e-ISSN 2320 –7876 www.ijfans.org
Vol.11, S Iss.1, 2022
 UGC CARE Listed ( Group -I) Journal

# A Study on Physico-chemical Properties and Nutritional Profile of an Indigenous Cultivar - Black cumin (*Nigella sativa* L.)

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## Abstract

**Objective:** The present study was aimed to investigate the physico-chemical properties evaluation, proximate analysis and minerals profile of *Nigella sativa* L. (AN-1 variety) seeds.

**Methods:** The physico-chemical properties, proximate analysis and minerals evaluation of black seeds were performed by following the standard methods.

**Results:** Physico-chemical properties of seeds; color, odor, taste, size and shape of seeds, weight of seeds, bulk density, tapped density and seed coat content was determined. Hydration properties including hydration capacity, hydration index and swelling capacity were also evaluated. In proximate analysis, it was found that black seeds contain moisture (7.06%), crude protein (18.67%), crude fat (45.09%), crude fiber (7.33%), ash (4.33%) and total carbohydrates (17.51%). The results of mineral analysis showed the presence of minerals like Ca (2.63µg/ml), K (1.94 µg/ml), Zn (1.24 µg/ml), Cu (0.31 µg/ml), Mg (0.30 µg/ml). The findings indicated the presence of an appreciable content of nutrients and minerals, which has the potential to satisfy the nutritional requirements of the population. Therefore, these kinds of medicinal seed spices should be studied in future.

**Keywords:** Black seeds, nutritional properties, seeds, hydration properties, minerals, proximate analysis

  

## Introduction

Since the beginning of life, mankind is using different plant sources to treat or prevent illness (Kinki, 2020). Undoubtedly, seed spices are the marvelous gift of Mother Nature to us that possess various health promoting properties (Aftab *et al.* 2018). Among all the seed spices, *Nigella sativa* L. is an effective seed spice of India and Middle East (Lal and Meena, 2020). It is an annual herbaceous plant that is the member of Ranunculaceae family and commonly recognized as Black cumin, Kalonji, Black caraway, Habbatul Baraka (Kabir *et al.* 2019). It is an Indigenous cultivar and particularly grown in Punjab, Himachal Pradesh, Rajasthan, Assam, Bengal and Maharashtra (Islam *et al.* 2019).

Black cumin is famous for the saying of the Prophet Muhammad (Sal Lal Lahu Alayhi Wa Sallam) that means "Hold on to use of black cumin seed, it has a remedy for every illness except death" (Shrivastava *et al.* 2011; Hassanien *et al.* 2015; Hussain and Hussain, 2016). Inspite of medical importance, black cumin is known for culinary purpose as well as for functional cosmetics and dietary (Yimer *et al.* 2019). In fact, this seed spice has occupied a special place in COVID-19 pandemic for its important medicinal applications. It is used in preparing a healthy concoction (*Kaddha*) mixing with other spices which has been used as immunity booster to fight against the corona infection (Khazdair *et al.* 2021). Apart from this, Black cumin is also used in several cooked and processed food products in India due to having antioxidant and antimicrobial properties (Ahamd *et al.* 2013; Sharma *et al.* 2017; Huchchannanavar *et al.* 2019). Interestingly, the tiny seeds contain essential (0.40%-0.45%) and fixed (32-40%) oils, carbohydrates (31-33.9%), protein (16-20.85%), fiber (5.50%-7.94%), tannins, alkaloids, saponins (Khan and Afzal, 2016), minerals such as Fe, Ca, k, Mg, Zn and Cu (1.79%-3.44%), vitamin C, vitamin A, niacin, thiamine, pyridoxine (Hangargekar *et al.* 2020).

Black cumin is referred as miracle herb because it possess wonderful power of healing and the seeds are effective for treatment of variety of diseases and conditions (Tembhurne *et al.* 2014) because it exhibit a diverse range of biological and pharmacological properties (Thilakaratnne *et al.* 2018), some of which includes anti-hypertensive, antidiabetic, diuretics, anticancer, anti-modulator, analgesic, antoxidant, antimicrobial, anti-inflammatory, hepato-protective, gastro-protective properties (Dubey *et al.* 2016). In this way, black seeds have earned a place among highest ranked evidence based herbal medicines (Allah *et al.* 2021).

