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# Improvement of Crude Groundnut Oil Stability Using Chaya Leaf Extract

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**Abstract:** The effectiveness of adding methanol and water extracts of chaya leaf to stabilize crude groundnut oil (CGNO) hydrolytically and oxidatively was investigated for twelve months at room temperature (27-33$^0$C). Extracts of chaya leaf were prepared by separately dissolving dried, ground and sieved chaya leaf into methanol and water in ratio 1:10 for 72 hours. The methanol chaya leaf extract (MCLE) and water chaya leaf extract (WCLE) were separately added at varying concentrations (200ppm to 1000ppm) to CGNO. Another set of CGNO which contained no additive (0ppm (control)) and 200ppmBHT was set-up. The colour, refractive indices, free fatty acid (FFA), acid value (AV) and peroxide value (PV) of CGNO samples were monitored monthly using standard methods for a period of twelve months. The colour and refractive index of CGNO containing MCLE ranged between 30.5-33.5 units and 1.464-1.467 respectively while the colour and refractive index of CGNO containing WCLE ranged between 30.0-30.5 units and 1.465-1.469 accordingly. And the colour and refractive index of CGNO which contained 200ppm BHT and no additive were 30.0 units and 1.463 respectively. There was slight difference in refractive index of CGNO containing plant additives (1.464-1.469) and CGNO which contained no additive (1.463). There was no significant difference at $P<0.05$ in FFA, AV and PV of CGNO containing MCLE and WCLE with CGNO containing no additive. The MCLE and WCLE at all concentrations considered are more effective in stabilizing CGNO against oxidative rancidity than 200ppmBHT. 200ppmBHT is only superior to 200ppm WCLE among the chaya leaf

extracts in stabilizing CGNO against hydrolytic rancidity.

**Keywords**: BHT, Quality Parameters, Crude Groundnut Oil, Stability and Chaya Leaf Extracts.

## 1. Introduction

Chaya is an evergreen leafy vegetable that is available throughout the year. Its English names are Cabbage star, Tree spinach and Tread softly while its French name is Manioc batard. Jatropha aconitifolia mill is its Latin name. Copapayo, Papayeulo and Chaya are its Spanish names. It is taxonomically called *Cnidoscolus acontifolus* [1]. In Nigeria, the plant is called "Efo Iyanapaja or Efo Jerusalem" in Yorubaland [2]. The plant is a large, fast growing leafy perennial shrub, native to the Yucatan of Mexico and Central America [3]. The young leaves and thick terminal stems of the plant constitute a highly nutritious and tasty vegetable when cooked. Its leaves are palimately cut into 3-5 lobes and sparsely covered with hairs that sting [4]. The leaf is a good source of protein, vitamin, calcium and iron. However, raw leaves are toxic as they contain a glucoside that can release hydrocyanic acid hence cooking is essential prior to consumption in order to inactivate the toxic components [3].

Groundnut oil is edible oil produced from groundnut seeds (*Arachis hypogaea Linn*). This vegetable oil is also known as Arachis oil and Peanut oil [5]. The extraction of groundnut oil from its seeds can be through either mechanical means or by the use of solvent [6]. The mechanical method which is most common for groundnut extraction involves three basic steps: groundnut pretreatment, screw pressing (expelling) and oil clarification [7]. The solvent extraction method of obtaining groundnut oil entails nut pretreatment, oil extraction using hexane or petroleum ether and solvent recovery from the oil and meal [7]. However, it is more effective and economical to use mechanical method than solvent extraction in obtaining groundnut oil from its seeds because the seeds contain about 45-50% [8].

