PARTIAL OIL CHARACTERIZATION, VITAMIN, MINERALAND ANTIOXIDANT CONTENT OF SESAME (*Sesamumindicum*) SEED

**ABSTRACT**

**Background and Objectives:** Sesame (*Sesamumindicum*) is one of the earliest human production and consumption crops in the family of Pedaliaceae. It is also an erect annual herb that grows 60–150 cm tall, having simple or branched stem, and with leave opposite or alternately at each node.**Materials and Methods:** The mineral properties, vitamin content, partial oil characterization, and antioxidant properties of sesame seed were analyzed using standard laboratory methods. **Results:** The mineral analysis carried out revealed the presence of calcium, magnesium, sodium, potassium, selenium, cobalt, copper, iron, zinc, and manganese in castor seeds to be 9.55 $\pm 0.01,$ 6.63 $\pm 0.02, $3.79$\pm 0.01,$ 3.34 $\pm 0.04, $0.36 $\pm 0.00$, 0.09 $\pm 0.00$, 1.43 $\pm 0.01,$ 0.14 $\pm 0.00$, 0.36$\pm 0.00$ respectively. The physicochemical properties were recorded at Specific gravity (0.93 $\pm 0.00), $Cloud pointoC( 12.4$\pm 0.20$)*,* Flash pointo C (267.66 $\pm 1.52$), Melting pointoC (6.23 $\pm 0.25$), Boiling pointoC (319 $\pm 3.00$). Vitamin C was the vitamin with the highest composition (56.75$\pm 0.43), followed by$ vitamin D (26.16 $\pm 0.13$ ), vitamin E (20.4$6 \pm 1.07$), vitamin A (17.39$\pm 0.08$ ).The partial oil characteterization and the antioxidants properties were also revealed. **Conclusion:** This study showed that the sesame seed is a good source rich in vitamin minerals and oil. *Sesamumindicum* L. The oil extracts exhibited good physicochemical properties and could be useful for health and industrial applications.

**Keywords:** sesame seed, physicochemical properties, mineral properties, vitamin, partial oil characterization, antioxidantproperties

**INTRODUCTION**

Sesame (*Sesamumindicum*) is one of the earliest human production and consumption crops in the family of Pedaliaceae (Zech-Matterne*et al.,*2015), rape, soybean, and peanuts, known as China’s four major oil crops. It was first discovered in ancient sites in Pakistan, sesame is a long-established cultivated crop (Bedigian, 2010). Globally, India, sesame (French), goma (Japanese), gergelim (Portuguese) and ajonjoli (Spanish Sudan, Myanmar, China, and Tanzania) are the major producers of sesame. In recent years, the production of sesame seeds in African countries has increased, and Tanzania has replaced India as the leading producer of sesame seeds. According to the Food and Agriculture Organization of the United Nations, the global production of sesame in 2017 was 5.899 million tons, of which 806,000 tons were produced in Tanzania and 733,000 tons in China (Xu and Zhang, 2018). Among the oilseed crops, sesame has been cultivated for centuries, particularly in Asia and Africa, for its high content of edible oil and protein. It is commonly known as til (Hindi), hu ma (Chinese).

 Sesame seeds are a source of edible oil such as sesame oil, used in cooking and decorating foods (Dakia*etal.,* 2015). Additionally, sesame seeds consist of various bioactive compounds, minerals vitamins and antioxidants, (El-Adawy and Taha, 2001).

They are known to be rich in healthy fats, particularly mono- and polyunsaturated fatty acid which have been associated with cardiovascular health (Siddique *et al.,*2017). Sesame seeds also contain a diversity of minerals which includes; calcium, iron magnesium, and zinc. These minerals play an important role in maintaining overall health and well-being (Dravie *et al* 2020). Furthermore, sesame seeds are a source of various vitamins, such as vitamin E, niacin, and folate (Badr *et al*., 2019) which contribute to their potential health benefits and functional properties. The present study aimed to provide information on the Antioxidant capacity, available nutrients and the physicochemical properties of the oil extracted from the seed of *Sesamumindicum*.

