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RESEARCH ARTICLE

Extraction and Characterization of Underutilized Seed Oils Sampled in South-western Nigeria

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ABSTRACT

Citrullus lanatus (watermelon) and *Sesamum indicum* (sesame) are edible plants that provide a lot of nutritional benefits to man; despite their wide consumption and benefits, their seed oils remain underutilized. Seed oils from these plants found in south-western Nigeria were analyzed for their physico-chemical properties. Oil was extracted from the seeds using Soxhlet apparatus and n-hexane as the solvent; physico-chemical properties were determined using standard analytical procedures. Watermelon seed oil had a golden brown colour while sesame seed oil had a carton brown colour; they had saponification values of 258.99 mgKOH/g and 261.34 mgKOH/g respectively. Acid value ranged from 2.13 – 2.51 mgKOH/g; iodine value of 39.7 - 42.3 gI_2/100g and peroxide value of 1.39 – 2.43 meqKOH/g was determined in the seed oils. Oils from these seeds have numerous domestic and industrial potentials such as cooking, frying, production of soaps, and cosmetics to mention a few.

Keywords: *Citrullus lanatus, Sesamum indicum,* underutilized, seed oils, physico-chemical properties, South-western Nigeria

1 Introduction

Watermelon (*Citrullus lanatus* Thunb.), a vine-like flowering plant belongs to the family Cucurbitaceae; it reaches maximum genetic diversity, having sweet, bland and bitter forms. Its fruit, which is also called watermelon, is referred to by botanists as a pepo, a berry which has a thick exocarp and fleshy center - mesocarp and endocarp [1, 2]. The fruit is made up of 91% water, 8% carbohydrate and fibre; it is a good source of lycopene, carotenoid and citrulline. Watermelon seeds are made up of protein, vitamin B, minerals, fat and oil.

Sesamum indicum L., an annual shrub of the family Pedaliaceae [3] is commonly grown in tropical and subtropical parts of the world, mostly in India, Sudan, Burma and China [4]. Sesame seeds which are of different colors ranging from creamy-white to charcoal black [3] are used as food seasoning; they contain protein, carbohydrate, minerals, vitamin B1, fibers and oil which are important nutrients for man [4, 5]. Plant seeds are important sources of oils which are of nutritional, industrial and pharmaceutical importance [6]. Seed oils have been reported to have properties which makes them raw materials for home and industrial use; for instance the domestic and industrial potentials of *Moringa oleifera* [7], melon and coconut [8] seed oils have been reported. Unfortunately, some seeds are often discarded and underutilized despite their numerous nutrients and potential applications [9], watermelon [10] and sesame seeds [11] are notable examples. Seed oils from these two plants found in some parts of Nigeria and the world have been reported, but there is scanty information on the characterization of seed oils from these plants grown in southwestern Nigeria. Plants grown in different environments usually have different composition [12], so this study aimed to determine the physico-chemical properties of oils from *Citrullus lanatus* and

Sesamum indicum plants grown in southwestern Nigeria and enumerate their potential uses.

2 Materials and Methods

2.1 Sample Collection and Preparation

Citrullus lanatus and *Sesamum indicum* seeds were purchased from traders at Bodija market, Ibadan, Oyo state, Nigeria. Bodija market was deliberately selected because it is majorly known for the sale of fruits and food crops in south-western Nigeria. Extraneous substances were separated from the seeds, they were sun dried and milled using stainless steel blender. Representative samples of each of the seeds were taken and analyzed.

2.2 Extraction of Oil

Oil was extracted from the representative samples using Soxhlet apparatus; n-hexane (boiling point range 40-60^{o}C) was used as the solvent according to the AOAC, 1975 procedure [13]. After extraction, n-hexane was removed at 40^{o}C under reduced pressure by means of a rotary evaporator; residual n-hexane was removed by placing evaporating dishes containing the extracted oil in a vacuum oven at 40^{o}C and 500mmHg until all traces of the residual solvent disappeared. Extracted oil was weighed and oil yield was calculated using the formula [14]:

$$\%\ Oil\ yield = \frac{Total\ weight\ of\ seed\ oil\ extracted}{Total\ weight\ of\ seeds\ before\ extraction} \times 100$$

2.3 Characterization of Physico-chemical Properties of the Seed Oils

2.3.1 Determination of Physical Properties

Colour of the seed oils was determined visually, while the Refractive index was determined with Abbe refractometer.

2.3.2 Determination of Specific Gravity

This was determined according to the method of Olaniyi and Ogungbamila [15]. The specific gravity of the oils was determined by comparing the weight of oil to the weight of an equal volume of distilled water. 10 mL standard stoppered volumetric flask was weighed (W_1 g), it was then filled with oil sample and weighed (W_2 g). The weight of oil in the flask was calculated as W_2 g- W_1 g. The oil was removed, and the flask properly washed and drained. It was then filled with distilled water to the mark and accurately weighed (W_3 g). The weight of water in the flask was calculated as W_3 g- W_1 g.

$$Specific\ gravity = \frac{W_2 - W_1}{W_3 - W_1}$$

The chemical properties were determined using AOAC, 1984 [16] method modified by [15].

