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Oxidative stability of palm oil (*elias guineesis*) at different storage conditions

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Abstract

The influence of presence/absence of air and presence and absence of light on the oxidation of palm oil (*Elias Guineesis*) from 3 to 15 days at the laboratory storage conditions: (i) oil kept in airtight container in the presence of (ii) Oil kept in airtight container in the absence of light (iii) Oil kept in open container in the presence of light (iv) Oil kept in open container on the bench in the absence of light in the laboratory for two weeks duration were studied. The analyses were on the changes in chemical characteristics such as acid, iodine, peroxide and saponification values using the Association of Official Analytical Chemists (AOAC) methods. The results from the four storage conditions of palm oil showed no significant changes ($p < 0.5$) in the chemical parameters except for iodine values for the storage period. The changes in the levels of iodine values of palm oil at both daylight (40.98 mgKOH/g) and presence of air (38.64 mgKOH/g) were very significant ($p < 0.5$). Saponification value (324.34 mgKOH/g) was the highest changing parameter in palm oil on exposure to daylight and 312.50 mgKOH/g on exposure to air/oxygen storage conditions. The oxidative stability of palm oil as functions of chemical parameters were generally dependent on the mode of storage.

Keywords: Air; Daylight; Darkness; Palm oil; Parameters

Introduction

Palm oil (*Elias Guineesis*) is a tropical plant with two species of *E. Guineensis and E. Oleifera.* The matured bunch can have 2000 riped fruits with the weight of about 30-40 kilograms as reported by Kalyana *et al* (2002). The plm tree are commonly grown in West and Central Africa, Indonesia and Malaysia. Malaysia is the largest producer and exporter of 85% of the world's production of palm oils (Kyriakidis & Katsiloulis, 2000; Yusuf et al., 2014; Siew, et al., 2002) . The palm oil is rich in β-carotene with oleic and palmitic acids as the major fatty acids present (Henry, 2011). The oil offensive and pungent odour, destruction of amino acids, vitamins, carotenes, fatty acids and chlorophylls are associated with the oxidative deterioration. The formation of new harmful compounds to humans such as free fatty acids, monoglycerols, diacyl-glycerols and other oxidative substances are promoted by oxidation (Clark and Serbia, 1991; Tarmizi and Lin, 2008).

However, due to seasonal variation in the availability of the fruits, different storage methods are employed and these storage conditions and duration have lead to loss of consumption benefits. Inappropriate storage practices makes the oil susceptible to hydrolytic and oxidative deterioration (Ifeoma, et al; 2011).

Inappropriate storage conditions of palm oil leads to deterioration which consequently affect the oil quality and sales and these led to the current work. To enhance better nutrition among human population, considerable research on the mode and storage conditions are to be investigated, unfortunately these information are not sufficiently reported in the literature.

Therefore, the present work aimed to investigate the oxidative stability of: (i) oil kept in airtight container in the presence of (ii) Oil kept in airtight container in the absence of light (iii) Oil kept in open container in the presence of light (iv) Oil kept in open container on the bench in the absence of light in the laboratory for two weeks duration.

Materials and method

Chemicals and reagents:

Chemicals and reagents were supplied by LGC (Teddington Middlesex, UK) and Sigma Aldrich (Gillingham Dorset, UK)

Sample storage conditions and chemical analyses

Palm oil samples were obtained from Oja Oba market in Ilorin, Kwara State, Nigeria. The oil samples were put in plastic containers. The 500 mL plastic containers with oils were placed at different storage conditions and locations in the laboratory: (i) oil kept in airtight container in the presence of (ii) Oil kept in airtight container in the absence of light (iii) Oil kept in open container in the presence of light (iv) Oil kept in open container on the bench in the absence of light in the laboratory for two weeks duration. 20 mL of oil was taken every three days from each container for two weeks and subjected to the physicochemical analyses such as iodine value (IV), saponification value (SV), peroxide value (PV) and acid value (AV). The percent free fatty acids (% FFA) were calculated from the experimental acid values (% FFA = 0.503 x acid value). These analyses were conducted using Pearson, Wiji's method and Association of Official Analytical Chemists Methods of Analysis (AOAC, 2012).

Statistical analyses:

The IBM SPSS Statistics 23 was used for data evaluation, with one-way Analysis of Variance (ANOVA). The significant values of $p<0.05$ were used.

Results and discussion

Table 1 shows the results of the analyses of palm oil (*Elias Guineesis*) at four different storage conditions in the laboratory using the Association of Official Analytical Chemists (AOAC, 2012) method. The physicochemical parameters: peroxide values (PV), acid values (AV), saponification values (SV), iodine values (IV), and free fatty acids (FFA) showed variations with the corresponding changes on the quality of oil as a result of differing storage conditions.