MATERIALSANDMETHODS

**Study area:** The mineral properties, vitamin content, partial oil characterization, and antioxidant properties were carried out in Docchy Analytical Laboratories, from March to May, 2023.

**Sample collection:** The sample (sesame seed) were purchased from Eke-Awka market, Awka south local government area in Anambra state.

**Sample preparation:** The outer covering (hull) of the sesame seed were de-shelled to give the endosperm. The endosperms which are whitish in color were what we used to carry out the analysis. The endosperm was blended and stored in an airtight plastic container.

ANTIOXIDANTS

**ABTS Scavenging activity**

The antioxidant effect of the sesame seeds were studied using ABTS (2, 2’-azino-bis- 3-ethylbenzthiazoline-6-sulphonic acid) radical cation decolourisation assay according to the method of (Shirwaikar *et al*.2006).

Superoxide scavenging activity

The superoxide scavenging ability of the sesame seeds were assessed by the method of (Winterbourn*et al*.1975).

**MEASUREMENT OF SUPEROXIDE SCAVENGING ACTIVITY**

The superoxide scavenging ability of the samples was assessed by the method of Winterbourn *et al*., (1975).

**MEASUREMENT OF NITRIC OXIDE SCAVENGING ACTIVITY**

The extent of inhibition of nitric oxide radical generation in *vitro* was followed as per the method reported by Green *et al*., (1982).

**MEASUREMENT OF HYDROXYL RADICAL SCAVENGING ACTIVITY**

The extent of hydroxyl radical scavenging from Fenton reaction was quantified using 2'-deoxyribose oxidative degradation as described by Elizabeth and Rao (1990).

**ESTIMATION OF VITAMIN A**

Vitamin A was estimated by the method of Bayfield and Cole (1980).

**ESTIMATION OF VITAMIN E**

Vitamin E was estimated in the sample samples by the Emmerie-Engel reaction as reported by Rosenberg (1992).

**DETERMINATION OF VITAMIN C**

Vitamin C was analysed by the spectrophotometric method described by Roe and Keuther (1943).

**VITAMIN D**

Vitamin D was assayed according to the method of Brockmann*et al*., (1974).

**DETERMINATION OF FATTY ACID**

**Acid value**

**Procedure:**

(i) Diethyl ether, 25ml was mixed with 25ml of alcohol and 1ml phenolphthalein (1%) and it was carefully neutralized with 0.1M NaOH.

(ii) Dissolve 1-10g of the oil or melted fat in the mixed neutral solvent and a titrate with aqueous 0.1M NaOH shaking constantly until pink colour which persists for 15 seconds is obtained.

Calculation:

Acid value = *titre (ml) x 5.61*

*weight of sample used*

The FFA figure is usually calculated as oleic acid (1ml 0.1M sodium hydroxide = 0.0282g oleic acid), in which case the acid value = 2x FFA.

For most oils, acidity begins to be noticeable to the palate when the FFA calculated as oleic acid is about 0.5- 1.5 %

For palm oil as palmic( 1ml 0.M NaOH = 0.0256g).

For palm kernel, coconut and similar lauric acid ( 1ml 0.M NaOH =0.0200g).

**IODINE VALUE**

**Determination of iodine value**:

(i) The oil was poured onto a small beaker, a small rod was added and a sutaible quantity of the sample was weighed into a dry glass-stoppered bottle of about 250ml capacity. The approximate weight in g of the oil to mbe taken was be calculated  by dividing 20 by  the highest expected iodine value.

(ii) Carbon tetrachloride 10ml was added to the oil or melted fat and dissolve.

(iii) Wijis’ solution 20ml was added, the stopper was inserted (previously moistened with potassium iodine solution) and it was allowed to stand in the dark for 30 minutes.

(iv) Potassium iodine solution (10%) 15ml and 100ml water was added, it was mixed and titrated with 0.1M thiosulphate solution using starch as indicator just before the end-point ( titration = aml).

