

## QUALITY CHARACTERIZATION AND THERMAL ANALYSIS OF COLD PRESS MORINGA OLEIFERA KERNEL OIL

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### ABSTRACT

Vegetable oils are prone to rancidity, their characteristics are rarely stable especially when subjected to thermal degradation which can alter the oil natural quality. Investigation on thermal analysis of essential oil can aid better understanding on decomposition rates in the oil properties before and after heating, findings which is important towards prolonging the oil shelf life. Thus far, the present study examines the changes in physicochemical properties and oxidative stability qualities of *Moringa oleifera* kernel oil (MOKO) extracted with cold press method and subjected to thermal heating at varying thermal cycle. The result showed physicochemical and oxidative stability properties values such as color, viscosity, peroxide value, free fatty acid, total polar compound and para-anisidine, all increased significantly ( $p < 0.05$ ) with increase in the thermal cycle. The decomposition rates for free fatty acid (FFA), peroxide value, P-anisidine, total polar compound, TOTOX value and the conjugate triene and diene were 38%, 76%, 65%, 20%, 75%, 30% and 45%, respectively. Clearly, decomposition was observed for most of the vital properties, although, the decomposition value obtained were still within allowable EU standards for edible vegetable oil.

**Keywords:** Cold pressing, *Moringa Oleifera* oil, thermal degradation, rancidity, and shelf life.

### INTRODUCTION

Importance of vegetable oils in daily culinary activities and dietary implication cannot be over emphasized because of their impact on food. Vegetable oils consist of triglycerides, soluble vitamins (A, D, E and K), phytosterols, natural pigments and phospholipids. In most trending, vegetable oil have replaced the use of animal fats because of the cholesterol content and low density lipoprotein. It has strong oxidative stability when compared with oil rich in polyunsaturated fatty acid during frying at high temperature and longer storage.

*Moringa oleifera* is a non-oily seed with the kernel containing approximately 30-40% oil content. The oil color is brilliant yellow with pleasant aroma and a high monounsaturated /saturated fatty acids (MUFA/SFA) ratio, sterols and tocopherols, as well as proteins rich in sulfated amino acids. 70% of the MUFA content is oleic acid, this are a promising resource for food and non-food applications in diverse industry.

Frying can cause lipids oxidation to occur, through process of initiation, propagation and termination that lead to changes in oil color, degradation of essential nutrients and micronutrients, functional properties,

changes to by-products and causing potential toxic oxidation products that are harmful to human health. Due to deterioration in oil quality at frying, European Union standard stipulates that maximum value ranging from 24 – 27% by weight of total polar compound makes oil unfit for domestic consumption. In view of the analogy, the present study examines the effects of thermal process on cold press *Moringa Oleifera* kernel oil (MOKO) and subsequently evaluates degradation rate on the physicochemical and oxidative stability properties at varying thermal cycle with constant temperature and time.

### MATERIAL AND METHODS

#### Procedure for Cold Press Extraction

*Moringa Oleifera* kernel oil was extracted using an electrically operated cold pressing machine (model SH-48-100, Malaysia), which contains 100kg load and operated at 1500psi, with a stainless steel mold thickness 31 mm and head circumference 147mm was used to extract oil at 45°C till oil recovery. The oil obtained was filtered, the amount of oil extracted was measured gravimetrically, centrifuge at 3500rpm for 30minutes, kept inside an amber bottle and flush with Nitrogen gas before storage at 4°C till further analysis.

**Procedure for Thermal Analysis**

Procedure of was adopted with some modification. In mimicking the conventional times used in frying during domestic cooking, thermal cycle was varied at 1, 3 and 5 for 10 minutes. The oil was heated from room temperature to 180°C, and kept constant for 10 minutes before allowing to cool back to room temperature. This procedure was repeated all through the thermal cycles. 50mL of MOKO were poured inside a stainless steel hollow pan with dimension 2 x 90mm x 80 mm for thickness, circumference and diameter respectively. Hand held automatic thermometer was used to determine the acquired temperature. After each thermal cycle process is completed, the samples were stored in an amber bottle and refrigerated at 4°C till further analysis. The raw MOKO sample were used as controls.