The problems of consumption of palm oils with respect to storage and food safety have been identified by previous studies (Tagoe, et al. 2012; Ohimain, et al. 2013)

The acid values may sometimes be overestimated due to presence of amino acids and acid phosphates components that are usually produced as a result of poor storage and inadequate processing. In Figure 1, there were no observed significant differences ($p<0.05$) within the acid values for both daylight and absence of light (darkness), as well as between the presence and absence of air for 15 days storage period. The mean acid values ranged between 31.28 – 35.82 (mgKOH/g), but the acid values were higher than 14.04mgKOH/g reported by Akubugwo and Ugbogu (2017). The large differences in values may be due to refining, moisture and deodorization processes (Ifeoma, et al. 2011)

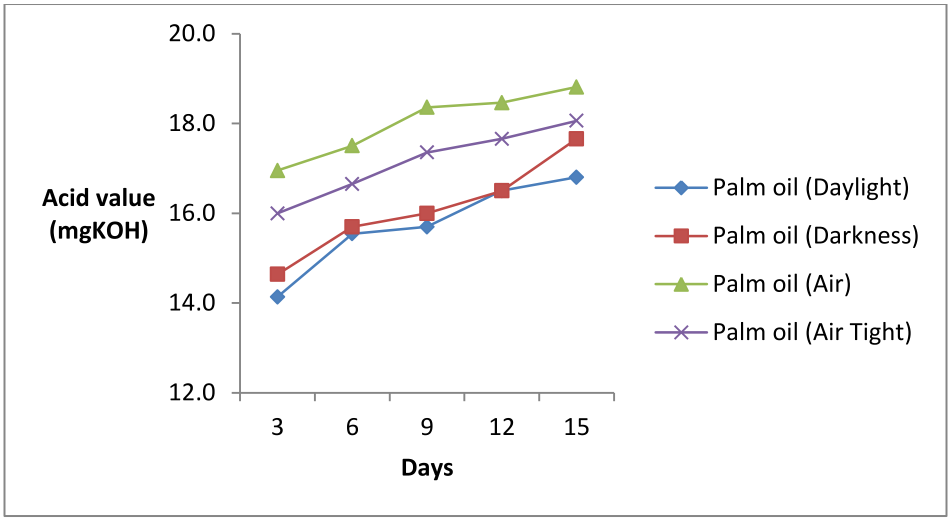

Figure 1: Acid values of oils at different storage conditions

The oxidation levels are measured by the acid value which gives the indication of palm oil deterioration (Okechalu *et. al.* 2011) as illustrated in Figure 2. The peroxide value in the vegetable oils is a measure of unsaturation of fatty acids and the susceptibility to spoilage. In this work, there were significant differences ($p<0.05$) in both peroxide 18.32 meg/kg for day and 15.86 meg/kg darkness; and iodine values 40.98 mg/iodine /100g for day and 30.14 mg/iodine /100g for darkness in the palm oil. The peroxide and iodine values indicates oxidative rancidity and the results compares well with studies of Bangash, et al., 2004 and Izah and Ohimain, 2013.

