

**EFFECT OF *MONDORA MYRISTICA* AND *TETRAPLEURA TETRAPTERA* ON  
OXIDATIVE STABILITY OF COCONUT OIL AND PALM KERNEL OIL**Frank-Oputu Ayibaene\*<sup>1</sup>, Ogidi Odangowei I.<sup>2</sup>, Wodu Ebizimor<sup>1</sup>, Eboh Abraham S.<sup>1</sup> and  
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**ABSTRACT**

Oxidative stability of oils is the resistance to oxidation during processing and storage. Lipid oxidation breaks down fatty acids thus causing loss of nutritional quality and produces undesirable color, flavor and toxic components making the food unacceptable by consumers. It is the major cause of deterioration of the quality of edible oils. Two spices, *Mondora myristica* and *Tetrapleura tetraptera* were investigated for their effect on the oxidative stability of coconut oil and palm kernel oil. Assessment of the stability of the various oil samples was by measurement of their peroxide value, oxidative stability and p-anisidine value. Results obtained from the study revealed that there was a significant ( $P < 0.05$ ) decrease in the oxidative stability of coconut oil and kernel oil with progression in time. Compared to the control and Vitamin E (tocopherol), specimen A (*M. myristica*) and specimen B (*T. tetraptera*) had a greater ability to stabilize coconut oil and Palm kernel oil. Natural antioxidants added to edible oils provide variable protection against light induced auto-oxidation. *M. myristica* and *T. tetraptera* have antioxidant phytochemicals that aid the prevention of lipid autooxidation which suggests their usefulness as spices and oil flavors, hence their use for flavoring of oils and improvement of oil shelf life is recommended.

**KEYWORDS:** *Monodora myristica*, *Tetrapleura tetraptera*, Oxidative stability, Coconut oil, Palm kernel oil.**INTRODUCTION**

Vegetable oils and fats are important part of our diet as they provide energy, fat soluble vitamins and essential fatty acids required for growth and development of the body. Oils and fats, apart from providing nutrition, are known to play functional roles during product preparation contributing to the palatability of processed foods. Coconut (*Cocos nucifera*) oil is one of the widely used cooking oil in many countries and remains important edible oil for the food industry for many years. It contains more than 90% of saturated fatty acids. Coconut oil being highly saturated oil is extremely stable against oxidation, therefore suitable for frying. Lauric acid is the major saturate fatty acid present in coconut oil. The generation of trans-fatty acids is also very minimal during frying operations (Khan *et al.* 2011).

Palm kernel oil is obtained from oil palm (*Elaeis guineensis*). In addition to palm kernel oil, their fractions are also produced globally to be used for edible purposes. Palm kernel oil is derived from the kernel of the fruit of the oil palm. Palm kernel oil contains high amount of lauric acid (45–55%), thus known as lauric oil. Fractionation of palm oil into palm stearin and palm

olein further enhances their applications in foods with different stabilities (Marinova *et al.*, 2012).

Lipid oxidation is one of the major reasons that food deteriorate and is caused by the reaction of fat and oil with molecular oxygen, leading to off-flavors that are generally called rancidity (Basturk *et al.*, 2007). Rancidity is associated with off-flavor and odor of the oil. There are two causes to rancidity. One occurs when oil reacts with oxygen and is called oxidative rancidity. The second cause is by the combination of enzymes and moisture. Enzymes such as lipase liberate fatty acids from triglycerides to form di- or mono-glycerides and free fatty acids which is called hydrolysis, hence hydrolytic or oxidative rancidity. Oils in general are known to be susceptible to oxidation and microbial attack. The composition of the various oils determines the extent of oxidation and type of organisms likely to thrive in them (Chow *et al.*, 2000).

The oxidative stability of vegetable oils is one of the key factors in determining its use in foods and their applicability in industrial situations. Several methods are developed for improving the stability of oils that includes genetic modifications, compositional changes via

chemical means, addition of synthetic antioxidants like T-Butylhydroquinone (TBHQ) and Butylated hydroxytoluene (BHT). The search for natural antioxidants that can replace synthetic antioxidants has always been an interesting research area among food scientists. Oleoresins and volatile oils from spices and herbs have attracted lot of attention in this regards (Tugba and Medeni, 2012).

