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HYDRODISTILLATION EXTRACTION AND EVALUATION OF ESSENTIAL OIL FROM BLACK SEED (*NIGELLA SATIVA*)

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ABSTRACT

The seed (Nigella sativa), commonly known as black seeds, is a widely used medicinal plant, and it is prevalent in various traditional systems of medicine. The oil has been used in traditional medicine and flavouring. This research study reported that the percentage yield of the essential oil obtained by the hydrodistillation method was (48%). The study of the physicochemical parameters determined the specific gravity (1.0475g/ml) degree of acidity of the oil is (7.29mg/KOH/g) while the saponification value (192mg/g) and Iodine value (122mg/100g.) The mineral composition determined were Ca (1104.7mg/100g), Mg (630mg/100g), K (4725mg/100g), P (2460mg/100g), Fe (2318.7/100mg). The results suggested that N. sativa has specific physicochemical properties and that N. saliva is also rich in minerals, with (K) being the most abundant element and (Mg) being the least. The seed oil serves as a good source for use in medicinal applications.

KEYWORDS

Black seed oil (*Nigella sativa*), hydrodistillation, physicochemical, minerals composition

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INTRODUCTION

Black cumin (*Nigella sativa*), also called black seed black caraway, is an annual plant grown for its pungent seeds, used as a spice and in herbal medicine. Black seed (*Nigella sativa)* is a small flowering shrub with purple or white-tinged flowers that grows in Eastern Europe, the Middle East,

western Asia, and Africa (Bita, 2012). Oils derived from non-traditional seeds, such as safflower, milk thistle, and black cumin seeds, have recently grown in popularity. Seed oil is in high demand due to consumer interest in illness prevention and health promotion through healthier diets with a high concentration of monounsaturated and polyunsaturated fatty acids and antioxidant phenolic components (Taraseviciene *et al.*, 2023).

The seeds of black cumin are fascinating since they contain considerable amounts of phytochemicals with antioxidant qualities and health benefits. The seeds have a high concentration of fixed oil, which benefits both human health and nutrition due to the presence of major (essential fatty acids) and minor substances (phenolic compounds, tocopherols, and sterols). Tocols (tocopherols and tocotrienols) protect the oil from lipid oxidation and enhance its oxidative stability. Among the minor chemicals, thymoquinone is the main active component of the seeds and has several beneficial characteristics, including antioxidant and anti-inflammatory capabilities (Ketenoglu *et al.*, 2020).

The seeds are commonly roasted and ground as a spice and are widely used in India, the Middle East, and parts of North Africa to season curries, rice, breads, and sweet confections. Black cumin is also essential in traditional medicine in many places and is an esteemed herbal remedy for various ailments. The plant is sometimes grown as an ornamental for its attractive flowers (Atta, 2003). Thymoquinone (2-isopropyl-5-methyl-1, 4-benzoquinone) is the main bioactive component of the essential oil of the medicinal plant *Nigella sativa* (Odeh *et al.,* 2012).

Both seeds and their oil have been a significant focus of research and extensively premeditated due to their wide variety of chemical constituents and biological activities, which are imperative in promoting human health and nutrition and have found versatile medicinal

significance against diseases. Seeds are reported as digestive stimulants and carminative, diuretic, anthelmintic, and asthmatic (Hashmi *et al.,* 2014). This article describes the extraction and evaluation of essential oil from black seed (*Nigella Sativa*) using hydrodistillation to determine the physiochemical and mineral properties.

MATERIALS AND METHODS

Materials

Black seed (*Nigella sativa)* was purchased from local herbal shops in Samaru market in Zaria. About 250g seeds were cleaned with fresh water to remove dust and then sundried. The seeds were ground into fine powder and then packed and stored in a refrigerator at 40°C before analysis. Solvents were procured as an analytical grade from the laboratory.

Methods

Essential oil extraction (Steam distillation)

Exactly 100g of the black seed (*Nigella sativa*) ground sample was weighed into a distiller container. About 250 ml of n-hexane solvent was poured into the extraction container through an inlet." Steam is injected through the plant material containing the desired oils, releasing its aromatic molecules and turning them into vapour. The vaporized plant compounds travel to the Condenser. Two separate pipes allow hot water to exit and cold water to enter the Condenser. This makes the vapour cool back into liquid form. The aromatic liquid by-product drops from the Condenser and collects inside the separator. The essential oil floats on top of the water siphoned off, and the oil is obtained.

Physicochemical Analysis

Determination of Specific Gravity:

An empty specific gravity (SG) bottle was weighed and recorded as the initial weight of the empty bottle (W_1). The empty SG bottle was filled to mark with distilled water and weighed as the weight of the bottle with distilled water (W_2). The SG bottle was washed, dried and allowed to cool. Then, it was filled to mark with the oil sample, weighed and recorded as the weight of the bottle with oil (W_3). The result was calculated using Equation 1.

$$\boldsymbol{S.G = \frac{W_3 - W_2}{W_2 - W_1}} \quad 1$$

Determination of acid value:

About 0.5g of the oil sample was weighed into a conical flask using a plastic dropper, followed by 20 ml of absolute ethanol. Exactly three drops of phenolphthalein were added, and the solution was titrated using 0.1M potassium hydroxide until the pink colour persisted and the result was read.

$$Acid\ value = \frac{acid\ value}{2} \quad 2$$

Determination of saponification value:

Exactly 0.5g of the oil sample was weighed into a conical flask, followed by 50 ml of 0.5 N alcoholic potassium hydroxide, refluxed for 30 minutes to ensure perfect dissolution. The solution was allowed to cool, and three drops of phenolphthalein were added. The solution was titrated with

0.5N HCL, and the titre value was recorded. Blank titration was carried out and also recorded. The value was calculated.

