Physicochemical Characterization and Fatty Acid Profile of seed oil of *Cucumis metuliferus*

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ABSTRACT

Cucumis metuliferus also called horned melon is a plant in the family of *Cucurbitacea* and is believed to have therapeutic uses. The seed oil of *Cucumis metuliferus* was analyzed for its physico-chemical properties using standard biochemical methods and fatty acid profile was analyzed using Gas chromatography-mass spectrometer. From the result, the oil has a light yellow colour, specific gravity of 0.81 ± 0.02, refractive index of 1.27 ± 0.10, acid value of 24.08 ± 2.38mgKOH/g, saponification value of 100.95 ± 3.91mgKOH/g, ester value of 76.87 ± 1.53mgKOH/g, iodine value of 29.29 ± 1.00 gI_2/100g, peroxide value of 46.00 ± 2.83 mEg/kg and free fatty acid (as oleic%) of 4.73 ± 0.14. The fatty acid composition indicated high levels of unsaturated fatty acids (67.11%) with linoleic acid as the highest in composition (31.84%). The saturated fatty acid content was 32.88% with stearic acid as the highest in composition (18.78%). The high content of polyunsaturated fatty acid indicates that the seed oil of *Cucumis metuliferus* may be nutritionally valuable in prevention of cardiovascular diseases but the high acid value and peroxide value make it unsuitable for consumption. The results of the physicochemical properties indicate that the oil could be a good raw material for industries in cosmetics and soap production

Keywords: *Cucumis metuliferus;* seed-oil; physicochemical, fatty acid, composition.

INTRODUCTION

Oils from seeds serve various purposes. In nutrition oils are used for cooking and food formulations, as raw materials for industries and neutraceuticals for therapeutic purposes. The compositions of oils from various sources determine their characteristics and so no particular oil can be used for all purposes. Therefore, it is imperative to evaluate their constituents. Fatty acid constituents of oils have various health implications as they are part of the major energy reserve of the body. They play vital roles in the body such as transportation of nutrients, regulation of metabolism and brain function as well as structural function in cell membranes. The unsaturated fatty acids in particular are of utmost benefit in the body. The polyunsaturated fatty acids and monounsaturated fatty acids reduce the risk of cardiovascular diseases and help in the reduction of low-density lipoproteins, triglyceride and total cholesterol with elevation in high-density lipoproteins [1]. Of importance is Omega -3 fatty acids; a polyunsaturated fatty acid which play vital roles in normal growth and development and essential in treatment and prevention of cardiovascular and various debilitating illnesses [2].

Many seed oils have been characterized and numerous fatty acids of nutritional and therapeutic importance have been reported but greater number is yet to be adequately evaluated. *Cucurbitaceae* is among the largest flora with hundreds of species and genera. They are generally called melons, and characterized by their high oil and protein composition [3]. The seed oil and seed of some species have been characterized and reported [4], [5], [6]. *Cucumis metuliferus* is of the *Cucurbitaceae* family. It is a climbing plant, grows annually and used for culinary purpose [7]. It is commonly called Kiwano or horned melon. The name; horned melon was given to it due to the presence of horn-like spines on the fruit. The skin of the ripe fruit is orange in colour and the pulp is greenish like lime, jelly texture like a pomegranate or passion fruit and has a refreshing taste like fruit. Various parts of *Cucumis metuliferus* are used for different culinary and medicinal purposes. The young and green fruits are used as seasoning and the dried fruits are incinerated and used for treatment of sore throat. The seeds and fruits are consumed raw as supplements. In some parts of Africa, the seeds are ground into a paste and eaten for treatment of parasitic worms in the body [8]. There has also been report of the nutritional and phytochemical properties of the seed [9]. Nevertheless, there are little or no reports on the physico-chemical properties and fatty acid profile of the seed oil. Therefore, this study evaluated the physicochemical characteristics and fatty acid profile of the seed oil.

MATERIALS AND METHODS

Material

All the chemicals and reagents used in this study were of analytical grade and were obtained from Sigma-Aldrich, Co, Ltd, UK.

Sample collection and identification

The fruits of *Cucumis metuliferus* were procured from Benue State, Nigeria. It was authenticated by Prof. C.E. Eze at Department of Applied Biology and Biotechnology, Enugu State University of Science and Technology, Agbani, Nigeria.

Sample Preparation

The fruits were rinsed to remove dirt. They were cut open using a kitchen knife. The pulp with the seeds was removed and the seeds were separated from the pulp, they were thoroughly washed and dried for 2 weeks under the sun. They were then blended into fine powder.

Oil Extraction

The ground *Cucumis metuliferus* seed was weighed and wrapped (20 g in succession) in a thimble and placed in the extraction chamber of Soxhlet extractor. N-hexane (350 ml) was placed in a round bottom flask and fixed in the Soxhlet apparatus. It was heated using electrothermal heating mantle for 4hrs and the oil extracted was recovered and oven-dried at 70 °C. The oil was used for the analysis.