**Reagents and Chemicals**

All reagents and chemical used were of analytical grade. 2,2,4-Trimethylpentane, acetic acid, ethanol, sodium hydroxide, potassium iodide, chloroform, sodium thiosulphate, starch indicator and diethyl ether were used respectively for all the analysis were all purchased from Sigma Aldrich co. ( St Louis MO) and Standard of official methods were used to determining analytical values.

**Determination of Polar Compounds.**

AOCS (1996) standard was adopted and the equipment used was a Biotech Microplate reader ELX-800, (COM,USA). Oil samples were placed inside a series of 90 cell standard disposable cuvette and heated at 60°C for 15 minutes inside an oven. The microplate was first zero against air, followed by detecting the absorbance of water before testing for both control and the degraded MOKO oil at 490nm.

**Color determination:** A Minolta spectrophotometer – colorimeter CM3500 d (Konica Minolta Business Technologies Incorporation Japan) was used to

determine the color, The colorimeter was zero calibrated, followed by water calibration using the marked cuvette, then samples were poured into the cuvette to the marked level and the measured target was clicked to determine the level of (L\* =lightness, a\*=red –green, b=yellow-blue, c\*=white and h\*=hue).

**Viscosity determination:** A Vibro SV-10 viscometer (A&D company limited Japan) was used, foremost, calibration of purified water was done, purified water was poured into a 35 – 40mL marked cuvette and the lever was raised to release the sensor unit into the cuvette, the start button was hold down till a stable theoretical viscosity that will be multiply by the density of water was displayed at a particular temperature, the same procedure goes for all the samples.

**Statistical analysis**

Analysis of variance (ANOVA) for data analysis and Duncan's new multiple range test was used to determine the differences among means at 0.05 significance levels.

**RESULTS AND DISCUSSION.**

**Physical properties**

Color and viscosity of frying oils are physical indicators of oil deterioration caused by oxidation and polymerization. Table 1 shows changes in oil color and viscosity values under different thermal cycle at 180 °C. Increase in color intensity may be due to the accumulation of non-volatile decomposition products such as oxidized triacylglycerol and free fatty acid, whilst increase in viscosity may be due to organization of high molecular weight polymer that can leads to higher degree of deterioration . The oil samples became lighter (L\*) with frying cycle but there was slight increase in greenness (-a\*) at the first degradation temperature, and sharp decrease in yellowness (b\*) was observed from 37.66 to 15.31 for all the thermal cycle.

**Table 1. Analysis on color and viscosity – thermal cycle**

Color parameter	Frying temperature 180°C			
	Control sample	Cycle 1	Cycle 3	Cycle 5
L*	94.52±0.3 <sup>b</sup>	95.28±0.6 <sup>b</sup>	97.16±0.1 <sup>a</sup>	97.16±0.3 <sup>a</sup>
a*	-4.63±0.1 <sup>a</sup>	-5.18±0.1 <sup>a</sup>	-3.97±0.4 <sup>b</sup>	3.15±0.4 <sup>c</sup>
b*	53.78±0.2 <sup>a</sup>	37.66±0.3 <sup>b</sup>	19.91±0.4 <sup>c</sup>	15.31±0.3 <sup>d</sup>
Viscosity (25°C)	66.90±0.02 <sup>d</sup>	70.71±0.01 <sup>c</sup>	74.32±0.10 <sup>b</sup>	76.32±0.11 <sup>a</sup>

Mean value in the same row followed by the same superscript letters are not significantly different (p? 0.05) value are means ±SD of triplicate determination. L=lightness, a=redness and b=yellowness.

The viscosity was observed to rise with increase in thermal cycle number. An approximate increments of 5%, 11% and 13% occurred for thermal cycle 1, 3 and 5 respectively. Similar outcome was reported in works of and , which implies polymerization of the oil sample.