The problem of edible oil deterioration has been a great concern to industries producing edible oils as well as consumers due to economic losses and health risk involved respectively. over 90% of vegetable oils production is consumed locally while only less than 10% is used industrially and medicinally in Nigeria [6,9]. For more than five decades, researchers have been looking for ways of preventing or reducing the extent of oil spoilage owing to hydrolytic and oxidative rancidity. The use of synthetic antioxidants has been found effective but they pose additional health risk because of their toxicity, carcinogenicity and mutagenicity ever at very low concentration [10-14]. Consequently, there is provoking interest in searching for better and safer means of combating oil rancidity through the use of

plant extracts [15-19]. The focus of this work is to obtain methanol and water extracts of chaya leaf and to investigate their antioxidant potential on crude groundnut oil by determining some physical and chemical quality characteristics of the oil for twelve months of storage.

## 2. Materials and Methods

### *2.1. Source of Material*

Chaya leaf was obtained from a local farm at Rufus Giwa Polytechnic Premises in Owo, Ondo-State and the crude groundnut oil was obtained from a local producer in Ore, Ondo-State, Nigeria.

### *2.2. Preparation and Extraction of Chaya*

The chaya leaf was cut into smaller pieces for easily drying. The dried leaf was ground using electric blending machine and it was sieved with 40mm mesh size. The powdered samples were packed into a black polyethene bags labeled appropriately prior to extraction. The powdered sample was extracted separately with methanol and water at ratio 1:10 for 72 hours during which it was intermittently shaken on a shaking orbit machine. The mixture was filtered through a 0.45μm Nylon membrane filter. The extracts were evaporated to dryness under reduced pressure at 40ºC by a rotary evaporator [10, 20]

### *2.3. Addition of Additive to Crude Groundnut Oil*

Methanol and Water extracts of chaya leaf at concentrations of 200ppm (0.02g per 100ml oil) to 1000ppm (0.10g per 100ml oil) were separately added to Crude Oil (CGNO) contained in white transparent plastic bottles of equal capacity and they were thoroughly shaken for proper mixing. CGNO containing 200ppmBHT (butylatedhydroxytoluene) (0.02g per 100ml oil) and that which contained no additive (0ppm of control) were also set- up. Each container was appropriately labeled and stored in an open place at room temperature ranging from 27ºC to 33ºC.

### *2.4. Physicochemical Analysis*

The colour, refractive index, Free Fatty Acid (FFA), Acid Value (AV) and Peroxide Value (PV) of each oil sample were monitored monthly using standard methods of analysis [21] for a period of twelve months.

#### *2.4.1. Determination of colour*

Lovibond Tintomer (model 520) was used to determine the colour of the oil. The oil sample was first filtered through a dry filter paper. The ½ inch cell was filled with the filtered oil and placed on the

stand in the cabinet in front of the aperture in the Lovibond Tintometer. The eyepiece was fixed and the cabinet was closed. The bulbs were lighted up and the colour slides were set to match with that of the cell. The colour of the oil was calculated thus: (5Red + Yellow - Blue) units.

*2.4.2. Determination of refractive index*

Abbey refractometer was used to determine the refractive index of the oil. The prism was first cleaned using acetone and the oil sample was spread upon the prism after conditioning it to temperature of $40\pm0.1^0$C. The prism was closed and clamped. The instrument was adjusted so that the light was properly directed and focused o the telescope o the cross hairs. The prism was adjusted so that the borderline between the dark and light field intersected sharply on the crosshair. The reading was taken from the scale in the instrument.

*2.4.3. Determination of free fatty acid and acid value*

Two grams of well mixed sample was accurately weighed into a conical flask; 10ml of neutralized 95% ethanol and 2 drops of 1% phenolphthalein were added. This was then titrated with 0.1M KOH solution, shaking constantly until a pink colour persisted for 30 seconds.

$$\text{FFA (\% Oleic acid)} = \frac{\text{Titre Value} \times \text{Molarity of KOH} \times 28.2}{\text{Weight of oil Sample}}$$

$$\text{Acid Value (mg KOH/g Oil)} = \frac{\text{Titre Value} \times \text{Molarity of KOH} \times 56.11}{\text{Weight of oil Sample}}$$