Physicochemical Properties Analysis

The Free Fatty Acids (FFA), Peroxide value**,** Acid value, Saponification value and Specific gravity were evaluated using the method of [10] while the ester value was evaluated using the method of [11].

Fatty Acid Composition Assay

The fatty acid profile of the oil was analyzed using gas chromatography in tandem with mass spectrometer

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according to the method of [12].

RESULTS

The physicochemical properties

The results of the physical and chemical properties of oil of the seeds of *Cucumis metuliferus* are shown in Table 1. The results showed that the oil is yellow in colour and has a specific gravity of 0.81. The Saponification value was the highest chemical property obtained. The free fatty acid was the least.

Table I: The Physicochemical Properties of Seed oil of *Cucumis metuliferus*

Properties	Value
Colour	Yellow
Specific gravity	0.81 ± 0.02
Refractive index	1.27 ±0.10
Acid value (mgKOH/g)	24.08 ± 2.38
FFA (as oleic (%))	4.73 ± 0.14
Saponification Value(mgKOH/g)	100.95 ± 3.91
Ester value (mgKOH/g)	76.87 ± 1.53
Iodine value (g_{I2}/100g)	29.29 ± 1.00
Peroxide value (mEq/kg)	46.00 ±2.83

Values are Means ± SD (n=3)

Fatty Acid Profile

Table II shows the fatty acid composition of seed oil of *Cucumis metuliferus* and ranged from C_{12} to C_{22}. Linoleic acid (31.84%) was the highest in composition followed by linolenic acid (10.97%) while Eicosapentanoic acid (0.01) was the least.

Table II: Fatty Acid Profile of Seed oil of *Cucumis metuliferus*

Fatty Acid	Percentage Composition
Lauric Acid (C_{12})	3.39
Myristic Acid (C_{14})	4.62
Palmitic acid (C_{16})	6.09
Stearic acid ($C_{18:0}$)	18.78
Oleic acid ($C_{18:1}$)	8.71
Linoleic acid ($C_{18:2}$)	31.84
Linolenic acid ($C_{18:3}$)	10.97
Eicosadienoic acid ($C_{20:2}$)	2.38
Eicosatrienoic acid ($C_{20:3}$)	4.47
Arachidonic acid ($C_{20:4}$)	4.67
Eicosapentanoic acid ($C_{20:5}$)	0.01
Docosahexaenoic acid ($C_{22:6}$)	4.06