  

## Plant Characteristics

**Table 1. Taxonomic classification (Samjdar S, 2017)**

| Taxonomic classification | |
|---|---|
| Kingdom | Plantae |
| Super division | Spermatophyta |
| Phylum | Magnoliophyta |
| Class | Magnoliopsida |
| Order | Ranunculales |
| Family | Ranunculaceae |
| Genus | *Nigella* |
| Species | *sativa* |

### *Plant Morphology*

*Nigella sativa* L. is a plant that blooms once a year and can reach a height of up to 95 centimeters. It has finely divided leaves, and the individual leaf segments range from being narrowly linear to looking like threads (Mamun and Absar, 2018). The flowers have typically shades of white, yellow, pink, pale blue, or purple, and they have a delicate appearance (Shariq *et al.* 2015). There can be four to ten petals present. The fruit is large, green, and capsulated; it contains three to eight united follicles; each follicle contains numerous black seeds (Kiralan *et al.* 2014).

**Fig.1** *Nigella sativa* Plant and Flowers

  

***Seed Characteristics***

Black cumin has small dicotyledonous seeds that are trigonus, angular, regulose-tubercular in shape, 2-3.5mm in size, black on outside and white from inside, with a mild aromatic odour and bitter flavor (Datta *et al.* 2012). Examined under the microscopic level, seeds showed a single-layered epidermis with thick walls which were packed with a dark brown content. The epidermis is followed by two to four layers of parenchymatous cells that have thick walls and are elongated tangentially (Javed *et al.* 2012; Shukla *et al.* 2015). The epidermis is then followed by a reddish brown pigmented layer that is composed of parenchymatous cells which are elongated rectangular. Endosperm is made up of cells that are predominantly filled with oil globules. These cells can be either rectangular or polygonal in shape. Parenchymatous cells and oil globules can be seen in the powder microscopy of seed powder (Abdallah *et al.* 2017).

**Fig.2** *Nigella sativa* seeds

*Nigella sativa* seeds have three angular corners, two of which are flat and one of which is convex. The outside of the seed can be either black or brown, while the interior is white and oleaginous. The seeds have a hot and peppery taste within strong, pleasant scent similar to that of nutmegs (Wako, 2020).

**Materials and Methods**

**Plant Material**

The seeds of *Nigella sativa* L. were procured during the month of April, 2021 at properly matured (dark black color) stage from National Research Centre on Seed Spices ICAR-NRCSS, Tabiji, Ajmer, Rajasthan, India. NRCSS designated this study material as Ajmer Nigella (AN -1 Variety).

  

**Preparation of Plant Material**

In order to remove any traces of dirt or other contaminants, the seeds were first washed thoroughly with tap water, and then washed again with distilled water. The washed black seeds (AN-1) were blotted on blotting paper and shade dried at room temperature. Fine powder of dried seeds was obtained by electric grinder for 1 minute until fine powder was obtained to further proceed with experiments.

**Physico-chemical Properties**

Physico-chemical parameters of black cumin seeds were determined in the initial stage of study. These properties included size and shape of seeds, seed coat content, hundred seed weight, bulk density, tapped density and hydration properties including hydration capacity, hydration index and swelling capacity were all determined. Some physical tests were also performed for testing the odor, taste and color of black cumin seeds.

***Size of black cumin seeds***

Size of seeds was measured in terms of length and width. Seeds length and width was measured in mm with the aid of digital Vernier caliper. Length and width of each seed was measured and the average value was obtained and expressed in mm.

***Kernel weight/Hundred Seed Weight***

For experimental assessment, 100 seeds of black cumin were arbitrarily selected and total kernel weight was determined using the electronic weight balance and the samples were taken in triplicates. The weight of individual seeds was also determined in grams.

***Seed coat content***

A sample of seeds weighed accurately 2.0g was soaked in distilled water at room temperature for 16 hours. After draining of water, the soaked seeds were dried on parchment paper and the seed coat was completely removed using the tweezers. The collected seed coat was dried for 24 hours in an oven at 60ºC and cooled in desiccator. The seed coat content was determined by using the electronic weighing balance and the percentage of seed coat content to seed coat was calculated.

***Bulk density***

The seeds were weighed precisely as 5.0g and then transferred to a measuring cylinder. After that 100ml distilled water was added to it. The volume of seed was measured as total volume (ml) and this volume was subtracted from 20ml volume. The density was measured in grammes per milliliter (g/ml).