*2.4.4. Determination of peroxide value*

Two grams of the oil was dissolved in 20ml of glacial acetic acid:chloroform (3: 2 v/v), 0.5ml of saturated KI was added to the solution and heated gently. $I_2$ was liberated as the KI reacted with the peroxide. The solution was then titrated with standardized 0.1M sodium thiosulphate using 0.5ml of 1% starch indicator.

$$\text{Peroxide Value (meq}O_2\text{ /Kg Oil)} = \frac{(\text{B}-\text{S}) \times \text{Molarity of } Na_2S_2O_3 \times 1000}{\text{Weight of oil Sample}}$$

Where B = blank titre value and S = sample titre value

*2.5. Statistical Analysis*

The results were compared by one-way analysis of variance (one-way ANOVA) to test for significant difference $P<0.05$ level. Means of twelve replicates of the group were compared using Duncan Multiple Range Test (DMRT) [22].

## 3. Result and Discussion

### *3.1. Effects of Additives on Colour and Refractive Index of Crude Groundnut Oil*

Table 1 shows changes in colour and refractive index of crude groundnut oil stored with varying concentrations of methanol and water chaya leaf extracts and 200ppm BHT. Colour of edible oils is an important physical quality factor that influences consumer decision of acceptance or otherwise [8]. The lower the colour unit, the more acceptable and attractive the oil becomes. The colour unit is measured as red and yellow slides by using Lovibond Tintometer in ½inch cell. It is observed that the addition of methanol chaya leaf extract (MCLE) did increase the colour units of crude groundnut oil (CGNO) but the addition of water chaya leaf extract (WCLE) and BHT did not cause any appreciable increase in colour unit of CGNO. CGNO containing 200ppm to 1000ppm MCLE had colour of 30.5units-33.5units while it was between 30.0 to 30.5units for CGNO containing 200ppm to 1000ppm WCLE. CGNO containing 200ppm BHT had colour of 30.0units. It can be seen that WCLE and BHT competed favorably well with each other and gave the same colour unit as CGNO which contained no additive (0ppm (control)).

**Table1:** Change in colour and refractive index of crude groundnut oil stored with varying concentration of methanol and water chaya leaf extract and 200ppm BHT over a period of twelve months

| **Concentration of Additive** | **Colour(Units) in $^1/_2$ inch cell** | **Refractive Index at $40^0$C** |
|---|---|---|
| 0ppm(No additive) | 2R+20Y=30.0 | 1.463$^a$ |
| 200ppmMCLE | 2.1R+20Y=30.5$^a$ | 1.464$^b$ |
| 400ppmMCLE | 2.5R+20Y=32.5$^b$ | 1.465$^b$ |
| 600ppmMCLE | 2.5R+20Y=32.5$^b$ | 1.465$^b$ |
| 800ppmMCLE | 2.7R+20Y=33.5$^b$ | 1.465$^b$ |
| 1000ppmMCLE | 2.6R+20Y=33.0$^b$ | 1.467$^c$ |
| 200ppmWCLE | 2R+20Y=30.0$^a$ | 1.469$^d$ |
| 400ppmWCLE | 2R+20Y=30.0$^a$ | 1.469$^d$ |
| 600ppmWCLE | 2R+20Y=30.0$^a$ | 1.465$^b$ |
| 800ppmWCLE | 2.1R+20Y=30.5$^a$ | 1.469$^d$ |
| 1000ppmWCLE | 2.1R+20Y=30.5$^a$ | 1.465$^b$ |
| 200ppm BHT | 2R+20Y=30.0$^a$ | 1.463$^a$ |

NOTE: Within each column, mean values followed by the same superscript are not significantly different at P<0.05 level according to Duncan Multiple Range Test (DMRT); MCLE= Methanol Chaya Leaf Extract; WCLE= Water Chaya Leaf Extract, BHT= Butylated hydroxytoluene ;R = Red Slide; Y = Yellow Slide; *Mean Value ± Standard Deviation

There was no significant difference (P<0.05) in colour of CGNO containing varying concentrations of WCLE. Refractive index of CGNO containing additives was measured at $40^0$C. The water and methanol extract of chaya leaf slightly increased the refractive index of CGNO by 0.001 and 0.006. The oil which contained 200ppmBHT as well as the oil which contained no additive had refractive index of 1.463 while CGNO which contained 200ppm – 1000ppm MCLE had refractive index of between 1.464 and 1.467; and CGNO containing 200ppm – 1000ppm WCLE had refractive index of between 1.465 and 1.469.There was significant difference (P<0.05) in refractive index of CGNO containing varying concentrations of MCLE and WCLE.