*Monodora myristica* is specie of calabash nutmeg, the edible seeds yield a nutmeg-flavored oil which is used in West Africa for cooking (Eggeling, 2002). The seeds and seed coats of the plant are used as a spice. Once dried, they have an aroma reminiscent of nutmeg and are sold whole to be grated as a nutmeg substitute (Talalaji, 1999). The whole seed coat and seed is either ground and used as a seasoning for West African soups or stews or is ground and used as a nutmeg-like flavoring in cakes and desserts. *Monodora myristica* seed extract contains important pharmacological compounds like alkaloids, flavonoids, and vitamins A and E as well as many important lipids. Interestingly, *M. myristica* extracts has been reported by researchers to exhibit a potent antioxidant activity and also effectiveness for achieving high sensory scores and lowering lipid oxidation (Akinwunmi and Oyedapo, 2013; George and Osiona, 2011; Okonkwo and Ogu, 2014).

*Tetrapleura tetraptera*, locally known as Apaipai in Izon, Aiden in Yoruba, Ubukirihu in Igbo languages of Nigeria, is a deciduous forest plant which belongs to the *Mimosaceae* family (Abii and Amarachi, 2007; Akin-Idowu *et al.*, 2011). It has a distinctive four winged fruits consisting of woody shell, a fleshy pulp and a small brownish-black seeds with characteristic distinct fragrance. The distinct fragrance is attributed to the essential oils content of the fruit (Akin-Idowu *et al.*, 2011). The dry fruit has a characteristic pleasant aroma which makes it a popular seasoning spice in Southern and Eastern Nigeria (Essien *et al.*, 1994; Adesina, 1982; Okwu, 2003). It is used extensively in soups of nursing mothers to prevent post partum contractions and gastrointestinal disorders especially stomach ulceration (Atawodi *et al.*, 2014; Nwawu and Alah, 1986; Noamesi *et al.*, 1992). The plant is claimed to be therapeutically useful in the management of convulsion, leprosy, inflammation and/or rheumatoid pains (Adewunmi, 2001).

These spices are considered as the major adjunct in contributing flavor to a large group of foods, rich sources of antioxidant phytochemicals. The addition of these spice extracts to a vegetable oil can thereby impart an effect as a natural antioxidant in extending the shelf life as well as a flavoring agent. Hence this research, which aimed at determining the effects of *Monodora myristica* and *Tetrapleura tetraptera* on the oxidative stability of coconut oil and palm kernel oil.

## MATERIALS AND METHODS

### Chemicals and reagents

Sodium thiosulphate, p-anisidine, n-hexane, potassium iodide, potassium dichromate,  $\alpha$ -tocopherol, were purchased from Sigma Co. (St Louis, USA). All the other chemicals used were of analytical grade.

### Extraction of plant

#### Sample collection

Coconut and Palm kernel samples were purchased at Kpansia market, Yenagoa, Bayelsa State, Nigeria.

### Coconut oil and Palm kernel oil extraction

Coconut oil samples were obtained from blended coconut flakes, sieved using cheese cloth, to obtain milky extract and stored in the refrigerator overnight, after which, the oily supernatant was separated and stored at room temperature till the time of the experiment in order to assess the oxidative stability. Classical chemical methods for determining primary and secondary oxidation products (peroxide value and p-anisidine value) were used.

Palm kernel oil samples were obtained from milled kernel nuts after which n-hexane was added to it and left to stand for 72 hours at room temperature. Then the oily supernatant was separated from the chaffs at the room temperature till the time of the experiment in order to assess the oxidative stability.

### Oxidation of oil sample

The resulting coconut and palm kernel oil (100 g) each was added crude extract of *Monodora myristica* and *Tetrapleura tetraptera* 0.01% and mixed in screw-capped glass bottles covered externally with aluminum foil and incubated at 30 °C in the dark for 0-12 days. The oxidative stability of coconut and palm kernel oil was investigated by comparison with the VitE at 0.01% (w/w).

### Determination of oil quality

#### Peroxide Value (PV)

The peroxide value (PV) was determined iodometrically according to standard methods for the oils analysis and the results were expressed in meq/kg oil. Peroxide Values (PV) were calculated for all vegetable oil samples using equation given by AOCS, (2004):

$$PV = \frac{V_s - V_b}{W} \times 100 \quad (1)$$

Where, *PV* is peroxide value of vegetable oil sample measured in milli-equivalent of peroxide per kg of oil sample,  $V_s$  is Volume of sodium thiosulphate solution (ml) used for neutralization,  $V_b$  is Volume of sodium thiosulphate solution used for neutralization for blank test determined as 2.8ml, *W* weight of vegetable oil sample measured (g), *F* is the factor from standardization with Potassium Iodide and *N* is normality of sodium thiosulphate solution (0.01 M).