  

***True density/ Tapped density***

The seeds were accurately weighed 5.0g and then transferred in 100ml measuring cylinder. Mechanically, cylinder containing the sample was tapped. In the beginning, the cylinder was tapped a hundred times, and the volume that was tapped, measured as ($V_1$) to the nearest graduated unit. A total of two hundred taps were performed, and each time the volume of each tap was measured as ($V_2$) to the nearest graduated unit. A calculation was made to determine the difference between two volumes, and the final volume was taken into consideration as ($V_2$).

***Hydration Capacity***

Water was poured to the measuring cylinder after the seeds were precisely weighed at 2.0g. The cylinder was kept overnight at room temperature and wrapped in aluminium foil. The following day, seeds were drained, excess water was filtered out using filter paper, swollen seeds were reweighed, and hydration capacity per seed was calculated.

***Hydration index***

Hydration index of black seeds was determined by evaluating of hydration capacity per seed and then divided by weight of each seed.

***Swelling capacity***

Seeds weighed 2.0g and their volume was noted down. After that seeds were soaked overnight. The swelling capacity per seed was calculated from the volume of soaked seeds in a graduated cylinder.

**Proximate Analysis**

Proximal analysis for moisture, crude fat, protein, dietary fiber and ash was performed according to respective methods of the official Methods of Analysis of the Association of Official Analytical Chemists (AOAC) followed by Khalid *et al.* (2019) with slight modifications. The carbohydrate of *Nigella sativa* seeds was calculated by subtracting the total of protein, fat, moisture, fiber and ash from 100. All the analytical procedures were performed at least in triplicates in order to ensure the results. The values were expressed as the mean ± standard deviation.

**Moisture content**

The moisture content of the sample was ascertained by hot air oven method as described in AOAC (2005). 5g of sample was weighed in pre-weighed petri dish (without lid) and petri dish was heated in hot air oven for drying the seed powder at $70^0$C for 6-7 hrs. After cooling

  

in desiccator, weight of the petri dish was noted for calculating the per cent of dry matter from the sample.

**Fat content**

Fat content of the sample was determined by using the standard procedure described in AOAC (2005). 5g of powdered sample was dried overnight in the oven to remove the moisture and then transferred into pre-weighed (dried) extraction thimble and extracted in Soxhlet extraction apparatus using petroleum ether as solvent for 5-6 h. Then petroleum ether was removed by evaporation and residue left was kept for drying at 100ºC in hot air oven for 10-15min. After cooling in desiccator, weight was measured. The percentage of fat was calculated as a result of the weight loss of the thimble.

**Protein content**

Crude protein content in each sample was determined by Macro-kjeldahl method which is described in AOAC (2005).

*Digestion:* Some glass beads and a pinch of catalytic mixture and 5g of seed powder sample were put into the digestion flask after proper weighing. Then 20ml of concentrated sulphuric acid was added and digestion was continued for 3-4 h till the content of digestion flask attained transparent color. Then the content was allowed to cool at room temperature. After filtration, final volume was made up to 100ml with distilled water.

*Distillation:* To a 150ml conical flask, 10ml boric acid and 2-3 drops of indicator were added and kept in contact with the condenser. Then to the distillation flask, 2ml aliquot and 10ml NaOH solution were transferred. Liberated ammonia was collected in the conical flask and distillation was carried out at least 80ml of the distillate. Then the contents of flask were titrated against 0.01N HCL solution. Reading of blank (same procedure except sample addition) was also obtained.

**Ash content**

Total ash content of the sample was calculated by using the procedure described in AOAC (2005). In precisely weighed (dry) silica crucibles, a 2g sample of seed powder was collected and placed on a hot plate for charring until the smoke disappeared. Then the charred samples were put into muffle furnace at 550ºC temperature for 5-6 h. Weight of the crucibles was noted after cooling in desiccator and percent ash was obtained.

  

**Crude fibre**

Crude fibre of the samples was calculated as per standard AOAC (2005) method. Residue of fat extract was used for the determination of crude fibre. Briefly, 2g fat free sample of seed powder and 200ml of 0.128M $H_2SO_4$ solution were added to a 1 litre tall beaker and were digested using crude fibre apparatus. After washing with distilled water and filtration using Buchner funnel, the samples were again digested with 200ml of 0.313M NaOH solution. Then the samples were washed with distilled water and filtered again. Washing with alcohol (twice) and acetone (thrice times) was also carried out. The samples were dried at 100ºC till constant weight was achieved, after that samples were places in muffle furnace at 550ºC-650ºC for 3-4 h for obtaining grey ash.