*3.2. Effects of Varying Concentrations of Additives on Free Fatty Acid of Crude Groundnut Oil*

Figure 1 shows free fatty acid (FFA) of CGNO stored with MCLE and BHT for twelve months while figure 2 reveals free fatty acid (FFA) of CGNO stored with WCLE and BHT for twelve months. It was observed that CGNO containing MCLE had four months of induction period while CGNO containing WCLE had six months induction period during which there were only very slight increase in the FFA of the oil samples. The effect of varying concentrations of MCLE was more pronounced than the effect of varying concentrations of WCLE as shown in the plot. In the last five months of storage, there was steady and gradual increase in the FFA of the oil samples containing MCLE whereas there was no steady and gradual increase in the FFA of the oil samples containing WCLE. There was no remarkable difference in FFA trend of CGNO containing additives and CGNO which contained no additive.

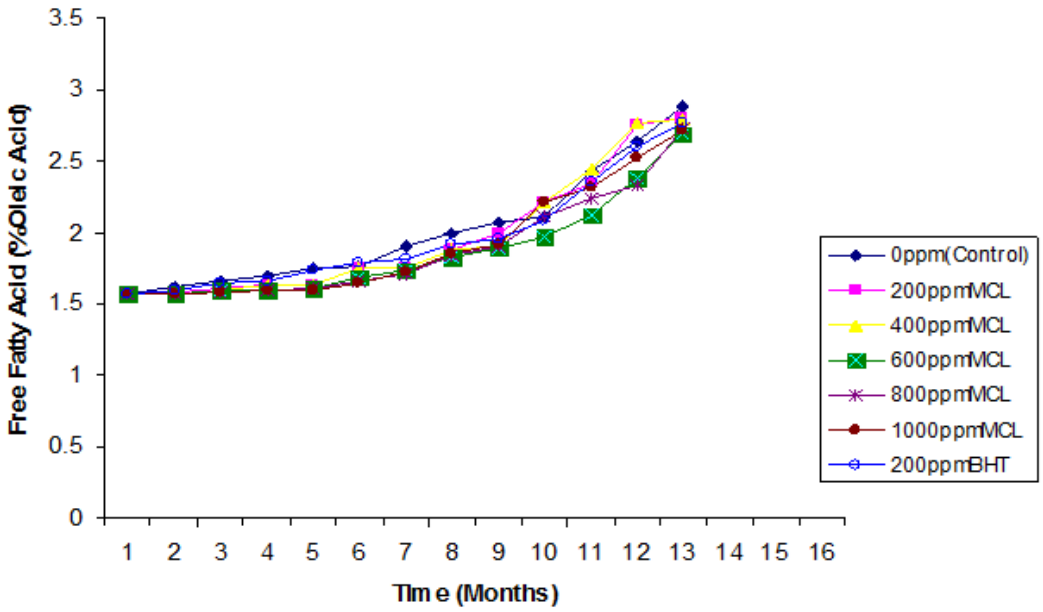


**Figure 1:** Free fatty acid of crude groundnut oil stored with Methanol Chaya Leaf (MCL) extract and BHT for twelve months

