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Ashok Pal Singh
 Punjab Agricultural
 University, Ludhiana, Punjab,
 India

Comprehensive analysis of the nutritional profile of mustard (*Brassica juncea* L.) Seeds

Ashok Pal Singh

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Abstract

Mustard (*Brassica juncea* L.) seeds are valued for their nutritional and medicinal properties. This study presents a comprehensive analysis of the nutritional profile of mustard seeds, including macronutrient and micronutrient content, phytochemical composition, and antioxidant activity. The findings highlight the potential health benefits of incorporating mustard seeds into the diet, providing a basis for further research and development of functional foods.

Keywords: Mustard seeds, *Brassica juncea*, nutritional composition, phytochemicals, antioxidants

Introduction

Mustard (*Brassica juncea* L.), a member of the Brassicaceae family, is widely cultivated for its seeds, which are used as a spice and in the production of mustard oil. Mustard seeds are known for their distinctive flavor and are a staple in various cuisines around the world. Beyond their culinary uses, mustard seeds have been recognized for their nutritional and medicinal properties, including potential benefits in managing chronic diseases due to their rich content of bioactive compounds.

Despite the growing interest in the health benefits of mustard seeds, there is limited comprehensive data on their nutritional composition. This study aims to fill this gap by providing a detailed analysis of the macronutrient and micronutrient content, phytochemical profile, and antioxidant activity of mustard seeds. Understanding the nutritional profile of mustard seeds can inform their potential use in dietary applications and the development of functional foods.

Objective of paper

The objective of this paper is to comprehensively analyze the nutritional profile of mustard (*Brassica juncea* L.) seeds, including their macronutrient and micronutrient content, phytochemical composition, and antioxidant activity, to understand their potential health benefits and applications in functional foods.

Materials and Methods

Sample Collection: Mustard seeds (*Brassica juncea* L.) were sourced from the local agricultural market in Ranchi, Jharkhand, India, on March 15, 2024. The seeds were cleaned to remove impurities and stored in a cool, dry place until analysis.

Proximate Analysis: Proximate analysis was conducted to determine the macronutrient composition of mustard seeds, including moisture, ash, protein, fat, and carbohydrate content. Standard methods from the Association of Official Analytical Chemists (AOAC) were employed for the analysis. Moisture content was determined by drying the seeds at 105 °C until a constant weight was achieved, following the AOAC 925.10 method. Ash content was measured by incinerating the seeds at 550 °C in a muffle furnace according to the AOAC 923.03 method. Protein content was analyzed using the Kjeldahl method, which determines total nitrogen content as per AOAC 979.09. Fat content was extracted using the Soxhlet extraction method with petroleum ether as the solvent, following the AOAC 920.39 protocol.

Corresponding Author:
Ashok Pal Singh
 Punjab Agricultural
 University, Ludhiana, Punjab,
 India

Carbohydrate content was calculated by difference, subtracting the sum of moisture, ash, protein, and fat from the total weight of the sample.

Mineral Analysis: The mineral content of mustard seeds, including calcium, magnesium, potassium, iron, and zinc, was determined using atomic absorption spectroscopy (AAS). The samples were first subjected to wet digestion with a mixture of nitric acid and perchloric acid according to the AOAC 975.03 method. The digested samples were then analyzed using AAS to quantify the levels of each mineral.

Phytochemical Analysis: Phytochemical constituents, including total phenolic content (TPC) and total flavonoid content (TFC), were analyzed using spectrophotometric methods. Total phenolic content was measured using the Folin-Ciocalteu reagent and expressed as milligrams of gallic acid equivalents (GAE) per gram of sample, based on the method described by Singleton & Rossi (1965). For total flavonoid content, the aluminum chloride colorimetric method was used, and the results were expressed as milligrams of quercetin equivalents (QE) per gram of sample, following the procedure outlined by Zhishen *et al.* (1999).

Antioxidant Activity: The antioxidant activity of mustard seed extracts was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay. This method assesses the ability of the antioxidants in the mustard seeds to quench DPPH free radicals. The reduction in absorbance at 517 nm, indicative of the scavenging of DPPH radicals, was measured using a spectrophotometer. The results were expressed as the percentage of DPPH inhibition, following the protocol described by Brand-Williams *et al.* (1995).

Statistical Analysis: All experiments were conducted in triplicate to ensure reliability and reproducibility of the results. Data were statistically analyzed using Analysis of Variance (ANOVA) to determine significant differences between the means of different treatment groups. Tukey's post hoc test was employed for pairwise comparisons to identify specific differences between groups. A significance level of $p < 0.05$ was used to determine statistical significance.

Results and Discussion

The results of this study provide a comprehensive overview of the nutritional composition, phytochemical content, and antioxidant activity of mustard (*Brassica juncea* L.) seeds. The findings are presented in detailed tables, followed by an in-depth discussion.

Proximate Composition

The proximate composition of mustard seeds was analyzed to determine their macronutrient content. The results are summarized in Table 1.

Table 1: Proximate Composition of Mustard Seeds

Component	Content (g/100 g)
Moisture	7.2±0.3
Ash	4.5±0.2
Protein	28.4±1.1
Fat	36.2±1.4
Carbohydrate	23.7±0.9

The moisture content of mustard seeds was found to be 7.2%, which is typical for seeds and indicates good storage stability. The ash content, representing the total mineral content, was 4.5%, reflecting the presence of essential minerals. Protein content was substantial at 28.4%, highlighting mustard seeds as an excellent source of plant-based protein. The fat content was notably high at 36.2%, indicating that mustard seeds are also a significant source of healthy fats. The carbohydrate content, calculated by difference, was 23.7%, providing an additional energy source.

