH decreased from the initial value which was 5.20 to 4.60 in the transparent container and from 5.20 to 4.90 in the opaque container, but there was a rapid increment from 4.60 to 5.40 in the transparent container and from 4.90 to 5.50 in the opaque container at day 42. After 63 days, the pH value increased from 5.40 to 6.40 in the transparent container and from 5.50 to 6.40 as well in the opaque container while after the third months, moved from 6.40 to 7.60 in the transparent container and from 6.40 to 7.00 in the container.

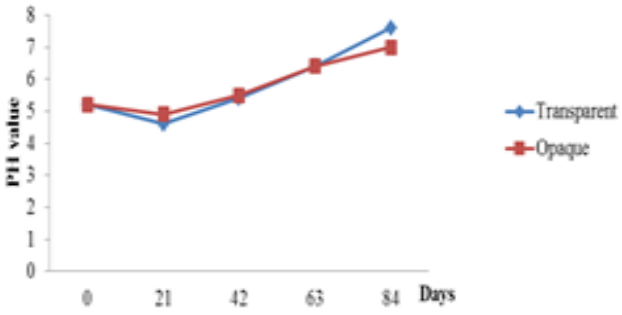

Figure 3: Effect of storage duration and packaging materials on the pH of the fresh palm oil.

Storage duration and storage conditions on the moisture content of the fresh palm oil

Figure 4 showed the effect of storage duration and storage conditions of the fresh palm oil on the moisture content. It was observed that the moisture content increased significantly with time in both samples with initial moisture content been 0.16 for the transparent container and the moisture content at the third month been 1.96 in this same container. For the opaque container, the initial moisture content on day 0 was also 0.16 but increases from here to 3.54 in the third month age. This shows that the moisture content increased more rapidly in the opaque container.

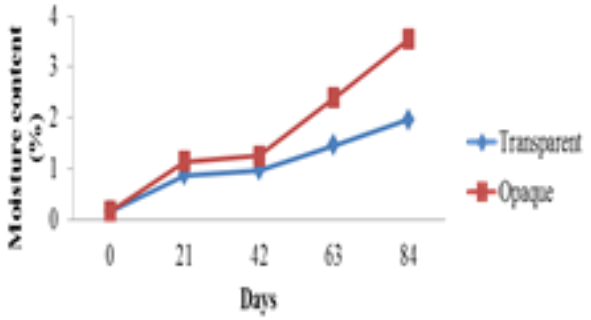

Figure 4: Storage duration and storage conditions on the moisture content of the fresh palm oil.

Effect of storage duration and storage conditions on the flash, smoke and melting point of fresh palm oil

Figures 5, 6 and 7 showed the effect of storage duration and the conditions of storage on the flash, smoke and melting points of the palm oil during storage. For the transparent container, the flash point increased from 80^{o}C which is the value for the flash point at day 0 to 105^{o}C at the third month of storage, the smoke point also increased from 140^{o}C at day 0 to 147^{o}C at the third month of storage while the melting point as well increased from 50^{o}C as the initial value to 61^{o}c at the third month. For the opaque container, the flash point increased from 80^{o}C which is the value for the flash point at day 0 to 89^{o}C at the third month of storage, the smoke point increased from 140^{o}C at day 0 to 141^{o}C at the third month of storage while the melting remains the same 50 ^{o}C in the first 6 weeks but later increased to 53^{o}C at the third month.

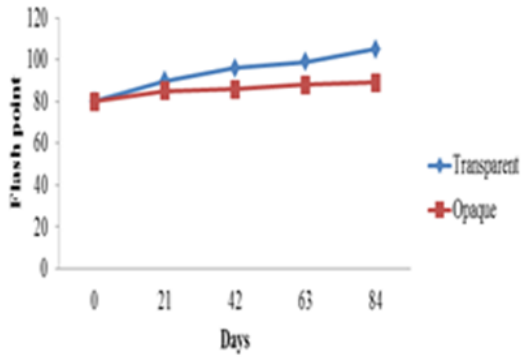

Figure 5: Effect of storage duration on the flash point of fresh palm oil during storage

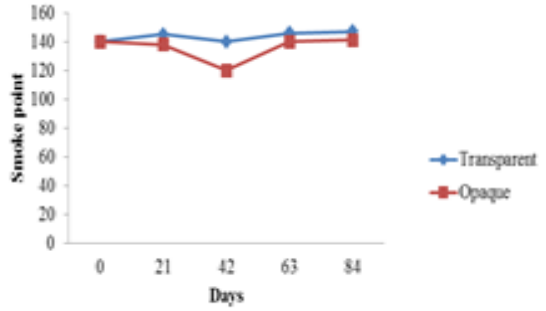

Figure 6: Effect of storage duration on the smoke point of fresh palm oil during storage