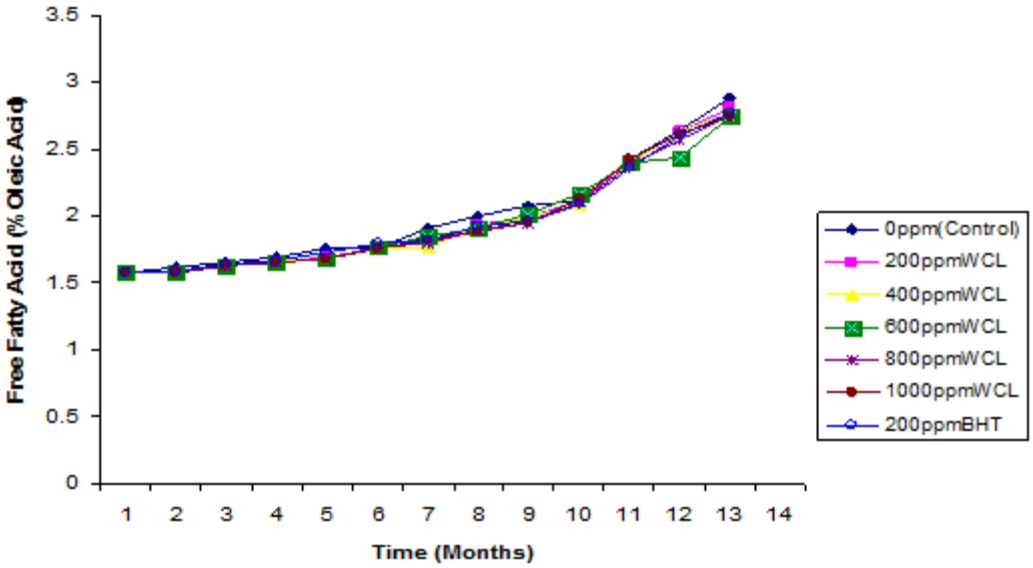


**Figure 2:** Free fatty acid of crude groundnut oil stored with Water Chaya Leaf (WCL) extract and BHT for twelve months

*3.3. Effects of Varying Concentrations of Additives on Acid Value of Crude Groundnut Oil*

Figure 3 depicts acid value (AV) of CGNO stored with MCLE and BHT for twelve months while figure 4 shows acid value (AV) of CGNO stored with WCLE and BHT for twelve months. The trend observed in figures 3 and 4 was similar to that of figures 1 and 2 respectively; the only difference was that the values obtained for acid value were higher than values obtained for free fatty acid in each of the month. This is an indication that both FFA and AV are measure of hydrolytic rancidity of oil [8].