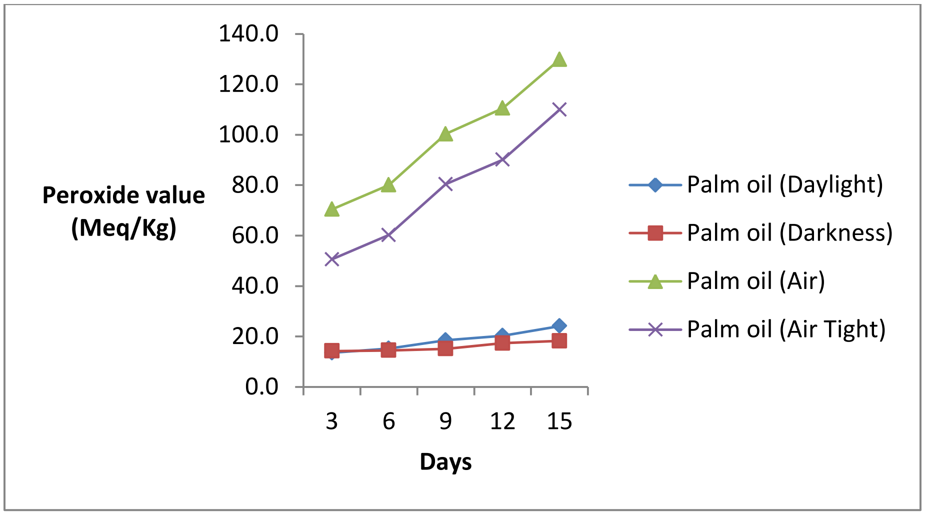

Figure 2: Peroxide values of oils at different storage conditions

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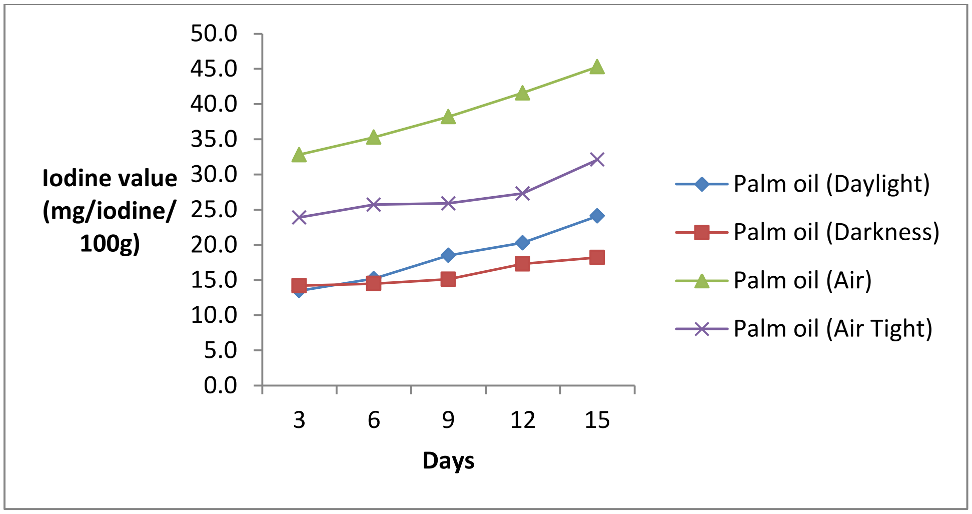

Figure 3: Iodine values of oils at different storage conditions

values for storages in daylight (40.98 mg/iodine/100g) and darkness (116.6 mg/iodine/100g); air-access (38.64 mg/iodine/100g) and air-tight (26.98 mg/iodine/100g), compares well with the results of Okechalu *et. al.* (2011) and Knothe (2000) with iodine value of 37-54 mg/iodine/100g for palm oil and 85-100 mg/iodine/100g for peanut oil. Iodine value is a measure of lipid oxidation (Ifeoma, 2011).

The saponification values and average molecular weigh of fatty acids in oil is inversely related, implying the trend in saponification with the shorter carbon chain of fatty acids (Abayeh *et. al.* 1998; Kirk & Sawyer, 1991). Figure 4 shows the storages dereases in trend in daylight with the mean saponification values of 324.34 mgKOH/g and darkness (207.66 mgKOH/g); air-access (312. 50 mgKOH/g) and air-tight (277.72 mgKOH/g).

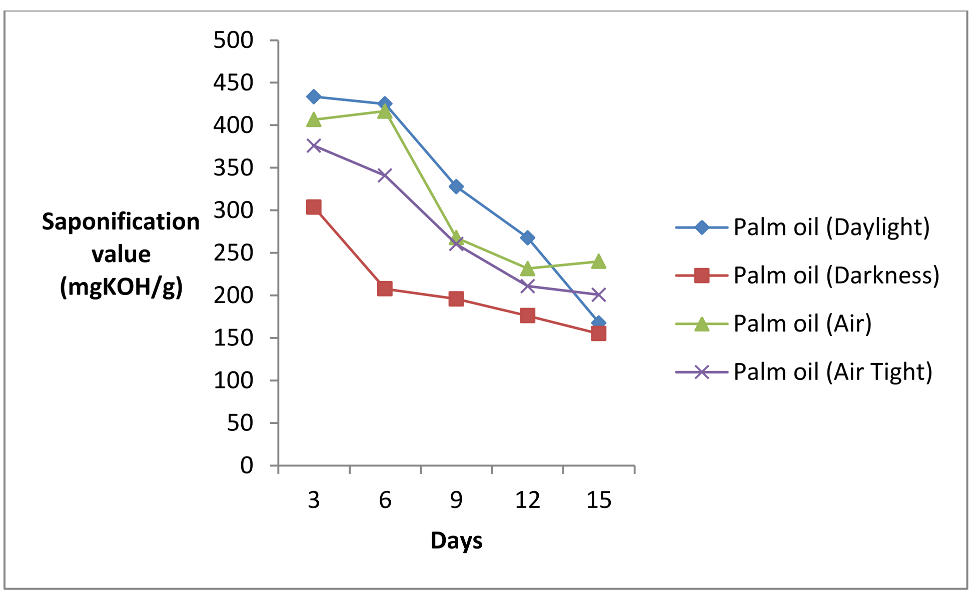

Figure 4: Saponification values of oils at different storage conditions

Kirk and Sawyer (1991) and Kyari (2008) similarly reported the saponification value 200 (mgKOH/g sample) for palm oil which were seeminly higher than our curent findings.

Conclusions

There were significant variations in the physicochemical properties of oil with storage conditions and time. Saponification was the highest changing property exhibited in the palm oil exposed to daylight (324.34 mgKOH/g) and air/oxygen (312.50 mgKOH/g). Little changes were found in the palm oil stored in the dark (absence of light), in tightly sealed containers. Therefore, to maintain the quality characteristics of edible palm oil the best storage conditions should be air tight containers at 25^{o}C where oxidative deterioration is maginal or have little change.

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