(v) A blank was carried out at the same time commencing with 10ml of carbon tetrachloride (titration = bml).

Iodine value =  *(b - a) x 1.269*

 *wt. (g) of sample*

Note: if (b-a) is greater than b/2 the test must be repeated using a smaller amount of the sample.

It should be noted also that the less unsaturated fats with low iodine values are solid at room temperature, or conversely, oils that are more highly unsaturated are liquid ( showing there is a relationship between melting points and the iodine value).

**Preparation of wijis’ solution**:

(i) Iodine trichloride 8g in 200ml glacial acetic acid was dissolved.

(ii) Iodine 9g in 300ml carbon tetrachloride was dissolved

(iii) The two solutions was mixed and diluted to 1000ml with glacial acetic acid.

**PEROXIDE VALUE**

Procedure:

(i) Oil or fat, 1g was weighed into a clean dry boiling tube and while still liquid, 1g powdered potassium iodide and 20ml of solvent mixture was added ( 2 vol glacial acetic acid + 1 vol chloroform).

(ii) The tube was placed in boiling water so that the liquid boils within 30 seconds and it was allowed to boil vigorously for not more than 30 seconds.

(iii) The contents was poured quickly into a flask containing 20ml of potassium iodide solution (5%), the tube was washed twice with 25ml water and titrated with 0.002M sodium thiosulphate solution using starch.

(iv) A blank was performed at the same time.

**SAPONIFICATION VALUE**

Procedure:

(i) Oil or fat, 2g was weighed into a conical flask and exactly 25ml of the alcoholic potassium hydroxide solution was added.

(ii) A reflux condenser was attached and the flask was heated in boiling water for 1hr, shaking frequently.

(iii) Phenolphthalein (1%) solution 1ml was added and a hot excess alkali was titrated with 0.5M hydrochloric acid ( titration = aml)

(iv) A blank was carried out at the same time ( titration  = bml)

Calculation:

Saponification value = *(b-a) x 28.05*

 *wt. (g) of sample*

**THIOBARBITURIC ACID NUMBER OR VALUE ( Tba)**

Procedure:

(i) Fatty food, 10g was macerated with 50ml water for 2 minutes and washed into a distillation flask with 47.5ml water.

(ii) Hydrochloric acid 2.5ml was added to bring the PH to 1.5, followed by an antifoam preparation and a few glass beads.

(iii) The flask was heated by the means of an electric mantle so that 50ml distillate is collected in 10 minutes from the time boiling commences.

(iv) Distillate of 5ml was pipette into a glass-stoppered tube, 5ml TBA reagent (0.2883g/100ml of 90% glacial acetic acid) stopper was added, it was shaked and heated in boiling water for 35minutes.

(v) A blank was prepared similarly using 5ml water reagent. Then cool the tubes in water for 10 minutes and measure the absorbance (D) against the blank at 538nm using 1cm cells. TBA ( as mg malonaldehyde per kg sample ) = 7.8D

**Specific gravity**

i. A 50ml pycometer bottle thoroughly washed was with detergent, water and petroleum ether, it was dried and weighed.

ii. The bottle was filled with water and it was weighed.

iii. After drying the bottle, it was filled with the oil sample and it was weighed

Calculation

Specific gravity = *weight of Xml oil*

 *Weight of Xml water*

**Refractive index**

i. The Abbe refractometer was reset with a light compensator

ii. The oil sample was seared on the lower prism of the instrument and closed

iii. A light was passed by means of the bangled mirror, the reflected light appears in form of a dark background

iv. Using the fine adjustment the telescope tubes was moved until the lack shadow appears central in the cross wire indicator

v. The refractive index smoke, flash and fire point was read off.

i. Volume of the oil 10ml was poured into an evaporating dish

ii. A thermometer was suspended at the centre of the dish ensuring that the bulb just dips inside the oil without touching the bottom of the dish.

iii. The temperature of oil was gradually raised using hot plate

iiii. The temperature at which the oil sample gave off a thin bluish smoke continuously was notted as the smoke point

v. Similarly the temperature at which the oil started flashing without supporting combustion was equally noted as the flash point

vi. The temperature at which the oil starts supporting combustion was recorded as the fire point.

