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# The Trend of Oil Produced from the Application of Mechano-Thermal Concepts of Extraction: The Characteristics of the Physiochemical Properties

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***Abstract***

*The agricultural production process generates a significant amount of waste in the form of by-products and unused resources. Chemical engineers have a significant position on the globe, resulting in the production of a wide range of products for pharmaceutical, chemical, food and other industrial as well as domestic utilization. Ineffective management of agricultural waste can cause serious harm to the environment and cause a waste of resources. As chemical production improves and the chemical industry's structure is adjusted, there is a decrease in waste deposed into the environment and a decrease in the traditional use of agricultural by-products. For the fact that the research has revealed the new trend of technology for converting waste into wealth. This creates pressure to develop and utilize agricultural waste more effectively. In this case, the production of oil from mango seeds was investigated to ascertain the physicochemical properties of the extracted oil using mechano-thermal process. The characteristics of the physicochemical parameters examines were refractive index of Enugu Species: with value of 1.3728; Opioro Species with value of 1.34827 and Benue Species with value of 1.34431, density Enugu with value of 1.1072, Opioro with value of 1.34827 and Benue with value of 1.34431 g/cc. Viscosity Enugu with value of 0.1995 cst, Opioro with value of 2.282 cst and Benue with value of 2.149 cst. Iodine value of Enugu with value of 13.70, Opioro with value of 13.201 and Benue with value of 16.62. Saponification value of Enugu with value of 18.513, Opioro with value of 17.111 and Benue with value of 8.35 %. Free fatty acid of Enugu with value of 32.26, Opioro with value of 25.86 % and Benue with value of 18.69 %. Peroxide value of Enugu with value of 80.01, Opioro with value of 85.0, and Benue with value of 40.0 % and acid value of Enugu with value of 1.46%, Oporo with value of 1.35% and Benue with value of 0.982%.*

**Keywords:** Trend, oil, application, mechano-thermal, extraction, characteristics, physiochemical

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## INTRODUCTION

The classic procedures for obtaining seed oils from plants are water distillation, steam distillation, and solvent extraction. While these methods may seem cost-effective, they may have detrimental impacts, such as hydrolysis and deterioration caused by heat. Steam distillation extraction combined with solvent separation is discouraged owing to the presence of residues in the essential oils and the loss of seed oil during the evaporation process [1–5]. To address this drawback, the supercritical fluids approach has been devised and suggested [6]. The techniques used to acquire essential oils include pressurized liquid extraction, pressurized hot water

extraction, membrane-supported solvent applications, solid-phase microextraction, and ultrasound applications. Recently, the use of microwave-assisted extractions has shown to be very effective due to its ability to rapidly heat aqueous samples [7].

Solvent extraction using the soxhlet apparatus is community used in the extraction of seed oil [8]. In this research a newly discovered method called MECHANO THERMAL extraction process will be used. In this process solvent, steam and any of the old existing extraction methods will not be used for extraction, but normal mechanical and low heat extraction/distillation process shall be used to obtain a pure and natural seed oil [8–9].

This new method is more efficient, convenient and produces an optimum yield. Physiochemical and GC analysis shall be carried out to ascertain the present of the vital element in the oil which will serve as raw materials for chemical pharmaceutical and food utilization industries [10–14].

## MATERIALS AND METHODS

### Determination of Acid Value and Free Fatty Acid

The acid value indicates how much lipase, or other processes have broken down the oil's glycerides. This breakdown process accelerates when the oil is exposed to heat and light. You can use the acid value as a general indicator of the state and edibility of oils since rancidity is typically accompanied by the production of free fatty acids. The procedure involves dissolving a specified amount of fat in a mixture of ethanol and diethyl ether, then titrating the free fatty acids in the solution using an ethanolic potassium hydroxide solution. Acidity is commonly used to represent the proportion of fat that is free of fatty acids.

### Procedure

We measured 10 grams of agro-seed oil into a 250-millilitre conical flask, added 25 milliliters of diethyl ester, 25 milliliters of 98% alcohol, and 1 milliliter of 1% phenolphthalein indicator to the oil. Then we analyzed the acid value and free fatty acid content of the oil. Thorough filtering of the mixture was carried out using 0.1M NaOH mixture until there was a color change to pink and it was stable for 15 seconds, which is the end point.

### Materials and Method for HPLC/MS GAS Chromatography

#### *Sample Preparation*

Petroleum ether was used in the Soxhlet extraction of the sample. For every Soxhlet extraction, which was carried out at 80°C for 8 hours, around 5 g of dried material and 80 ml of petroleum ether (60 to 90°C) was used. Following the extraction process, the solvents were removed using a vacuum, then kept at 4°C for future reference.