**p-anisidine value (p-AV)**

The p-anisidine value (p-AV) is a measurement of carbonyl content in the oils or fats, and was determined by the standard method according to American Oil chemists 'Society (AOCS, 2004). It is based on the reactivity of the aldehyde carbonyl bond on the p-anisidine amine group, leading to the formation of a Schiff base that absorbs at 350 nm. 2 g (w) of coconut oil samples were dissolved in 25 mL isooctane and absorbance (A1) of this fat solution was measured at 350 nm against a blank of isooctane. An aliquot (5 mL) of this solution, respectively 5mL of isooctane (as blank) was transferred to each of two test tubes of 10 mL and 1 mL anisidine solution (0.25 % g/v glacial acetic acid) was added to each. After 10 min, the absorbance (A2) was measured at 350 nm against isooctane containing p-anisidine. p-AV was calculated according to the formula below:

$$p - AV = \frac{25 \times 1.2 \times A_2 - A_1}{W} \quad (2)$$

**Oxidative Stability**

Oxidative stability (S) was evaluated from peroxide values as shown in equation (3):

$$S = \frac{PV_i - PV_j}{PV_j} \times 100 \quad (3)$$

**Table 1: Peroxide Value of Coconut Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control (0%)	3.90±0.24 <sup>a</sup>	6.27±0.43 <sup>a</sup>	6.49±0.05 <sup>a</sup>	5.03±0.06 <sup>a</sup>
Vitamin E (0.01%)	3.6±0.59 <sup>a</sup>	6.42±0.03 <sup>b</sup>	6.74±0.12 <sup>b</sup>	6.79±0.03 <sup>b</sup>
SpecimenA(0.01%)	2.70±0.84 <sup>b</sup>	3.07±0.05 <sup>c</sup>	4.62±0.23 <sup>c</sup>	3.45±0.08 <sup>c</sup>
SpecimenB(0.01%)	3.8±0.73 <sup>c</sup>	2.45±0.03 <sup>d</sup>	2.78±0.42 <sup>d</sup>	4.78±0.03 <sup>d</sup>

*Note:* Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

**Table 2: Peroxide Value of Palm Kernel Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control(0%)	4.0±0.24 <sup>a</sup>	4.2±0.06 <sup>a</sup>	4.45±0.05 <sup>a</sup>	4.94±0.04 <sup>a</sup>
Vitamin E(0.01%)	3.6±0.35 <sup>a</sup>	6.98±0.03 <sup>b</sup>	4.82±0.12 <sup>b</sup>	5.90±0.06 <sup>b</sup>
SpecimenA(0.01%)	1.7±0.84 <sup>b</sup>	7.99±0.05 <sup>c</sup>	5.62±0.23 <sup>c</sup>	6.10±0.09 <sup>c</sup>
SpecimenB(0.01%)	5.7±0.73 <sup>c</sup>	8.94±0.03 <sup>d</sup>	9.43±0.42 <sup>d</sup>	7.30±0.05 <sup>d</sup>

*Note:* Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

**Oxidative Stability Value of Coconut and Palm kernel Oils.**

The effect of *Mondora myristica* and *Tetrapleura tetraptera* on the oxidative value of coconut and palm kernel oils are showed in Tables 3 and 4. Results revealed that there was a non-significant difference between the control oil samples and the samples treated with the antioxidant vitamin E. However, the extracts of *Mondora myristica* and *Tetrapleura tetraptera* values were observed to have more stabilizing ability than vitamin E on both coconut and palm kernel oils.

S is the oxidative stability measured in percent, PV<sub>i</sub> is the peroxide value of vegetable oil with antioxidant, PV<sub>j</sub> is the peroxide value of sample without antioxidants.

**Statistical Analysis**

The data were analyzed by SPSS software program (Version 17.0).

**RESULTS****Peroxide Values of Coconut Palm kernel Oils**

The effect of *Mondora myristica* and *Tetrapleura tetraptera* on the peroxide value of coconut and palm kernel oils are presented in Tables 1 and 2. Results revealed that there was a non-significant difference between the control oil samples and the samples treated with the antioxidant vitamin E in both coconut and palm kernel oils. However, on the 12<sup>th</sup> day of experiment, a significant difference between the control samples and Vitamin E was observed which may be due to the antioxidative effects of α-tocopherol in coconut oil. The extracts of *Mondora myristica* and *Tetrapleura tetraptera* were observed to have more stabilizing ability than vitamin E on both oils.