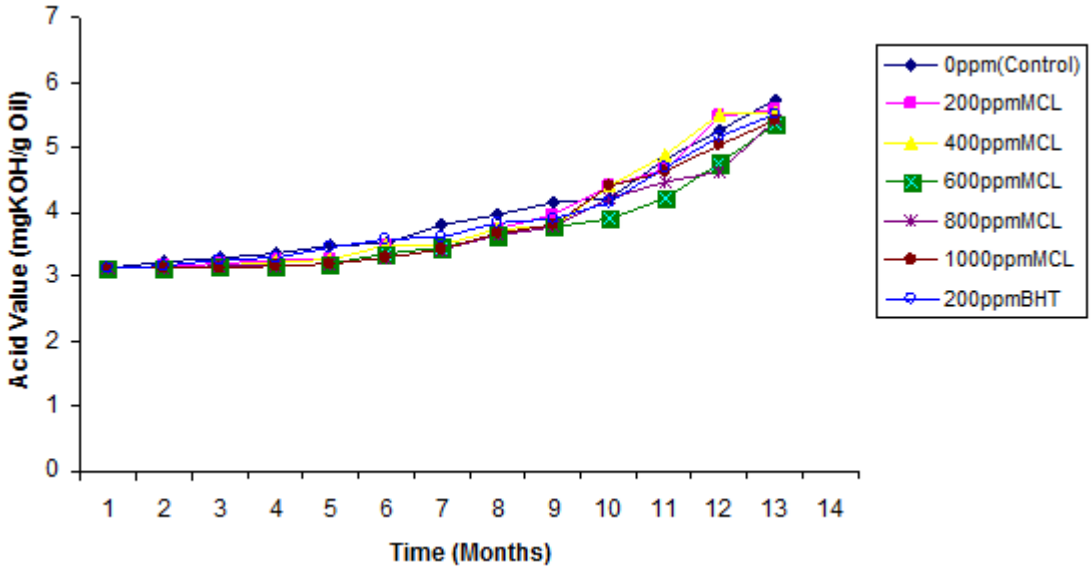


**Figure 3:** Acid value of crude groundnut oil stored with Methanol Chaya Leaf (MCL) extract and BHT for twelve months

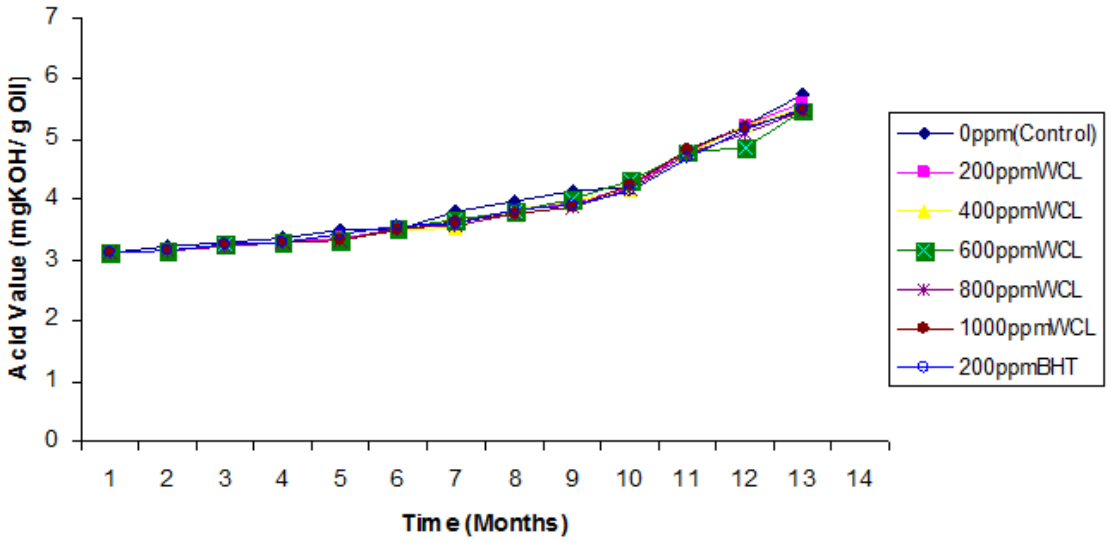


**Figure 4:** Acid value of crude groundnut oil stored with Water Chaya Leaf (WCL) extract and BHT for twelve months

*3.4. Effects of Varying Concentrations of Additives on Peroxide Value of Crude Groundnut Oil*

Figure 5 shows the peroxide value of crude groundnut oil stored with methanol chaya leaf (MCL) extract and BHT for twelve months; and figure 6 depicts peroxide value of crude groundnut oil stored with water chaya leaf (WCL) extract and BHT for twelve months. There was slight increase in the peroxide value of CGNO in the first five months of storage. The trend observed in the plots was in agreement with the observation reported by Amir *et al*.[10] After five months of storage, the effect of varying concentrations of MCLE was more pronounced than the effect of varying concentrations of WCLE as shown in the plot. In the last seven months of storage, there was steady and gradual increase in the PV of the oil samples containing both MCLE and WCLE. All the additives gave lower peroxide value of CGNO at varying degrees than CNGO which contained no addittive. The peroxide value of CGNO decreased gradually as the concentration of MCLE and WCLE increased from 200ppm to 1000ppm.