Determination of iodine value:

About 0.5g of the oil sample was weighed into a conical flask, followed by 15 ml of chloroform, after which 25 ml of Wiji's solution was added and covered tightly using a sheet of foil and kept in a dark for about 30 minutes. Precisely 20 ml of 10% potassium iodide, 150 ml of distilled water, and 5 ml of 1% starch indicator were added. The whole solution was titrated with 0.1N sodium thiosulphate until the endpoint was achieved. The iodine value was calculated using Equation 3.

$$Iodine\ value\ (IV) = \frac{260X}{45.150} \qquad 3$$

Where X is the volume of Hubl's iodine in meters.

Estimation of Minerals

The dry powder was kept in an incubator at 50^{o}C overnight due to moisture and then digested by HNO_3 and ($HClO_4$). The seeds' mineral contents were determined by Petersen's analytical method (2002). The Calcium (Ca), Magnesium (Mg) and Iron (Fe) were analysed by Atomic Absorption Spectrophotometry, Phosphorus (P) by Spectrophotometry and Sodium (Na) as well as Potassium (K) by Flame photometry.

RESULTS AND DISCUSSION

Result of Physiochemical Analysis

The result obtained from this research study is that essential oil was obtained from *Nigella sativa* seed by hydro distillation method according to the above method, the percentage yield (%) of the essential oil obtained by this method was (48%) which shows it contains much essential oil. The physiochemical parameters (Table 1) determined during this research were specific gravity, acid

value, saponification and iodine value with corresponding values of 1.0475 g/ml, 7.29 mg KOH/g, 192 mg/g and 122 mg/ g, respectively. The acid values indicate that oil hydrolysed predominantly during the enzymatic hydrolysed process.

Free Fatty Acids are fatty acids that exist in oil molecules or triacylglycerol (TAGs) that have been hydrolysed, and their presence indicates that degradation may have occurred in the oil through poor handling during seed harvesting or oil processing. Free fatty acids can influence the organoleptic value of the oil. (Rubalya, *et al.,* 2014). Free fatty acids are fatty acids that exist in oil molecules that have been hydrolysed. According to Table 1.1, the saponification value determined was 192mg/kg, while the values in the literature ranged between 190-222 mg/kg (Mohammed *et al.,* 2019).

The saponification value measures the alkali-reactive groups in oils, which can be used to predict the type of TAGs in the screening test for characterizing types of acyl groups present in an oil. However, the saponification value determined falls within the agreed literature with other studies, and the high saponification value suggests high TAGs content (Mohammed *et al.,* 2019).

In addition, the iodine value of 122 mg/100g falls at the end of the result in the range set by FAO/WHO standards (2014), which indicated that the oils of *N. saliva* might be useful for domestic and industrial applications. It is still essential in assessing the stability of oil in oleo chemical applications such as making soap. The iodine value was within the reported range.

Table 1: Physicochemical parameters of *Nigella sativa*

S/N	Parameters	Determined value	Values in literature
1	Specific gravity (g/ml)	1.0475	0.9-1.16
2	Acidvalue(mgKOH/g)(%FFA)	7.29	7.49-22.7
3	Saponification value (mg/g)	192	190-226
4	Iodine value (mg/g)	122	98-122

Result of Mineral Analysis

Mineral analysis carried out in this research study, as shown in Table 2, comprising five elements such as calcium (Ca), magnesium (Mg), potassium (K), phosphorous (P) and iron (Fe) were determined. The average results indicate that the data of mineral analysis of black seed (*Nigella sativa*) contains an abundant amount of minerals, where the contents obtained for calcium, magnesium, potassium, phosphorous and iron were 1104.75mg/kg, 630mg/kg, 4725mg/kg, 24600mg/kg and 2318.75 mg/ kg respectively. However, phosphorous showed the highest mineral content of 24600 mg/kg, with the high levels indicative that it is essential for plant growth. In humans, phosphorous compounds carry, store and release energy, assisting many enzymes and vitamins in extracting energy from nutrients (Devi *et al*., 2020).

Table 2: Mineral composition of black seed *(Nigella sativa*)

Minerals	**Mg/kg**	**(%)**
Calcium	1104.7	0.111
Magnesium	630	0.063
Potassium	4725	0.473
Phosphorus	24600	2.46
Iron	2318.75	0.232

CONCLUSION

This study obtained 48% essential oil from black seed (*Nigella sativa*) by hydrodistillation. The result showed that the physicochemical properties of *Nigella sativa* are a high percentage of the studied parameters and agree with the values in the literature. Therefore, it could be suggested that they are useful in traditional medicine and popularly used in some instances of eczema (Ali and Blunden, 2003; Atta, 2003). Black seed oils are known for their nutritive properties and are used for various applications throughout the nutritional supplement and personal care industries. Black seed has remarkable healing and health properties, making it one of man's most potent medicinal plants. The nutrient information obtained in this study would be critical to the success of efforts to promote the broader use of indigenous plant alternative raw materials and educate people regarding the nutritional benefits of the many cultivated plant foods in the environment.

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