2.3.3 Determination of Saponification Value

2.0 g of oil was accurately weighed into a quick fit round bottom flask, 25 mL of 1M ethanolic KOH was added. A reflux condenser was attached to the quick fit round bottom flask, and the mixture was refluxed for one hour on a water bath swirling the contents frequently. The water bath was removed, 5 mL of phenolphthalein solution was poured down the condenser, and the flask was cooled for five minutes under the tap. The content of the flask was then titrated against 0.5M Hydrochloric acid. Blank determination was performed under the same conditions. Saponification value was determined using the equation below.

$$Saponification\ value = \frac{F\ x\ (b - a) x\ 28.05}{weight\ \ (in\ g) of\ oil}$$

a= titer value of sample; b = titer value of blank determination; mg of KOH equivqlent to 1mL of 0.5M HCl = 28.05; F = factor of 0.5M HCl derived from standardization = 1.00

$$F = \frac{weight\ of\ primary\ standard\ (Na_2CO_3)}{milliequivalent\ (Na_2CO_3 : \ HCl) x\ titre\ volume}$$

1 mL of 0.5M HCl is equivalent to 0.0265g Na_2CO_3

2.3.4 Determination of Iodine Value

0.17 g of oil was treated with 10 mL of carbon tetrachloride and 20 mL of 0.2M iodine monochloride solution. The solution was allowed to stand in the dark for 30 minutes. 15 mL of 10% KI solution and 100 mL of distilled water were added. The content of the iodine flask was titrated against 0.1M sodium thiosulphate ($Na_2S_2O_3$) solution. Few drops of 1% starch were added as the indicator towards the end point, before the yellow color was almost disappeared. The titer value was noted. Blank titration was performed, omitting the oil. The iodine value was calculated as shown below.

$$Iodine\ value = \frac{F\ x\ (b-a)\ x\ 1.269}{weight\ (in\ g) of\ oil}$$

b = titer value of blank determination; a = titer value of sample; F = factor of 0.1M $Na_2S_2O_3$ solution derived from standardization = 1.32

$$F = \frac{weight\ of\ primary\ standard\ (KIO_3)}{milliequivalent\ (KIO_3{:}\ Na_2S_2O_3)\ x\ titre\ volume}$$

1mL of 0.1M $Na_2S_2O_3$ solution is equivalent to 0.003567g KIO_3

2.3.5 Determination of Acid Value

25 mL of ethanol, 25 mL of diethyl ether and 1 mL of phenolphthalein solutions were mixed in a 250 mL conical flask, the mixture was added to 10.0 g of oil also in a 250 mL conical flask. When the oil was completely dissolved, it was titrated against 0.1M aqueous KOH with constant shaking until a pink color persisted. The acid value was calculated as shown below.

$$Acid\ value = \frac{F\ x\ a\ x\ 5.61}{weight\ (in\ g) of\ oil}$$

a = titer value; mg of KOH contained in 1 mL of a 0.1M solution = 5.61; F = factor of 0.1M KOH solution derived from standardization = 1.04

$$F = \frac{weight\ of\ primary\ standard\ (H_2NSO_3H)}{milliequivqlent (H_2NSO_3H{:}\ KOH) x\ titre\ \ volume}$$

2.3.6 Determination of Peroxide Value

1.0 g of oil sample was dissolved in 25 mL of 3:2 mixture of glacial acetic acid and chloroform. 0.5 mL of saturated KI solution was added, the mixture was allowed to stand for one minute, and 30 mL of distilled water was added. The liberated iodine was titrated with 0.01M $Na_2S_2O_3$ using starch as indicator. Blank determination was carried out in the same way. Peroxide Value was calculated from the equation below.

$$Peroxide\ value = \frac{F\ x\ (a-b) x\ 10}{weight\ (in\ g) of\ oil}$$

a = titer value of sample; b = titer value of blank determination; F = factor of 0.01M $Na_2S_2O_3$ derived from standardization = 1.04

$$F = \frac{weight\ of\ primary\ standard\ (KIO_3)}{milliequivalent\ (KIO_3{:}\ Na_2S_2O_3)\ x\ titre\ volume}$$

1 mL of 0.1M $Na_2S_2O_3$ solution is equivalent to 0.0003567g KIO_3

3 Results and Discussion

3.1 Physical Properties

Table 1 shows the results of the physical properties of the seed oils.

