PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (4) 741-746 April 2023

Effect of Storage Time at Ambient Temperature on pH and Iodine Value of Palm Oil and Groundnut Oil

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ABSTRACT: The study was carried out to investigate the effect of storage time at ambient temperature on pH and iodine value of palm oil and groundnut oil using appropriate standard methods. The iodine value of palm oil decreased from 45.69 ± 0.01^{a} to 45.11 ± 0.00^{k} while that for groundnut oil decreased from 56.72 ± 0.01^{a} to 56.22 ± 0.01^{k} during the period of storage indicating loss of unsaturation due to oxidation. On the other hand, the pH of both palm and groundnut oils showed a more impressive decrease from 6.85 ± 0.05^{a} to 4.19 ± 0.00^{j} and 6.40 ± 0.00^{a} to 4.40 ± 0.00^{h}., respectively, due to autoxidation of the oils. A trend of decreasing order of iodine and pH value as the number of days of storage increases for both oils (palm and groundnut oil) was observed. This study shows that the storage time has a high significant effect on the iodine Value and pH value of both oil (palm and groundnut oil) with $p < 0.00$ as against $p \leq 0.05$. It was also observed that there was loss of unsaturation in both oils but higher in palm oil. However, groundnut oil had a higher iodine value, implying that groundnut oil had more of unsaturated fatty acid than palm oil which tends towards saturation due to high level of decreasing iodine value. However, from literature, it has been stated that groundnut oil is likely to be healthier for consumption due to the presence of unsaturated fat it contains.

DOI: https://dx.doi.org/10.4314/jasem.v27i4.14

Cite this paper as: OMOZUWA, O. P; AGHEDO, O. N; IDEMUDIA, O. S. (2023). Effect of Storage Time at Ambient Temperature on pH and Iodine Value of Palm Oil and Groundnut Oil. *J. Appl. Sci. Environ. Manage.* 27 (4) 741-746

Dates: Received: 17 February 2023; Revised: 08 April 2023; Accepted: 16 April 2023
Published: 30 April 2023

Keyword: Saturation, Unsaturation, oxidation, Storage time, Iodine value.

Palm oil is liquid which separates into two phases (liquid and solid portions) when allowed to rest. It is extracted from the mesocarp of the freshly orange-red fruit of the oil palm (*Elaeis guineensis*). It is a lipid which is only soluble in fat solvents and not soluble in water (Corley and Tinker, 2003; Edem, 2002). Pure palm oil is orange-red in colour, depending on the amount of carotenoids present. Palm oil is naturally reddish in colour because it contains a high amount of beta-carotene. It also contains Alphacarotene and lycopene which are the same nutrients that gives tomatoes, carrots and other fruits and vegetables their rich colours. Palm oil contains at least 10 other carotenes, along with tocopherols, tocotrienols, phytosterols and glycolipids (Bonnie Tay Yen ping *et al*., 2000). Scientist characterized red palm oil as mono-unsaturated (Andreusevilla *et al*., 2009) and it gives attractive colour to French fries (Choo YM et al., 1993). Palm oil is produced in Malaysia, Indonesia, Colombia, Kenya, Ghana and Nigeria. The presence of palm oil in diet helps in maintaining smooth healthy and youthful skin (Enig *et al*., 1983). Groundnut oil (Arachis hypogeae) is an organic oil derived from peanuts, noted to have the slight aroma and taste of its parent legume, it is grown in the US, turkey and most often used in South Asian and Southwest Asian cuisine much as olive oil is used in the Mediterranean (Oyinlola *et al*., 2004). Its major component fatty acids

are Palmitic acid, oleic acid and linoleic acid. Others include Arachidic acid, arachidonic acid, behenic acid, Lignoceric acid. Groundnut oil obtain from groundnut consists of more than thirteen vitamins including vitamin A, B, C and E. It is rich in essential minerals such as calcium, iron, zinc and boron (Asibuo *et al*., 2008). The relative linoleic acid in groundnut oil is a major factor affecting variation in stability of the oil (Kabagambo *et al*., 2005). Groundnut oil in diet help matured women in reducing pains associated with menstrual bleeding (Russel, 1980). Our major focus is on the two important parameters of the oils that can be affected by the storage time which are the pH and iodine values. lodine value is a measure of the level of unsaturation of fats and oils. It is expressed as the number of grams of iodine absorbed by 100 grams of oil or fat under the test conditions (Rossell, 1987). The higher the iodine value, the higher the degree of unsaturation of the oils or fats. Therefore, Iodine value is a quantitative measure of the degree of unsaturated fatty acid in a lipid (oil). This present studies focus is on the relationship between pH and iodine values of stored oils (palm and groundnut oils), to assess the degree and type of relationship between the chemical parameters of oil quality, It is therefore important to aimed at studying the effects of storage time on the pH and iodine values.