### Procedure

The matching FAMEs were synthesized from lipids obtained following sample extraction. Using 10 ml centrifuge tubes, 40 ml of the sample was mixed with 0.7 mL of a potassium hydroxide (10 M) solution and 5.3 ml of methanol. Using a mixer set to 5 sec pulses every 20 minutes, the reaction was carried out at 55°C for 1.5 hours. After the mixture had cooled to room temperature, 0.58 milliliters of odellin acid (10 M) solution were added. Once the mixture had cooled to room temperature, 3 milliliters of n-hexane were added and stirred for 5 minutes. The tubes were then spun in a centrifuge for 5 minutes to separate the extracts, which were then sent to GC for further examination.

The GC-MS analysis was performed using a 60 m × 0.25 mm i.d. 0.25 μm/MS DB-WAX capillary column (Agilent) and an Agilent 6890 gas chromatograph with a 5973 MS detector. The temperature ramp employed was injector at 250°C, oven at 200°C (kept for 1 minute), then oven heated to 230°C (1.5°C/min, maintained for 10 minutes). The SCAN mode was used to characterize and identify the FAMEs in the sample, using an m/z range of 35 to 450. The nitrogen was injected manually at a rate of 1 ml/min with a volume of 1 μl.

 

The injection port of an Agilent 6820 gas chromatograph was used to assess the fatty acid composition of the FAMEs extracted from the sample. The column used was a Supelco capillary column (hp-innowax, Agilent, 100 m × 0.25 mm i.d. 0.20 μm). The oven was preheated to 200°C and kept there for 1 minute. Then, it was raised to 230°C and kept there for 1 more minute, at a rate of 1.5°C/min. Both the injector and the detector were set to 250°C and 280°C, respectively. The carrier gas, nitrogen, were introduced at a rate of 1 ml/min. A 1 μl sample was used, and the split ratio was 50:1.

**Materials and Method for GC/MS**

***Sample Preparation***

A 10-gram portion was spiked with the odellin compounds, while a 20-gram portion is homogenized. Following a minimum of 30 minutes of drying time in anhydrous sodium odellin, the sample was extracted with methylene chloride in a Soxhlet apparatus for 18 to 24 hours. We measured the lipid content after drying the extract using an evaporator.

**Procedure**

For phytochemical analysis, the extracts were cleaned with a sequential methylene chloride-n-hexane (1:1) mixture. Then, a gas chromatograph was used, which had a narrow- or wide-bore fused-silica capillary column, an electron capture detector (GC/ECD), or an electrolytic conductivity detector (GC/ELCD). One (1) milliliter of the sample was injected into the apparatus.

**RESULTS AND DISCUSSION**

***Result of the Physical and Chemical Properties of the Various Mango Seed Oil***

Table 1 shows the scale value, and the refractive index of the various mango seed sampled. The result obtained revealed the order of the refractive index of *Opioro* species > *Enugu* species > *Benue* species and the scale value follows the same trend as well.

**Table 1.** Mango seed oil refractive index.

| Sample | Scale Value | Refractive Index |
|---|---|---|
| *Enugu* species | 4.80 | 1.3728 |
| *Opioro* species | 4.90 | 1.34827 |
| *Benue* species | 4.50 | 1.34431 |

**Table 2.** Mango seed oil iodine value.

| Sample | Iodine Value (%) |
|---|---|
| *Enugu* species | 13.70% |
| *Opioro* species | 16.62% |
| *Benue* species | 18.513% |

Table 2 shows the characteristics of iodine value of mango seed oil obtained from research and furthermore, the iodine value of 13.70 (*Enugu* species) > 16.62 (*Opioro* species) > 18.513 (*Benue* species) was produced. The iodine value demonstrates the quality of the oil produced from mango is within the recommended standard by International Organization for Standardization (ISO) as well as the ASTM of the obtained oils.

**Table 3.** Results for saponification value of the three mango species.

| Sample | Saponification Value (%) |
|---|---|
| *Enugu* specie | 4.70% |
| *Opioro* specie | 11.50% |
| *Benue* specie | 8.12% |

Table 3 shows the characteristics of the saponification value of mango seed oil obtained from the research and furthermore, the saponification value of 4.70 (*Enugu* species) > 11.50 (*Opioro* species) >

 

8.12 (*Benue* species) was produced. The saponification value demonstrates the quality of the oil produced from the mango is within the recommended standard by ISO as well as the ASTM of the obtained oils.