Table 1: *Physical properties of seed oils*

Physical Properties	***Citrullus lanatus* (watermelon) seed oil**	***Sesamum indicum* (Sesame) seed oil**
Oil yield	23.8%	49.3%
Specific gravity	0.88	0.90
Refractive index (30°C)	1.47	1.47
Colour	Golden brown	Carton brown

The oil yield of *Citrullus lanatus* seeds was found to be 23.8%, this is similar to 28.68% reported by Saeed and Shola [17], who determined the physicochemical properties of some edible seed oils in Kano state (Northern Nigeria); while that of *Sesamum indicum* seeds was 49.3% which is higher than 38.54% reported by Mbaebie *et al.*, [18], who determined the physicochemical properties of Sesame seed oil grown in Southeastern Nigeria. These values could be considered commercially economical for the production of oil in Nigeria [17]. Specific gravity of 0.88 was determined in watermelon seed oil; while that of Sesame seed oil was 0.90. Refractive index of 1.47 at 30°C observed in this study for watermelon seed oil is similar to 1.4712 which was reported by [19] for watermelon seed oil analyzed in India; sesame seed oil also had a refractive index value of 1.47. Refractive index is an indication of the level of saturation [11], the similarity of the refractive index of the two seed oils suggests that they have similar levels of saturation [19]. Watermelon seed oil analyzed in this study had a golden brown colour, while sesame seed oil had a carton brown colour, Mbaebie *et al.*, [18] reported a dark brown colour for sesame grown in Southeastern Nigeria.

3.2 Chemical Properties

Table 2 shows the results of the chemical properties of the seed oils

Table 2: *Chemical Properties of seed oils*

Chemical Properties	***Citrullus lanatus* seed oil**	***Sesamum indicum* seed oil**
pH	5.76	5.87
Saponification value	258.99±0.81 mgKOH/g	261.34±0.81 mgKOH/g
Acid value	2.51±0.04 mgKOH/g	2.13±0.02 mgKOH/g
Ester value	256.48±0.77 mgKOH/g	259.21±0.79 mgKOH/g
Iodine value	39.7±0.58 $gI_2/100g$	42.3±0.98 $gI_2/100g$
Peroxide value	1.39±0.60 meqKOH/g	2.43±0.60 meqKOH/g

The results of the chemical properties of the seed oils are shown in Table 2. pH value of 5.76 was detected in watermelon seed oil, this is more acidic than 6.42 reported by Saeed and Shola [17]. Sesame seed oil had pH of 5.87 which is also more acidic than 6.12 reported by Saeed and Shola, [17]. Saponification values of the two seed oils analyzed were on the high side, watermelon seed had 258.99mg KOH/g oil, which is a bit higher than 218mg KOH/g oil reported by Gladvin *et al.*, [19] for Indian watermelon seed oil. Sesame seed oil on the other hand had 261.34 mg KOH/g oil; this is higher than 192.70mgKOH/g reported by Saeed and Shola, [17]. Saponification value has an inverse correlation with the molecular weight or chain length of fatty acids present in the oil [20]. Oils having high saponification values can be used in producing soap, cosmetics, shaving cream and hair shampoo [20]. Acid value, a measure of free fatty acid (FFA) content of oils indicates that both oils are in good non-degradable state [17]. Watermelon seed oil had acid value of 2.51mgKOH/g, this is lower than 4.4mg KOH/g oil reported by Gladvin *et al.*, [19] while sesame seed oil had acid value of 2.13mg KOH/g, this is similar to the value reported by [18]. According to Saeed and Shola [17], maximum acceptable level for acid value is 4mgKOH/g oil, acid values of the oils analyzed is below this, which means they are acceptable for consumption. Ester value of watermelon seed oil was 256.48 mgKOH/g; sesame seed oil had 259.21 mgKOH/g which is higher than 188.639 mgKOH/g reported by Belsare and Badne [21] who analyzed edible oils from agencies of Buldhana district in India. High ester value shows the presence of high quantity of ester and low molecular weight fatty acid content [21]. Iodine value determination is used in measuring the degree of unsaturation of oil samples; it shows the ease of oxidation and drying capacity of the oil. Watermelon seed oil had iodine value of 39.7 $gI_2/100g$ which is lower than 114.4 $gI_2/100g$ reported by Saeed and Shola [17]. Sesame seed oil had iodine value of 42.3 $gI_2/100g$ which is higher than 1.27 $gI_2/100g$ reported by Mbaebie *et al.*, [18]. The iodine values of the two seed oils indicates their low degree of unsaturation, as such, they are classified as non-drying oils. Watermelon seed oil had peroxide value of 1.39 meqKOH/g while sesame seed oil had 2.43 meqKOH/g, these values are lower than those reported by Saeed and Shola, [17]. These values are within the standard range of 2-10meqKOH/g as reported by AOAC [22, 17]; low peroxide values indicate that the oils may be stable to oxidative degradation [17].

4 Conclusion

The study concludes that slight differences are present between the properties of the seed oils found in southwestern Nigeria and those found in other parts of the world. The seed oils have abundant potentials for industrial and domestic uses. They can serve as source of edible oils for human consumption. They can also be used industrially for soap making and production of cosmetics. The disposal of watermelon seeds should therefore be discouraged while increased cultivation of the two plants should be enhanced so that they can be used as alternatives for some widely utilized seed oils.

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6 Competing Interest

Author declared that no conflict of interest exists in this work.

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