MATERIALS AND METHODS

Sample collection: The palm oil was collected from a local palm oil processing unit at Isihor quarter, Benin City, Nigeria. The groundnut oil was gotten from a collection of fresh groundnut oil from Ring Road market in Hausa quarters, here in Benin City, Nigeria. All reagents were all analytical grade from Research laboratory (NIFOR).

Determination of pH Value: The pH of the oil samples (palm and groundnut oils) were analyzed by measuring their pH value with a well calibrated pH meter using tablet buffers of pH 4.0 and 7.0 and 9.2, respectively, to standardize the pH meter before use.

Determination of Iodine Value: The iodine value of an oil or fat is defined as the weight of iodine absorbed by 100 g of the oil or fat. The glycerides of the unsaturated fatty acids (particularly of the oleic acid series) unite with a definite amount of halogen and the iodine value is therefore a measure of the degree of unsaturation. It is consistent for a particular oil or fat, however, the exact figure obtained depends on the particular technique employed (Akintola et al., 2010). Wij's method was used for the determination of iodine value, as outlined in British Standard 684: section 2.13 1976. The palm oil and groundnut oil samples were analyzed at 3 day intervals for a period of 30 days for each sample, starting from day zero. 0.4g of both palm and groundnut oil was weighed into a 500ml iodine flask. 15ml of carbon tetrachloride was added to each sample in the flask to facilitate dissolution of the oil sample by warming the flask slightly. 25ml of Wij's solution was added and shaken gently. The stopper was inserted and shaken gently and the bottle placed in the dark for one hour. 20ml of potassium iodide solution and 150ml of distilled water were added and swirled gently.

The solution was titrated with sodium thiosulphate solution until the yellow colour due to iodine almost disappeared.

1 to 2ml of starch indicator was added to the solution and titration continued until the blue dark colour disappeared and the solution became colourless after very vigorous shaking and swirling.

A blank test was also carried out simultaneously with the test samples under the same condition. This procedure was repeated at 3 day intervals for a period of 30days and titration reading was recorded.

$$Iodine\ Number = \frac{12.69N(V_2 - V_1)}{W}$$

Where N = is the exact normality of the sodium thiosulphate solution used: V_2 = is the volume, in mililitres, of the sodium thiosulphate solution used for the blank test; V_1 = is the volume, in mililitres, of the sodium thiosulphate solution used for the determination: W = is the weight in grams of the test portion of the oil sample.

Statistical analysis: Results are expressed as mean values ± standard error of duplicate analysis of all parameters. Analysis of variance (ANOVA) and least significant differences were calculated using Statistical Analysis Software (IBM SPSS Statistics 22). Duncan's Multiple Range Test (DMRT) was performed for pair-wise comparison of treatment effects at 5% significance level and Regression was used to analyze the relation between the two variables (pH and Iodine value).

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RESULTS AND DISCUSSION

Tables 1 and 2 shows results of the iodine and pH values for both oil (palm and groundnut oils) stored for 30 days and analyzed at three day intervals. It was observed that there was a gradual decrease in the iodine value for both oils and there was a drastic change in the pH values of the samples considering the difference in range. The iodine value for palm oil changed from 45.69 ± 0.01^{a} to 45.11 ± 0.00^{k} and the pH from 6.85 ± 0.05^{a} to 4.19 ± 0.00^{j}. The iodine value of groundnut oil changed from 56.72 ± 0.01^{a} to 56.22

± 0.01[k] and pH changed from 6.40 ± 0.00[a] to 4.40 ± 0.00[h].

Table 3.1: Iodine and pH values for palm oil stored at room temperature for 30 days

Days of storage	iodine value (g/100g)	pH
0	45.69±0.01[a]	6.85±0.05[a]
3	45.63±0.01[b]	6.50±0.00[b]
6	45.59±0.01[c]	6.20±0.00[c]
9	45.54±0.01[d]	5.85±0.05[d]
12	45.46±0.01[e]	5.80±0.00[d]
15	45.41±0.01[f]	5.48±0.03[e]
18	45.35±0.01[g]	5.20±0.00[f]
21	45.25±0.02[h]	4.70±0.01[g]
24	45.18±0.01[i]	4.40±0.00[h]
27	45.14±0.01[j]	4.30±0.00[i]
30	45.11±0.00[k]	4.19±0.01[j]

Table 2: Iodine and pH values for Groundnut oil stored at room temperature for 30 days