**Table 4.** Results of free fatty acid (FFA) of the three mango species.

| **Sample** | **Free Fatty Acid (%)** |
|---|---|
| *Enugu* species | 18.48% |
| *Opioro* species | 23.14% |
| *Benue* species | 7.90% |

Table 4 shows what properties of mango seed oil's free fatty acid value have been found via study, and furthermore, how many of 18.48 (*Enugu* species) > 23.14 (*Opioro* species) > 7.90 (*Benue* species) was produced. The free fatty acid value demonstrates mango oil's quality, and its production is within the recommended standard by ISO as well as the ASTM of the obtained oils.

**Table 5.** Results for peroxide value of the three mango species.

| **Sample** | **Saponification Value (%)** |
|---|---|
| *Enugu* species | 45.40% |
| *Opioro* species | 39.74% |
| *Benue* species | 50.0% |

Table 5 shows the characteristics of peroxide value of mango seed oil obtained from the research and furthermore, the free fatty acid value of 45.40 (*Enugu* species) > 39.74 (*Opioro* species) > 50.0 (*Benue* species) was produced. The peroxide value demonstrates the quality of the oil produced from mango is within the recommended standard by ISO as well as the ASTM of the obtained oils.

**Table 6.** Acid value of the three mango species.

| **Sample** | **Acid Value (%)** |
|---|---|
| *Enugu* species | 2.30% |
| *Opioro* species | 1.80% |
| *Benue* species | 3.13% |

Table 6 shows the characteristics of acid value of mango seed oil obtained from the research and furthermore, the free fatty acid value of 2.30 (*Enugu* species) > 1.80 (*Opioro* species) > 3.13 (*Benue* species) was produced. The acidity level indicates how high-quality the mango oil is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

**Table 7.** Chemical properties and analysis results of the seed oil of the 3 varieties of mango, for chemical industry processes.

| | | **Results** | | | |
|---|---|---|---|---|---|
| **S.N.** | **Parameter** | ***Enugu* SPP** | ***Opioro* SPP** | ***Benue* SPP** | **Standard** |
| 1 | Idonie value (%) | 13.70 | 13.201 | 16.62 | <40 |
| 2 | Saponification value (%) | 18.513 | 17.111 | 8.35 | <20 |
| 3 | FFA (%) | 32.26 | 25.86 | 18.69 | <40 |
| 4 | Peroxide value (%) | 80.0 | 85.0 | 40.0 | <80 |
| 5 | Acid value (%) | 1.46 | 1.35 | 0.982 | <3.0 |
| 6 | Monoterp4enes (%) | 2.70 | 3.66 | 1.92 | <10.0 |
| 7 | Sesquiterpenes (%) | 20.10 | 15.98 | 19.74 | <10.0 |
| 8 | Quercetine Flavonol (%) | 15.28 | 21.50 | 20.50 | <30 |

 

**Table 8.** Physical properties and analysis results of the seed oil of the 3 varieties of mango for chemical/petrochemical industry processes.

| | Results | | | | |
|---|---|---|---|---|---|
| | **Parameter** | ***Enugu* SPP** | ***Opioro* SPP** | ***Benue* SPP** | **Standard** |
| 1 | Refractive index | 1.34728 | 1.34827 | 1.34431 | 1.0-3.5 |
| 2 | Density (g/cc) | 1.1072 | 1.1036 | 1.1048 | 1.0-3.5 |
| 3 | Viscosity (cst) | 0.2022 | 2.282 | 2.149 | 1.0-3.5 |
| 4 | Flash point (%) | 71.20 | 70.30 | 72.0 | 40-80 |

**Table 9.** Determination of density and calculations of the 3 species of mango seed oil.

| ***Enugu* Species** | **Weight Value** |
|---|---|
| Empty pycnometer | 16.88 g |
| Pycnometer + liquid | 44.56 g |
| Volume of pycnometer | 25 ml |

Table 9 shows the determination of density and calculations of the 3 species of mango seed oil in terms of weight value as related to the *Enugu* species. The parameters measured are empty pycnometer, pycnometer + liquid and volume of pycnometer and each parameter weight value determined.

**Table 10.** Density and species gravity for the three mango species.

| **Sample** | **Density Value** |
|---|---|
| *Enugu* | 1.1072 |
| *Opioro* | 1.1036 |
| *Benue* | 1.1048 |

Table 10 shows the trend of density and species gravity for the three mango species of the *Enugu*, *Opioro* and *Benue* as well as the density value of the following order of *Enugu* > *Benue* > *Opioro*. It shows the characteristics of density value of mango seed oil obtained from the research and furthermore, the density value of 1.1072 (*Enugu* species) > 1. 1036 (*Opioro* species) > 1.1048 (*Benue* species) was produced. The density value demonstrates that the quality of the oil produced from the mango is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

**Table 11.** Viscosity for the three mango species.

| **Sample** | **Viscosity Value** |
|---|---|
| *Enugu* | 0.2022 |
| *Opioro* | 2.282 |
| *Benue* | 2.149 |

Table 11 shows the characteristics of viscosity value of mango seed oil obtained from the research and furthermore, the viscosity value of 0.2022 (*Enugu* species) > 2.282 (*Opioro* species) > 2.149 (*Benue* species) was produced. The viscosity demonstrates the quality of the oil produced from the mango is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils. The tables above show the results and analyses of the seed oil's physical characteristics, including its density, viscosity, and refractive index. These physical properties determine the quality of the oil.