**Minerals content**

The Samples were digested by wet-ashing and minerals were determined using a GBC 932+ model of atomic absorption spectrophotometer as in the method given by AOAC (2005). The ash obtained from muffle furnace was dissolved in HNO3 for the determination of the minerals content present in black cumin seeds powder.

**Results and Discussion**

The physico-chemical properties and nutritional composition of (AN-1) variety of *Nigella sativa* (black cumin) seed powder samples were analyzed. The results of different physicochemical characteristics are presented in **Table 2.** and quality attributes in proximate analysis of black cumin seeds are presented in **Table 3.** The results indicated that it contained the following nutritional components in the range of 7.06% moisture, 18.67% protein, 45.09% fat, 7.33% crude fibre, 4.33% ash and 17.51% nitrogen free extract. In minerals analysis, the result of major contributing minerals was presented in **Table 4.** The minerals were found in the ranges of 2.63µg/ml (Ca), 1.94µg/ml (K), 1.24µg/ml (Zn), 0.31µg/ml (Cu) and 0.30µg/ml (Mg). The data was expressed as mean ± standard deviation. The current study was carried out in order to estimate the nutritional composition and minerals composition of indigenous cultivar of AN-1 *Nigella sativa* L. cultivated in Rajasthan. The results showed that it has high nutritional composition as compared to the earlier studies found in literature.

  

**Table 2. Physico-chemical Properties of black cumin seed powder**

| **Physico-chemical parameters** | |
|---|---|
| Kernel weight (g) | 1.26±0.54 |
| Seeds Size<br>( Length in mm)<br>(Width in mm) | <br>1.91±0.52<br>1.32±0.37 |
| Seed coat content (g) | 1.26±0.54 |
| Bulk density (g/ml) | 0.29±0.05 |
| True density (g/ml) | 0.46±0.20 |
| Hydration capacity(g) | 0.04±0.03 |
| Hydration index (g) | 0.31±0.32 |
| Swelling capacity(g/ml) | 0.6±0.2 |

**Table: 3. Proximate analysis of black cumin seed powder**

| **Sr. No.** | **Nutritional components** | **Composition (%)** |
|---|---|---|
| **1.** | Moisture | 7.06±0.52 |
| **2.** | Crude Protein | 18.67±1.98 |
| **3.** | Crude Fat | 45.09±0.84 |
| **4.** | Crude fiber | 7.33±1.04 |
| **5.** | Ash | 4.33±0.47 |
| **6.** | NFE | 17.51±0.3 |

**Values represented as mean ± standard deviation and data performed in triplicate*

  

**Table: 4. Mineral analysis of black cumin seed powder**

| Minerals content | Conc. (µg/ml) |
|---|---|
| **Zinc (Zn)** | 1.24 ±0.085 |
| **Copper (Cu)** | 0.31±0.048 |
| **Potassium (K)** | 1.94±0.068 |
| **Magnesium (Mg)** | 0.30±0.012 |
| **Calcium (Ca)** | 2.63±1.084 |

**Values represented as mean ± standard deviation and data performed in triplicate*

*****The standard deviation values were measured by using the standard deviation calculator.

**Conclusion**

One of the most significant seed spices, *Nigella sativa* is used all over the world for its health benefits. It has also been used as a medicine from ancient times. Food manufacturers also use it as a preservative and flavouring agent in food products. Black cumin seeds are essential for boosting human immunity, treating cancer, viral infections, and other illnesses linked to immunological deficiencies. During the COVID-19 pandemic, black seeds were also utilized in decoction with other spices due to its great antioxidant activity. The nutritional components of black cumin seeds are crucial for maintaining the human health because they provide the right proportions of nutrients including protein, lipids, carbs, and fibres as the body required. The nutritive value of black seeds is increased by the inclusion of bioactive components, which makes them a potentially healthy dietary source.

**Conflicts of Interest**

We declare that we have no conflicts of interest.

**Declarations**

This manuscript is original work of the mentioned authors that has not been submitted anywhere else and follows the research ethics.

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