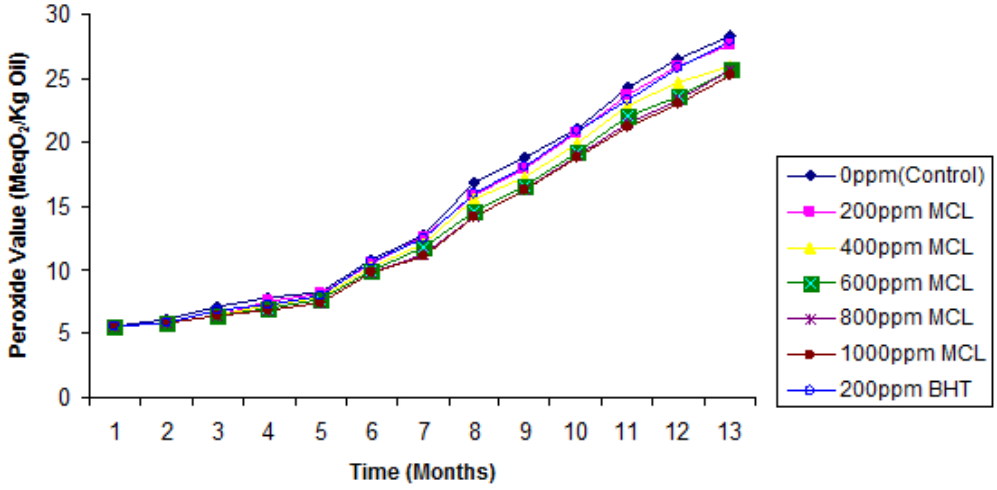


**Figure 5:** Peroxide value of crude groundnut oil stored with Methanol Chaya Leaf (WCL) extract and BHT for twelve months

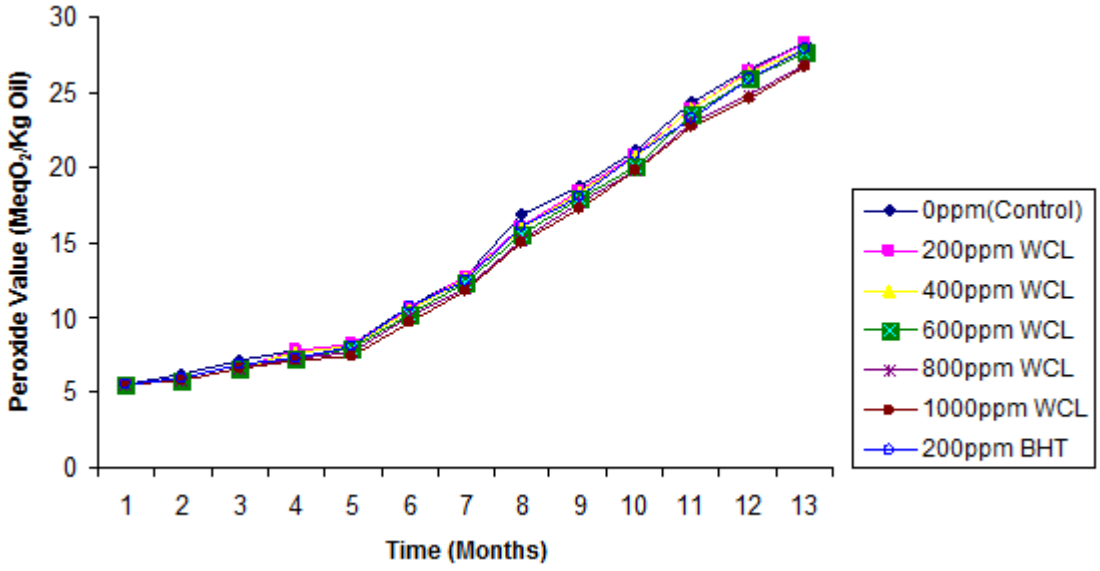


**Figure 6:** Peroxide value of crude groundnut oil stored with Water Chaya Leaf (WCL) extract and BHT for twelve months

Table 2 shows the mean value of FFA, AV and PV of crude groundnut oil stored with varying concentrations of methanol and water chaya leaf extracts and 200ppmBHT for a period of twelve months. The FFA, AV and PV of CGNO containing MCLE, WCLE and 200ppmBHT had lower values than oil sample which contained no additive (0ppm). All the varying concentrations of chaya leaf extracts except 200ppmWCLE gave lower values of FFA and AV in CGNO than 200ppmBHT, although the difference is not so significant ($P<0.05$). The FFA and AV of CGNO containing all varying concentrations (except 400ppm) of MCLE were lower than FFA and AV of CGNO containing WCLE. The PV of CGNO