**Methods for the Elemental Analysis**

Heavy metal analysis was conducted using Agilent FS240AA Atomic Absorption Spectrophotometer according to the method of APHA 1995 (American Public Health Association).

**Working principle**: Atomic absorption spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS's light beam is directed through the flame into the monochromator, and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral oklhuuoradiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Sample Digestion (Adrian, 1973)

1. Approximately 2g of the dried sample was weighed out in to a digestion flask and add 20ml of the  acid mixture (650ml  conc HNO3; 80ml perchloric acid; 20ml conc H2SO4)
2. The flask was heated until a clear digest is obtained.
3. It was diluted the digested with distilled water to the 100ml mark.

**Preparation of reference solutions**

A series of standard metal solutions in the optimum concentration range are prepared, the reference solutions were prepared daily by diluting the single stock element solutions with water containing 1.5 mL concentrated nitric acid/litre. Calibration blank was prepared using all the reagents except for the metal stock solutions.

**RESULTSANDDISCUSSION**

**Antioxidant results**

**Hydroxyl Radical Scavenging Activity Result**

The graph below shows that the sesame seed has lower activity in hydroxyl radical scavenging antioxidant activity compared to the standard, gallic acid with a higher activity in hydroxyl radical scavenging antioxidant activity.

Gallic acid

**Figure 1: Hydroxyl radical scavenging antioxidant activity of the seed of *sesamum***

***indicum***

**Superoxide Scavenging Activity Result**

The figure below shows that sesame seed has superoxide scavenging activity, but when compared to the standard, gallic acid it is slightly lower.

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Gallic acid

**Figure 2: Superoxide scavenging activity of the seed of *sesamumindicum***

**Ferric Reducing Power Activity Result**

The graph below shows that the sesame seed has lower activity in ferric reducing power activity when compared to the standard, gallic acid with a higher activity in ferric reducing power activity.

Gallic acid

**Figure 3: Ferric reducing power activity of the seed of *sesamumindicum***

**Abts Activity Result**

The graph below shows that sesame seed have an effective ABTS activity, but when compared with the standard, gallic acid, it is slightly lower than the standard.

Gallic Acid

**Figure 4: ABTS activity of the seed of *sesame indicum***

**Nitric Oxide Activity Result**

The graph below show that sesame seed has a very low nitric oxide activity when compared to the standard, gallic acid.

Gallic acid

**Figure 5: Nitric oxide activity of the seed of *sesamumindicum***

**Vitamin Result**

The vitamins concentration found in *sesamumindicum* are shown in table 2. In *sesamumindicum* the vitamin A content is 17mg/kg, vitamin C (56.75mg/kg), vitamin D (26.16mg/kg), and Folate (0.27mg/kg).

**Figure 6: A bar chart showing different vitamin results**

**Partial Oil Characterization Results**

The partial oil characterization parameter found in the seed of *sesamumindicum* are shown in table 1. In the seed of *sesamumindicum* the Free fatty acid and acid value is 6.00% and 12.01% respectively. The shows that seed of *sesamumindicum* is less susceptible to oxidative aging. The value of peroxide value (6.00mleq/kg) shows that it is fresh and of good quality, considered suitable for human consumption. The iodine value (110.84) shows that the oil of*sesamumindicum* contains unsaturated fatty acid (oleic and linoleic fatty acid) and it also has stability and nutritional quality. The value of specific gravity shows that the oil of *sesamumindicumis*less dense than water.