### Oxidative stability

Table 2 showed the oxidative stability parameters of *MOKO* before and after thermal degradation. An increment of 20% and 30% was noted in the FFA oil values during thermal cycle 3 and 5, frying analysis, respectively. Although, the FFA decomposition rate are

within acceptable range for edible vegetable oil , the research of ,explained that moisture attack the esters of the heated oil to form FFA, glycerol, mono and diacylglycerol, but the amount of FFA produce by hydrolysis in thermal oxidation has less effect on the oxidation of unsaturated fatty acid . PV decomposition analysis showed 67% and 77% for heating cycles 3 and 5 respectively. These decomposition values surpass the EU acceptable standard for vegetable oil with maximum value of 10Meq/kg oil. This implies that the PV is sensitive to thermal degradation compared to other properties, . (Casal et al., 2010).

**Table 2: Decomposition of oxidation parameter under varying heating cycle**

Oxidation parameters	Frying temperature 180°C				Annexes II and IV EU standard
	Control sample	Cycle 1	Cycle 3	Cycle 5	
FFA (%)	2.80±0.02	2.77±0.05	3.50±0.01	4.55±0.01	.
PV(Meq/kg oil)	3.60±0.06	5.63±0.05	11.52±0.07	15.46±0.03	? .
P-AV	2.06±0.05	2.51±0.02	3.57±0.01	5.96±0.01	? .
TPC (%)	3.03±0.04	3.21±0.05	3.56±0.03	3.78±0.01	Max.27
TOTOX Values	9.26±0.06	13.77±0.04	26.61±0.03	36.88±0.02	Max.26
K <sub>232</sub>	1.73±0.01	1.78±0.01	1.84±0.02	2.45±0.01	2.50
K <sub>270</sub>	0.13±0.02	0.14±0.07	0.20±0.04	0.24±0.01	0.25

Mean values are means ±SD of triplicate determination. FFA-free fatty acid, PV-peroxide value, P-AV-para-anisidine value, TPC- total polar compound, K<sub>232</sub> and K<sub>270</sub>- conjugated diene and triene.

The decomposition rate in P-anisidine values were 18%, 58% and 65% for heating cycle 1, 3 and 5, respectively, yet, the values were within the acceptable range for edible vegetable oils. During heating of vegetable oil, the less stable primary oxidation compounds decomposes to form carbonyl and aldehyde which causes secondary oxidation products of lipids. Analysis of the total polar compound (TPC) showed decomposition rates of 5%, 15% and 20% for heating cycles 1, 3 and 5, respectively. The heating and thermal cycle has less effect on the TPC overall quality content within the oil after thermal degradation. Thermal oxidation, polymerization and hydrolysis effects do not alter the TPC negatively. arrived at similar conclusion in their study with maximum range of 21 – 23% TPC content after frying. TPC content in oil above 27% after heating makes the vegetable oil unfit for consumption, . Stability of thermally degraded oil against oxidative

change, reveals that more polymeric compounds are found with unsaturated than saturated fatty acid. Thus decomposition of TOTOX value at heating cycle 1 is within acceptable limit, but at higher thermal cycle complete decomposition is observed. There was no significant impact of thermal cycles on conjugated diene and triene, however as the thermal cycle increased the rate of decomposition increased. It is known that changes in conjugated diene and triene reveals large amount of dienes that deals with available polyunsaturated fatty acid, while the triene goes for the primary and secondary oxidation of the already formed carbonyl compounds, .

### CONCLUSION

Quantification of the physicochemical properties during thermal degradation showed steady decompositions of the *MOKO* natural qualities. There

were obvious alterations in the physical and oxidative properties with respect to the number of thermal cycle. Decomposition in the vital compounds increased with increase in the number of thermal cycles. Physicochemical and oxidative stability showed average decomposition rate of 27%. The TPC was the least affected by the degradation. However, the level of decomposition of the vital compounds, the MOKO properties are within acceptable EU standards of 25-27%. Thus far, there are needs to further increase the thermal degradation temperature and cycle of the MOKO to detect rancidity.

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