containing 200ppm-1000ppmWCLE was lower than PV of CGNO containing 200ppm-1000ppmMCLE. This shows that the water extract is more effective in combating oxidative rancidity of crude groundnut oil than methanol extract.

**Table 2:** Mean values of some selected quality properties of crude groundnut oil stored with varying concentrations of methanol and water chaya leaf extract and 200ppm BHT over a period of twelve months

| **Concentration of Additive** | ***Free Fatty Acid (FFA) (% Oleic acid)** | ***Acid Value (AV) (mgKOH/g Oil)** | ***Peroxide Value (PV) ($meqO_2/KgOil$)** |
|---|---|---|---|
| 0ppm(No additive) | $2.007\pm0.413^a$ | $3.995\pm0.822^a$ | $9.913\pm4.183^a$ |
| 200ppmMCLE | $1.962\pm0.435^a$ | $3.904\pm0.864^a$ | $9.232\pm3.465^a$ |
| 400ppmMCLE | $1.961\pm0.445^a$ | $3.902\pm0.886^a$ | $9.044\pm3.376^a$ |
| 600ppmMCLE | $1.864\pm0.350^a$ | $3.709\pm0.697^a$ | $8.836\pm3.206^a$ |
| 800ppmMCLE | $1.880\pm0.367^a$ | $3.740\pm0.730^a$ | $8.672\pm3.123^a$ |
| 1000ppmMCLE | $1.910\pm0.402^a$ | $3.801\pm0.800^a$ | $8.526\pm3.039^a$ |
| 200ppmWCLE | $1.965\pm0.413^a$ | $3.910\pm0.822^a$ | $8.748\pm3.473^a$ |
| 400ppmWCLE | $1.957\pm0.404^a$ | $3.895\pm0.803^a$ | $8.571\pm3.332^a$ |
| 600ppmWCLE | $1.954\pm0.377^a$ | $3.889\pm0.750^a$ | $8.409\pm3.238^a$ |
| 800ppmWCLE | $1.949\pm0.391^a$ | $3.879\pm0.779^a$ | $8.059\pm3.024^a$ |
| 1000ppmWCLE | $1.957\pm0.399^a$ | $3.893\pm0.795^a$ | $7.886\pm2.899^a$ |
| 200ppm BHT | $1.962\pm0.388^a$ | $3.903\pm0.772^a$ | $9.100\pm3.564^a$ |

NOTE: Within each column, mean values followed by the same superscript are not significantly different at $P<0.05$ level according to Duncan Multiple Range Test (DMRT); MCLE= Methanol Chaya Leaf Extract; WCLE= Water Chaya Leaf Extract, BHT= Butylated hydroxytoluene *Mean Value of Quality Properties ± Standard Deviation.

## 4. Conclusion

The addition of water extract to crude groundnut oil did not have remarkable difference in the colour of the oil but methanol extract did. Chaya leaf extract had a better antioxidative performance in crude groundnut oil than 200ppmBHT. Methanol and water extracts of chaya leaf were able to exhibit pronounced antioxidant activity against hydrolytic and oxidative rancidity of crude groundnut oil stored in white transparent plastic bottles. Water extract of chaya leaf was superior to its methanol extract in inhibiting oxidative rancidity of crude groundnut oil. However, the addition of both methanol and water extracts to crude groundnut oil gave appreciable increase in the refractive index of the oil. Further research work can be conducted on other oils using these extracts or other solvent extracts of this

vegetable and other vegetables.

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