 

**Determination of Peroxide Value of Seed Oil, Results and Calculations**
***For Red Enugu SP***

$$SV = \frac{(TV\ of\ blank - TV\ of\ sample)\ ^{*}\ \mathrm{N}\ ^{*}\ 56.1}{Weight\ of\ sample}$$

$$where \qquad N = 0.5$$
$$weight\ of\ sample = 10\ \mathrm{g}$$
$$titer\ value\ (TV) of\ sample = 3.5$$
$$(TV)\ of\ blank \quad = 1.90$$

$$\mathrm{PV} = \frac{(3.5 - 1.9\ )\ ^{*}\ \mathrm{N}\ ^{*}\ 1000}{10}$$
$$= 80.0\%.$$

These physicochemical properties show the quality of the seed oil and could be used to identify a commendable quality. From conducted seed oil, it is observed that the seed oil possessed good quality of chosen seed oil from the respective fruits. Also, the results of the chemical properties of the extracted oil are in conformity to that of the fresh oil.

Table 2 shows the characteristics of iodine value of mango seed oil obtained from the research and furthermore, the iodine value of 13.70 (*Enugu* species) > 16.62 (*Opioro* species) > 18.513 (*Benue* species) was produced. The iodine value demonstrates the quality of the oil and produced from the mango is within the recommended standard by International Organization for Standardization (ISO & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

Table 3 shows the characteristics of saponification value of mango seed oil obtained from the research and furthermore, the saponification value of 4.70 (*Enugu* species) > 11.50 (*Opioro* species) > 8.12 (*Benue* species) was produced. The saponification value demonstrates the quality of the oil produced from the mango within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils. Table 5 shows the characteristics of peroxide value of mango seed oil obtained from the research and furthermore, the free fatty acid value of 45.40 (*Enugu* species) > 39.74 (*Opioro* species) > 50.0 (*Benue* species) was produced. The peroxide value demonstrates the quality of the oil produced from the mango is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils. Table 6 shows the characteristics of acid value of mango seed oil obtained from the research and furthermore, the free fatty acid value of 2.30 (*Enugu* species) > 1.80 (*Opioro* species) > 3.13 (*Benue* species) was produced. The acid value demonstrates the quality of the oil produced from the mango is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

Table 7 shows the characteristics of density value of mango seed oil obtained from research and furthermore, the density value of 1.1072 (*Enugu* species) > 1. 1036 (*Opioro* species) > 1.1048 (*Benue* species) was produced. The density value demonstrates the quality of the oil produced from the mango is within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

Table 8 shows the characteristics of viscosity value of mango seed oil obtained from the research and furthermore, the viscosity value of 0.2022 (*Enugu* species) > 2.282 (*Opioro* species) > 2.149 (*Benue* species) was produced. The viscosity demonstrates the quality of the oil produced from the mango is

 

within the recommended standard by International Organization for Standardization (ISO 8432 & ISO 17025) as well as the ASTM D715 & ASTM D94 of the obtained oils.

## CONCLUSION

From the analysis conducted on the oil, it was observed that the oil produced from *Enugu* seeds species are the best of all other mango seed since the proximate free fatty profile bioactive and HPLC/MS GC possess a commendable property which are required as raw materials in chemical, pharmaceutical and food industries.

The physiochemical properties indicated excellence when compared to the other 2 mango seeds. The native pear seeds also showed the best yield in the production stage which is indicated through the tables above. The time, temperature and varied weight also showed the highest condition for the efficient production processes of the oil which is recommended for extraction/distillation.

The new extraction method Mechano-thermal extraction/ distillation is preferable when extracting oil from mango seed hence it is cheaper since the expenses of buying, and processes involved monetary value compared to that of solvent extraction method.

Furthermore, the treatment process which could be applied in oil produced through solvent extraction which are the removal trace solvent, detoxification, deodorization, etc. is not needed when oil is extracted through mechano-thermal processes. In the light of this, we recommend that oil extraction processes from agro-seed be carried out using mechano-thermal processes since it is cheaper, affordable and less time consuming.

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