**Table 3: Oxidative Stability Value of Coconut Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control(0%)	6.37±1.42 <sup>a</sup>	7.17±0.34 <sup>a</sup>	9.06±0.02 <sup>a</sup>	9.70±0.03 <sup>a</sup>
Vitamin E(0.01%)	6.08±1.12 <sup>a</sup>	6.77±0.65 <sup>a</sup>	7.09±0.02 <sup>a</sup>	6.29±0.06 <sup>a</sup>
Specimen A(0.01%)	2.65±1.37 <sup>b</sup>	4.90±0.45 <sup>b</sup>	6.56±0.02 <sup>b</sup>	5.76±0.04 <sup>b</sup>
Specimen B(0.01%)	2.13±0.32 <sup>c</sup>	3.41±0.29 <sup>c</sup>	6.00±0.02 <sup>c</sup>	3.47±0.73 <sup>c</sup>

**Note:** Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

**Table 4: Oxidative Stability Value of Palm Kernel Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control(0%)	5.45±1.23 <sup>a</sup>	5.84±0.24 <sup>a</sup>	4.34±0.05 <sup>a</sup>	5.42±0.02 <sup>a</sup>
Vitamin E(0.01%)	5.62±1.54 <sup>a</sup>	5.09±0.64 <sup>a</sup>	5.92±0.23 <sup>b</sup>	4.34±0.63 <sup>a</sup>
Specimen A(0.01%)	3.51±1.67 <sup>b</sup>	3.87±0.35 <sup>b</sup>	3.65±0.66 <sup>c</sup>	2.36±0.34 <sup>c</sup>
Specimen B(0.01%)	3.17±0.09 <sup>c</sup>	2.07±0.09 <sup>d</sup>	2.36±0.76 <sup>d</sup>	1.76±0.03 <sup>b</sup>

**Note:** Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

#### p-anisidine value of Coconut Oil

The effect of *Mondora myristica* and *Tetrapleura tetraptera* on the p-anisidine value of coconut and palm kernel oils were presented in Tables 5 and 6. A non-significant difference between the control oil samples

and the samples treated with the antioxidant vitamin E were observed. The extracts of *Mondora myristica* and *Tetrapleura tetraptera* values were observed to have more stabilizing ability than vitamin E on coconut and palm kernel oils.

**Table 5: p-anisidine value of Coconut Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control(0%)	6.45±1.24 <sup>a</sup>	6.17±2.84 <sup>a</sup>	6.27±2.74 <sup>a</sup>	6.45±2.83 <sup>a</sup>
Vitamin E(0.01%)	5.96±1.80 <sup>a</sup>	4.77±0.54 <sup>a</sup>	5.34±0.64 <sup>a</sup>	5.67±0.34 <sup>b</sup>
Specimen A(0.01%)	4.24 ±1.37 <sup>b</sup>	4.56±0.02 <sup>b</sup>	3.72±0.45 <sup>b</sup>	3.57±0.64 <sup>c</sup>
Specimen B(0.01%)	3.47±0.02 <sup>c</sup>	2.49±0.84 <sup>c</sup>	3.98±0.43 <sup>c</sup>	4.47±0.65 <sup>d</sup>

**Note:** Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

**Table 6L p-anisidine value of Palm Kernel Oil.**

Oil Sample/Time	After 3 days	After 6 days	After 9 days	After 12 days
Control(0%)	5.45±1.38 <sup>a</sup>	6.72±0.32 <sup>a</sup>	5.47±0.32 <sup>a</sup>	5.27±0.55 <sup>a</sup>
Vitamin E(0.01%)	4.96±1.80 <sup>a</sup>	5.72±0.53 <sup>a</sup>	4.62±0.35 <sup>a</sup>	6.80±0.76 <sup>a</sup>
Specimen A(0.01%)	3.21±1.37 <sup>b</sup>	4.75±0.45 <sup>b</sup>	3.17±0.23 <sup>b</sup>	4.34±0.56 <sup>b</sup>
Specimen B(0.01%)	2.72±0.02 <sup>c</sup>	3.27±0.84 <sup>c</sup>	2.37±0.26 <sup>c</sup>	3.12±0.47 <sup>c</sup>

**Note:** Values are presented in mean±SD of triplicate determinations. Values with different superscript are statistically significant at 95% confidence level. Specimen A = *Mondora myristica*, Specimen B = *Tetrapleura tetraptera*.

## DISCUSSION

In this study, the effect of *Mondora myristica* and *Tetrapleura tetraptera* on the oxidative stability of coconut oil and Palm kernel oil was evaluated. Numerous experimental works have established the positive effect of anti-oxidants on the oxidative stability of vegetable oils for both edible uses and industrial uses. Vegetable oils in their natural form possess constituents that function as natural antioxidants. Amongst them are ascorbic acids,  $\alpha$ -tocopherol (Vitamin E), carotene, chlorogenic acids and flavanols (Ullah *et al.*, 2003).