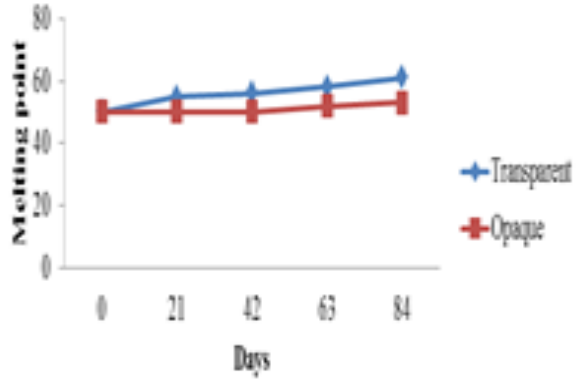

Figure 7: Effect of storage duration and packaging materials on melting point of fresh palm oil

Effect of storage duration and the storage conditions on the saponification value of palm oil

Figure 8 showed that the saponification value of the palm oil increased with time in both samples and this indicates that the quantity of potassium hydroxide needed to turn the palm oil into soap increases with time of storage. The research carried out by other researchers on the quality assessment of palm oil sold in major markets in Abia state is in compliance with this result (Udensi and Iroegbu, 2007).

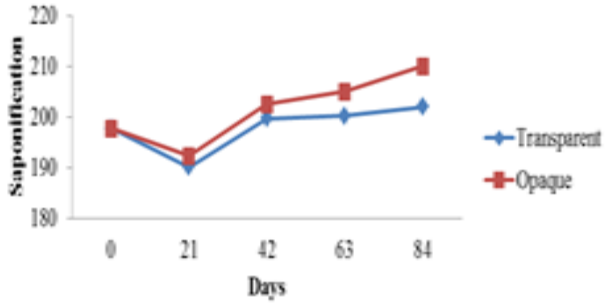

Figure 8: Storage duration and packaging materials on the saponification value of palm oil.

Effect of storage duration and packaging materials on the viscosity of palm oil

Figure 9 showed that the viscosity reduced in both samples with increase in storage time. The research carried out by (Udensi and Iroegbu, 2007) on the quality assessment of palm oil sold in major markets in Abia state is in agreement with this result.

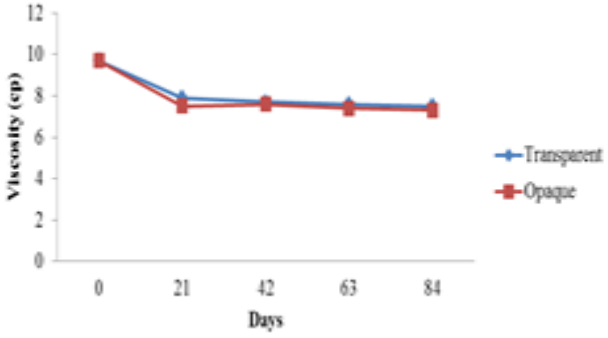

Figure 9: Effect of storage duration and packaging materials on the viscosity of fresh palm oil.

Effect of storage duration and packaging materials on specific gravity.

Figure 10 showed the effect of storage duration and packaging materials on the specific gravity of palm oil. It was observed that the specific gravity decreased with time in both samples. At the 0 day, the specific gravity was 1.09, in the transparent container, at 21 days, it decreased to 0.91 and 0.90 in the opaque container, at the 42 days and 63 days, it remained constant at 0.91 in the opaque container while it was 0.92 and 0.96 at day 42 and day 63 in the transparent container. At day 84 in the transparent container, it increased to 0.97 and 0.92 in the opaque container.

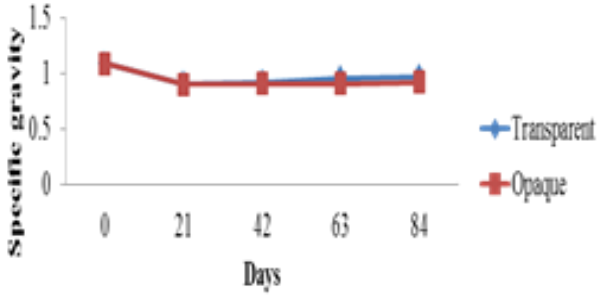

Figure 10: Effect of storage duration and packaging materials on the specific gravity of fresh palm oil.

Conclusion

Storage duration has effect on quality of palm oil therefore oil should not be stored for too long before usage in order to prevent deterioration of quality of the palm oil as a result of longer period of storage.

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