Saturated Fatty acid	32.88
Unsaturated fatty acid	67.11

DISCUSSION

Physicochemical properties

From the result of the physical properties, the oil has a specific gravity of 0.81 and this indicates that the oil is less dense than water and could be useful in producing cream as the oil will easily flow and spread on the skin [4]. The value was below the recommended range of 0.87–0.90 for oil requirement for biodiesel production and thus may not be suitable as raw material in bio-fuel production [13]. The refractive index defined as the ratio of the speed of light in vacuum to its speed in a given medium was found to be 1.27. This is high and indicative of the saturation level of the oil which corresponds to the higher number of carbon atoms in their fatty acids [14]. Increase in the double bond leads to increase in the refractive index [15]. This value is however lower than the reported values of other oils which range from 1.466- 1.470 and 1.449- 1.451 for soybean and palm oil respectively [16]. Acid values are essential indices of the oil quality and show the concentration of KOH that is required for the neutralization of the organic acids (FFAs) present in 1 g of fat. It measures the free fatty acid present in the oil. From the result, the acid value was 24.08 KOH/g. This is higher than the WHO Standard value of 0.6mgKOH/g for human consumption [17]. Studies have shown that high free fatty acid has the tendency to increase the risk of cardiovascular diseases by increasing the level of cholesterol [18]. The recommended acid value for cooking oil is 0.00 to 3.00 mgKOH/g [19]. Therefore, the seed oil of *Cucumis metuliferus* may not be suitable for cooking. The free fatty acid (FFA) value of the oil was 4.73%. This is however below 5.00% free fatty acid content which is the codex standard and highest recommended value for non–rancid oil [20]. By implication, the oil is not rancid oil and may not be prone to rancidity. Saponification value is the number of milligram of KOH required to saponify 1g of fat. The saponification value of the oil was 100.95 mg/g. This is below that reported on seed oils of watermelon (115.94mgKOH/100g) and baobab (240.4mgKOH/100g) [21], [22]. This is an indication that the oil may not be saponified easily in comparison with codex standard oil (168 – 265 mg/g). Saponification value is the mean molecular mass of oil [23]. Saponification value is inversely proportional to the molecular mass and so low saponification value shows a larger molecular mass than the common oil. Oils that have low saponification values can be used for the production of soap and candle and as chemical feed stocks for lubricant [20]. The iodine value obtained from this study was low (29.29 ± 1.00gI_2/100g). This value is lower than that of watermelon seed (74.5 ±0.5 meq/kg) and Bambara groundnut (121.00 ± 0.05gI_2/g) but higher than that of Coconut seed (9.73 ± 0.48mg of I_2/g and 10.99 ±0.73 mg of I_2 /g) as reported by [4], [24], [25] respectively. The low value indicates that the seed oil is a non-drying oil as non–drying oil has iodine value that falls within the range of 9.00 –65.00mg/g. Oil with iodine value in this range is excellent as adhesives and for the production of cosmetic [26]. The oxidative rancidity of oil is measured by the peroxide value [27]. Recommended peroxide value from standard organization of Nigeria for edible oils is below 10 meqquive O_2/Kg oil while peroxide value of 10 – 20 meqquive O_2/Kg oil gives rise to rancidity. Oxidative rancidity arises when oxygen is added in unsaturated fatty acid at the double bonds. The flavor and odor linked to rancidity are caused by release of short chain carboxylic acids. The peroxide value obtained in this study was 46 mEg/Kg). This is higher than peroxide values of most melon seed oils reported which ranged from 2.8- 8.3 [6], [4], [5]. This high value indicates that the oil is highly prone to rancidity as high peroxide values are indicative of higher rancidity rate at room temperature. Rancidity can lower the food’s nutritional value. Rancid oil forms free radicals which are harmful to the body by causing cellular damage and have been associated with many deleterious diseases such as diabetes, Alzheimer’s diseases, DNA damage leading to development of cancer and tissue degeneration. However, certain measures can be taken to prevent or slow down the rancidity of the oil. The measures include reduction of exposure to oxygen (as oxidative rancidity is the commonest type), limiting light exposure (as light, particularly UV light, facilitates the oxidation process which leads to rancidity) by packaging the oil in opaque or dark containers that block or limit light, controlling temperature, limiting moisture and addition of antioxidants which destabilizes and deactivates free radicals, thereby slowing down the oxidation process. These can be applied during processing and packaging of the oil.

Fatty Acid Profile

The fatty acid composition comprises of 32.88% saturated fatty acid and 67.11% unsaturated fatty acid. Of the unsaturated fatty acid, linoleic acid (31.84% was the highest in composition followed by linolenic acid (10.97%). For the saturated fatty acids, stearic acid (18.78%) was the highest in composition followed by palmitic acid (6.09%). These values are close to that reported for *Citrullus lanatus* and *Cucurbita pepo* seed oils which contain mostly, linoleic, linolenic and stearic acids with linoleic as the highest in composition [5], [28], [29] and *Telfairia occidentalis* oil which contains mostly linoleic acid and palmitic acid [30].They differ from those reported for peanuts and palm olein oils which have oleic acid as the most abundant [31]. Linoleic acid is polyunsaturated acid that is very important in human health. In addition to its role in prevention of cardiovascular diseases, it also protects against high blood pressure [30]. Even though linolenic acid is an omega-3 fatty acid with good health effect, it is easily prone to peroxidation, thus, it is not desirable in edible oil due to the oxidation by-products formed which are potentially harmful and the off-flavours [5]. Of utmost interest in this study, is that *Cucumis metuliferus* seed oil contained eicosapentaenoic acid, an omega -3 fatty acid. From studies it has been shown that eicosapentaenoic acid plays a beneficial role in mental disorders such as schizophrenia [32]. The major saturated fatty acid constituent of *Cucumis metuliferus* seed oil was stearic acid. Stearic acid is a long-chain fatty acid and though classified for the dietary recommendation for purpose of nutrition labeling and biochemically as a saturated fatty acid, has been shown from accumulated data to be unique among other saturated fatty acids in the food supply [33], [34], [35]. Other saturated fatty acids like palmitic, lauric and myristic acids elevate cholesterol levels in the blood but stearic acid has been reported to have no profound effect on levels of blood low-density-lipoprotein (LDL) and total cholesterol [36], [33], [34], [35]. It then shows that stearic acid may not be a risk factor for cardiovascular illness.

CONCLUSION

This study showed that *Cucumis metuliferus* seed is a potential good source of raw material for industries in cosmetics and soap production. The high acid and peroxide values make it unsuitable for consumption as it may be prone to rancidity. The fatty acid composition is high in polyunsaturated fatty acid which indicates that the seed oil of *Cucumis metuliferus* may be nutritionally valuable in prevention of cardiovascular diseases. Further studies should be geared towards research on processing methods for improved and better nutritious oil.

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DECLARATION OF COMPETING INTEREST

Authors declare no conflict of interest.

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