Peroxide value results shows that there was a non-significant ( $P < 0.05$ ) difference in peroxide value between the oil samples treated with Vitamin E and

control whereas a significant difference was observed in the peroxide value of coconut oil samples treated with *Mondora myristica* and *tetrapleura tetraptera*. After twelve (12) days, the peroxide value of the coconut oil after treatment with specimen A (*Mondora myristica*) was observed to have significantly ( $p < 0.05$ ) decreased (from 5.03±0.06 to 3.45±0.08) whereas it was observed to have decreased significantly ( $p < 0.05$ ) from 5.03±0.06 to 4.78±0.03 after treatment with specimen B (*Tetrapleura tetraptera*). On the other hand, After 12 days of experimentation, the peroxide value of Palm Kernel oil was observed to have increased significantly ( $P < 0.05$ ) from 4.94±0.04 to 6.10±0.09 and 4.94±0.04 to 7.30±0.05 after treatment with *Mondora myristica* and *Tetrapleura tetraptera* respectively. The findings of this



study are in accordance with the reports of Azizkhani and Zandi, (2009) and Abdelazim *et al.*, (2013). Measuring fatty acid formation and the measurement of peroxide values as a means of monitoring oxidation, results indicate an inhibitive effect on oxidation (Ullah *et al.*, 2003). For both static and dynamic conditions, improvements in oxidative stability are observed with the application of anti-oxidants, which showed that the relative effectiveness of the different anti-oxidants differed for static and dynamic conditions, although all showed superior performance when compared with  $\alpha$ -tocopherol (Dunn, 2005).

In oxidative stability, the results revealed that there was a significant ( $P<0.05$ ) difference in oxidative values of the coconut oil sample treated with Vitamin E, *Mondora myristica* and *tetrapleura tetraptera* and the control. After twelve (12) days, the oxidative stability of coconut oil after treatment with specimen A (*Mondora myristica*) was observed to have significantly ( $p<0.05$ ) decreased (from  $9.70\pm 0.03$  to  $5.76\pm 0.04$ ) whereas it was observed to have decreased significantly ( $p<0.05$ ) from  $9.70\pm 0.03$  to  $3.47\pm 0.75$  after treatment with specimen B (*Tetrapleura tetraptera*). These results are in agreement with the work done by Azeez *et al.*, (2013). Interestingly, in a study of the effects of tocopherols on the oxidative stability of soybean oil by Jung *et al.*, (1990) concentrations of the tocopherols that were higher than what was determined as optimum resulted in pro-oxidant effects (Jung *et al.*, 1990). In palm kernel oil, after 12 days of experimentation, the oxidative stability value was observed to have decreased significantly ( $P<0.05$ ) from  $5.42\pm 0.02$  to  $2.36\pm 0.34$  and  $5.42\pm 0.02$  to  $1.76\pm 0.03$  after treatment with *Mondora myristica* and *Tetrapleura tetraptera* respectively. These findings are in accord with the reports of Abdelazim *et al.*, (2013).

In p-anisidine value, the results revealed that there was a slight difference in p-anisidine value between the oil samples treated with Vitamin E and control in both oil samples. Whereas a significant ( $P<0.05$ ) difference was observed in coconut and palm kernel oil samples treated with *Mondora myristica* and *tetrapleura tetraptera*. After twelve (12) days, the p-anisidine value of coconut oil after treatment with specimen A (*Mondora myristica*) was observed to have significantly ( $p<0.05$ ) decreased (from  $6.45\pm 2.83$  to  $3.57\pm 0.64$ ) whereas it was observed to have decreased significantly ( $p<0.05$ ) from  $6.45\pm 2.83$  to  $4.47\pm 0.65$  after treatment with specimen B (*Tetrapleura tetraptera*). Also in palm kernel oil, after 12 days of experimentation, the p-anisidine value was observed to have decreased significantly ( $P<0.05$ ) from  $5.42\pm 0.02$  to  $4.34\pm 0.56$  and  $5.42\pm 0.02$  to  $3.12\pm 0.47$  after treatment with *Mondora myristica* and *Tetrapleura tetraptera* respectively. These findings are synonymous with the works of Azeez *et al.*, (2013) and Azizkhani and Zandi, (2009).

## CONCLUSION

Natural oils can undergo oxidation if not properly stored. To give oil longer shelf life and decrease the rate of rancidity (oxidation or spoilage) antioxidants in the form of odorants and flavors are applied. From this study, *Mondora myristica* and *Tetrapleura tetraptera* have antioxidant phytochemicals that aid the prevention of lipid autoxidation which reveals their usefulness as spices and oil flavors. Thus, their use for flavoring of oils and improvement of oil shelf lives is recommended.

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