Mineral Content

The mineral content of mustard seeds was determined using atomic absorption spectroscopy, and the results are presented in Table 2.

Table 2: Mineral Content of Mustard Seeds

Mineral	Content (mg/100 g)
Calcium	254±10
Magnesium	345±12
Potassium	687±15
Iron	9.8±0.4
Zinc	5.6±0.3

Mustard seeds were found to be rich in potassium (687 mg/100 g) and magnesium (345 mg/100 g), which are crucial for maintaining electrolyte balance and muscle function. Calcium content was also significant at 254 mg/100 g, contributing to bone health. The seeds provided 9.8 mg/100 g of iron, essential for oxygen transport in the blood, and 5.6 mg/100 g of zinc, important for immune function and enzyme activity.

Phytochemical Composition

The phytochemical analysis of mustard seeds focused on total phenolic content (TPC) and total flavonoid content (TFC). The results are summarized in Table 3.

Table 3: Phytochemical Composition of Mustard Seeds

Phytochemical	Content (mg/g)
Total Phenolic Content (TPC)	65.3±2.1 (GAE)
Total Flavonoid Content (TFC)	28.7±1.0 (QE)

The total phenolic content was 65.3 mg GAE/g, indicating a high concentration of phenolic compounds, which are known for their antioxidant properties. The total flavonoid content was 28.7 mg QE/g, further contributing to the antioxidant potential of mustard seeds. These bioactive compounds can help mitigate oxidative stress and reduce the risk of chronic diseases.

Antioxidant Activity

The antioxidant activity of mustard seed extracts was assessed using the DPPH radical scavenging assay. The results are presented in Table 4.

Table 4: Antioxidant Activity of Mustard Seeds

Sample	DPPH Inhibition (%)
Mustard Seeds	82.5±2.4

The DPPH radical scavenging assay revealed that mustard seeds exhibited strong antioxidant activity, with an inhibition percentage of 82.5%. This high level of

antioxidant activity suggests that mustard seeds can effectively neutralize free radicals, contributing to their health benefits.

Discussion

The proximate composition analysis indicates that mustard seeds are a rich source of protein and fat, making them a valuable dietary component for plant-based diets. The high protein content (28.4%) is particularly noteworthy, as it positions mustard seeds as a competitive alternative to other plant-based protein sources such as legumes and nuts. The significant fat content (36.2%) primarily comprises healthy fats, which are beneficial for heart health and overall well-being.

The mineral analysis underscores the nutritional value of mustard seeds, highlighting their high levels of potassium and magnesium, which are essential for various physiological functions. The presence of calcium and iron further enhances the nutritional profile of mustard seeds, making them a well-rounded addition to a balanced diet.

The phytochemical composition analysis revealed that mustard seeds are rich in phenolic compounds and flavonoids, which are potent antioxidants. The high total phenolic content (65.3 mg GAE/g) and total flavonoid content (28.7 mg QE/g) suggest that mustard seeds can significantly contribute to the dietary intake of these beneficial compounds. These findings are in line with previous studies that have demonstrated the antioxidant properties of phenolics and flavonoids in various plant foods.

The strong antioxidant activity of mustard seeds, as evidenced by the DPPH inhibition assay (82.5%), indicates their potential role in protecting against oxidative stress and related chronic diseases. This antioxidant capacity can help mitigate the damage caused by free radicals, thereby reducing the risk of conditions such as cardiovascular diseases, diabetes, and cancer.

Overall, the comprehensive analysis of mustard seeds highlights their nutritional richness and potential health benefits. These findings support the inclusion of mustard seeds in the diet and their use in the development of functional foods aimed at enhancing health and preventing chronic diseases. Further research should explore the bioavailability of these nutrients and the health effects of regular consumption of mustard seeds.

Conclusion

The comprehensive analysis of mustard (*Brassica juncea* L.) seeds revealed a rich nutritional profile, including high levels of protein, fat, essential minerals, and bioactive phytochemicals. Mustard seeds demonstrated substantial macronutrient content, with notable amounts of protein (28.4%), fat (36.2%), and carbohydrates (23.7%). The seeds are also a significant source of essential minerals such as potassium, magnesium, calcium, iron, and zinc, which are vital for various physiological functions and overall health.

The phytochemical analysis indicated that mustard seeds are rich in phenolic compounds and flavonoids, known for their potent antioxidant properties. The total phenolic content was measured at 65.3 mg GAE/g, and the total flavonoid content was 28.7 mg QE/g. These bioactive compounds contribute to the strong antioxidant activity of mustard seeds, with a DPPH inhibition percentage of 82.5%, highlighting their

potential role in reducing oxidative stress and preventing chronic diseases.

These findings support the inclusion of mustard seeds in the diet and their use in the development of functional foods aimed at enhancing health and preventing diseases. The high nutritional and antioxidant content makes mustard seeds a valuable addition to plant-based diets and a promising ingredient in health-focused food products. Further research should focus on the bioavailability of these nutrients and the long-term health effects of regular mustard seed consumption.

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