**Table 1: Partial oil characterization parameters of *sesamumindicum***

**Parameters Concentrations**

**Acid value (%) 12.01** $\pm 0.5$**0**

**Free fatty acid (%) 6.00** $\pm 0.22$

**Saponification value(mgKOH/kg) 273.95** $\pm 7.05$

**Peroxide value (mleq/kg) 6.46**$\pm 0.30$

**Iodine value 110.84** $\pm 1.36$

**Refractive index 1.41** $\pm 0.01$

**Viscosity (Mpas.sec) 138** $\pm 1.73$

**Specific gravity 0.93** $\pm 0.00$

**Cloud pointoC 12.4** $\pm 0.20$

**Flash pointo C 267.66** $\pm 1.52$

**Melting pointoC 6.23** $\pm 0.25$

**Boiling pointoC 319** $\pm 3.00$

**Minerals Results**

The table 2 and 3 shown above consist of the macromolecule andnmicromolecule contained in the seed of *sesamumindicum*

**Table 2: The macrominerals and their concentrations**

**Macrominerals Concentrations[ppm]**

 **Magnesium 6.63** $\pm 0.02$

**Sodium 3.79**$\pm 0.01$

**Calcium 9.55** $\pm 0.01$

**Potassium 3.34** $\pm 0.04$

**Table 3: The microminerals and there concentrations**

**Microminerals Concentrations[ppm]**

**Iron 1.43** $\pm 0.01$

**Zinc 0.14** $\pm 0.00$

**Selenium 0.36** $\pm 0.00$

**Copper 0.57** $\pm 0.01$

**Cobalt 0.09** $\pm 0.00$

**Manganese 0.36**$\pm 0.00$

**Discussion**

Free radical production is a continuous process which occurs as part of normal cellular function. However, excessive production of free radicals is strongly implicated in many diseases (Young and Woodside, 2001). The key function of antioxidants is to prevent adverse effects caused by free radicals (Naczk and Shahidi, 2004). To determine if sesame seeds could exert antioxidant effects through single-electron donation, the ABTS assay was used. The pattern of results for this assay was 71.161%. Previous studies reported a scavenging activity of 58% or between 62 - 79% of sesame seed extracts. These observations suggest that the results for the current study were significantly higher than that of Dravie et al., 2020.

The potent hydroxyl radical can be generated through the Fenton reaction in cells. The radical chain reaction mediated by the hydroxyl radical depends on Fe3+. Thus, the ability of a compound to reduce Fe3+ to Fe2+ could contribute to its antioxidant potential. The results obtained in Ferric reducing power activity indicated that sesame seed has an effective reducing power. The reducing power of sesame seed is concentration-dependent similarly with Gallic acid. Higher absorbance indicates increasing reducing power capacity.

To determine the other nutritional benefits that can be derived from the consumption of sesame seeds, physicochemical, mineral and vitamin analysis was carried out. This analysis showed that the magnesium, sodium, calcium and potassium content of sesame seed was 6.63 $\pm 0.02 mg,$ 3.79$\pm 0.01 mg,$ 9.55 $\pm 0.01 mg$ and 3.34 $\pm 0.04 mg$ respectively. This mineral content of sesame seed is similar to that of the ones found in the previous studies which shows that magnesium, sodium, calcium and potassium content of sesame seeds are 5.79 ± 0.04 mg, 1.22 ± 0.04 mg, 4.15 ± 0.03 mg and 8.51 ± 0.03 mg ( Nzikuo*et al*., 2009).

The results obtained from the physicochemical analysis indicates that sesame oil has an effective refractive index, iodine value which determines the types of fatty acid present in sesame oil, such as saturated fatty acids (e.g., palmitic acid), monounsaturated fatty acids (e.g., oleic acid), and polyunsaturated fatty acids (e.g., linoleic acid). The fatty acid profile of sesame oil contributes to its nutritional properties and potential health benefits (Pham *et al.,* 2015).

**Conclusion**

This study showed that the sesame seed is a good source rich in vitamin minerals and oil. *Sesamumindicum* L*.* seed oil is of unsaturated type and contains mainly the fatty acids oleic C18:1 and linoleic C18:2. The oil can be classified in the oleic-linoleic acid group. High saponifiable matters content (273.95mgKOH/kg**)** guarantees the use the oils in cosmetics industry. The oil extracts exhibited good physicochemical properties and could be useful for health and industrial applications.

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