Days of storage	Iodine value (g/100g)	pH
0	56.72±0.01[a]	6.40±0.00[a]
3	56.68±0.01[b]	6.15±0.05[b]
6	56.62±0.01[c]	5.95±0.05[c]
9	56.59±0.00[d]	5.85±0.05[c]
12	56.53±0.01[e]	5.70±0.00[d]
15	56.48±0.00[f]	5.48±0.03[e]
18	56.45±0.00[g]	5.05±0.05[f]
21	56.39±0.01[h]	5.00±0.00[f]
24	56.32±0.01[i]	4.85±0.05[g]
27	56.28±0.01[j]	4.35±0.05[h]
30	56.22±0.01[k]	4.40±0.00[h]

Figure 1A, 1B, 1C, 1D shows a trend of decreasing order of iodine and pH value as the number of days of storage increases for both oils (palm and groundnut oil). However, there is a significant difference between the iodine values of the palm oil in respect to increase in storage time (0 – 30 days), but for the pH value, it was observed that day 9 and day 12 had similar significant effect on the pH of the palm oil while other days had different significant effect (table 1).

The result obtain in table 2 for groundnut oil shows that on comparing each of the days (0 – 30 days), the storage time had different significant effect on the iodine value of the groundnut oil, but for the pH, day 6 and 9, day18 and 21, and day 27 and 30 had same significant effect on the pH of the groundnut oil respectively, while the remaining other days had different significant effect on the pH of the groundnut oil using ANOVA test and Duncan test.

Comparing the iodine value and pH value of both oil in relation to storage time, this study shows that the storage time has a high significant effect on the iodine Value and pH value of both oil (palm and groundnut oil) with $p < 0.00$ as against $p \leq 0.05$.

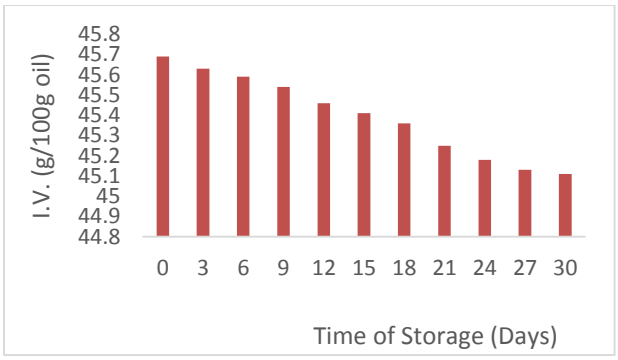

Fig 1A: Changes in the IV of palm oil stored for 30 days

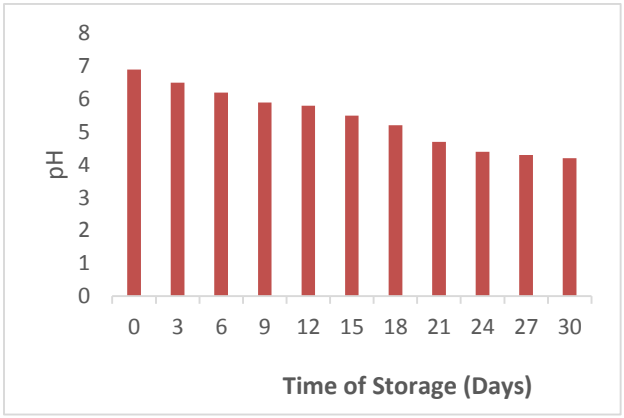

Fig 1B: Changes in the pH of palm oil stored for 30 days

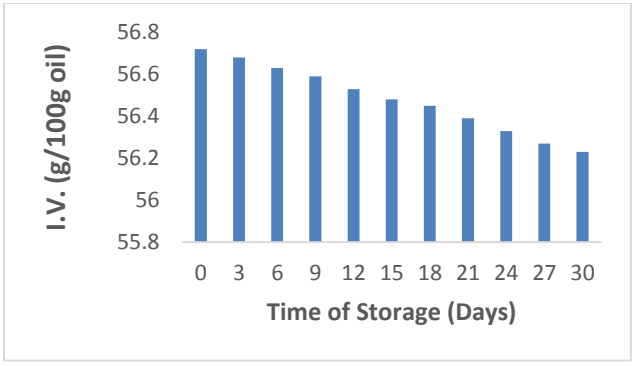

Fig 1C: Changes in the IV of groundnut oil stored for 30 days

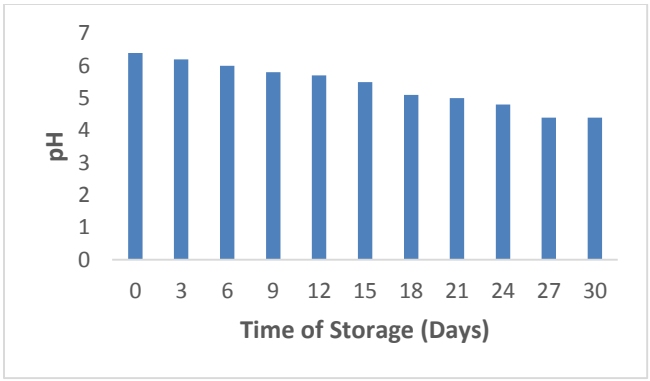

Fig 1D: Changes in the pH of groundnut oil stored for 30 days

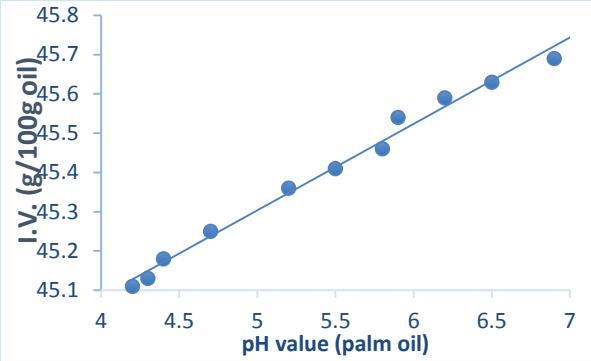

Fig 2A: Relationship between iodine value and pH value in palm oil using linear regression graph with regression equation
The regression line of Y on X is given by $Y=b_0 + b_1X$, where b_0 and b_1 are obtained by solving the normal equations.

Table 3. ANOVA

	F	Sig.
pH of palm oil	1632.098	.000
pH of groudnut oil	341.160	.000
Iodine value of palm oil	1414.785	.000
Iodine value of groundut oil	704.176	.000

From the regression coefficient table, we find out that b_0 =44.203 and b_1 =0.22 and Y = 44.203 +0.22X

Due to longer storage periods, the component of unsaturated fatty acids that have double bonds will be reduced; consequently, the unsaturation is reduced (Kasmin *et al.*, 2015). The oxidation of oil can lead to the unbonding of unsaturated fatty acids, which in turn can cause a reduction in the oil's unsaturation level as indicated by its iodine value (Ulfah *et al.*, 2016). This study shows that there was loss of unsaturation in both oils but higher in palm oil, which occurred gradually from day 0 to day 30. However, groundnut oil had a higher iodine value, implying that groundnut oil had more of unsaturated fatty acid than palm oil which tends towards saturation due to high level of decreasing iodine value.

Although saturated fatty acids are less stable than saturated fatty acid in terms of stability and resistance to oxidation (Chukwu *et al*., 2021), but Studies have recommended to switch from saturated to unsaturated fats because of the risk of cardiovascular disease associated with high consumption of saturated fatty-acids (Negash et al., 2019). Hence the observed higher iodine value in the groundnut oils indicated that they are likely to be healthier for consumption. Figure 2A shows a simple linear regression graph of iodine value against pH value for palm oil. The graph shows us that there was a linear relationship between these two parameters, because the iodine value was decreasing while the pH value was also decreasing.

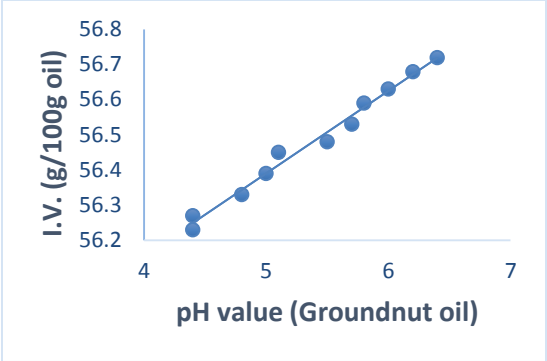

Fig 2B: Relationship between iodine value and pH value in groundnut oil using linear regression graph with regression equation The regression line of Y on X is given by $Y=b_0 + b_1X$, where b_0 and b_1 are obtained by solving the normal equations.
From the regression coefficient table, we find that b_0 =43.816 and b_1 =0.293 and Y = 43.816 +0.293X

Fig. 2B shows a simple linear regression graph of iodine value against pH value of groundnut oil. It was observed that there was a linear relationship between these parameters.
The regression equation for palm oil was

Y= 44.203+0.22x as seen in Fig. 2A, which can be expressed as: IV = 44.203+0.22pH

Where Y = IV and X = pH.

That for groundnut oil was Y = 43.816 + 0.293X as seen in Fig. 2B.

All these expression can be substituted for one another to calculate either for pH or IV when experiments to determine IV or pH are available to predict theoretical pH or IV values respectively.

Conclusion: This study shows that unheated palm and groundnut oils lose their unsaturation gradually during storage due to oxidation and that oils tends to become acidic during storage due to autoxidation. However, Palm and groundnut oils that have been stored for a long period of time should not be used for cooking since undesirable oxidation changes could have occurred.

Acknowledgments: The authors would like to thank The Nigerian Institute for Oil–Palm Research NIFOR for providing support for this research work.

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