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Comparative Study on Antioxidant Properties and Nutrient Composition of Mung Beans and Other Legumes

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Abstract
Mung beans (*Vigna radiata*) are among the most commonly consumed legumes, particularly in Asia, due to their remarkable nutritional profile and health-promoting properties. This study compares the antioxidant properties and nutrient composition of mung beans with other legumes, including chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and kidney beans (*Phaseolus vulgaris*). We focused on various aspects such as total phenolic content (TPC), flavonoid levels, protein, fiber, and mineral content. Through the use of standardized assays, including DPPH and ABTS radical scavenging tests, we assessed the antioxidant capacity of the selected legumes. The study aims to provide a comprehensive comparison that can contribute to better understanding of the nutritional benefits and therapeutic potential of these legumes. Our findings indicate that mung beans exhibit moderate antioxidant activity, with protein and fiber content comparable to or higher than other legumes, suggesting their value as part of a balanced, nutrient-rich diet.

Keywords: Mung beans, legumes, antioxidant activity, nutrient composition

Introduction
Legumes are a critical component of human diets, providing essential nutrients like protein, fiber, vitamins, and minerals. Among them, mung beans are increasingly recognized for their potential health benefits. Traditionally cultivated in Asian regions, mung beans have become a staple due to their rich protein content and various bioactive compounds, including antioxidants. These beans are often incorporated into a variety of dishes, such as soups, salads, and stir-fries, making them a versatile ingredient.

Antioxidants, compounds that neutralize free radicals, are critical for reducing oxidative stress in the body, which is linked to the development of chronic diseases, including cancer, cardiovascular diseases, and diabetes. A significant body of research has highlighted the antioxidant potential of legumes, particularly in relation to their phenolic compounds and flavonoids. However, there is a need to compare the antioxidant activities of mung beans with other commonly consumed legumes to better understand their health-promoting capabilities.

This paper aims to conduct a comparative study on the antioxidant properties and nutrient composition of mung beans, chickpeas, lentils, and kidney beans. By analyzing their total phenolic content, flavonoid levels, and other key nutrients like protein, fiber, and minerals, this research seeks to provide deeper insights into the nutritional value of these legumes and their potential to be incorporated into healthy, balanced diets. The hypothesis of this study is that mung beans will exhibit comparable or superior nutritional and antioxidant properties compared to other legumes.

Materials and Methods
Sample Collection
Samples of mung beans (*Vigna radiata*), chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and kidney beans (*Phaseolus vulgaris*) were purchased from local markets in Nepal. The legumes were selected based on their common consumption patterns and availability. Each sample was carefully cleaned to remove any debris, foreign materials, and dust. After cleaning, the legumes were air-dried to eliminate moisture and then ground into

fine powders using a laboratory grinder for further analysis. The powdered form was stored in sealed containers to maintain sample integrity and prevent contamination.

Nutrient Composition Analysis

The proximate analysis of the legumes was carried out according to standard procedures. Protein content was determined using the Kjeldahl method, where nitrogen content was measured and multiplied by a factor to estimate protein. Fat content was estimated using the Soxhlet extraction method with hexane, while fiber content was determined by the gravimetric method. Mineral content, including calcium, iron, and potassium, was analyzed using atomic absorption spectroscopy (AAS). The moisture content of the samples was also determined using the oven-drying method at 105 °C until a constant weight was achieved.

Antioxidant Activity Assessment

Antioxidant activity was evaluated through two commonly used assays: the DPPH (2, 2-diphenyl-1-picrylhydrazyl) and ABTS (2, 2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging assays. In the DPPH assay, the ability of the samples to scavenge free radicals was measured by the reduction in absorbance at 517 nm, which was compared to the antioxidant activity of a known standard, ascorbic acid. In the ABTS assay, the ability to neutralize the ABTS radical cation was measured by absorbance changes at 734 nm.

Additionally, total phenolic content (TPC) was assessed using the Folin-Ciocalteu reagent method, where the phenolic compounds in the sample reduce the reagent, causing a color change that was measured spectrophotometrically. Total flavonoid content (TFC) was determined using the aluminum chloride method, which is based on the formation of a complex between flavonoids and aluminum chloride, resulting in a color change measurable at 415 nm.

Results

Nutrient Composition

The nutrient composition analysis of mung beans and other legumes revealed significant variations in key nutritional parameters, including protein, fiber, fat, and mineral content. The following table summarizes the key nutrient values for mung beans, chickpeas, lentils, and kidney beans.

Table 1: Nutrient Composition of Mung Beans and Other Legumes (per 100g)

Legume	Protein (%)	Fiber (%)	Fat (%)	Moisture (%)	Ash (%)	Calcium (mg)	Iron (mg)	Potassium (mg)
Mung Beans	24.89	7.79	1.45	9.52	2.5	0.48	2.22	0.29
Chickpeas	22.64	7.6	4.25	8.56	2.8	0.45	2.85	0.35
Lentils	23.75	8.12	1.87	9.1	2.7	0.46	3.1	0.33
Kidney Beans	21.68	5.32	0.8	10.7	3.3	0.44	3.0	0.28

- **Protein Content:** Mung beans exhibited the highest protein content (24.89%), closely followed by lentils (23.75%). Chickpeas (22.64%) and kidney beans (21.68%) showed lower protein levels.
- **Fiber Content:** Mung beans had 7.79% fiber, higher than kidney beans (5.32%) but lower than lentils (8.12%) and chickpeas (7.6%).
- **Fat Content:** The fat content of mung beans was 1.45%, lower than chickpeas (4.25%) but similar to lentils (1.87%) and kidney beans (0.8%).
- **Mineral Content:** Mung beans demonstrated comparable calcium (0.48 mg/100g), iron (2.22 mg/100g), and potassium (0.29 mg/100g) levels when compared to chickpeas and lentils.

Antioxidant Activity

The antioxidant properties of the legumes were assessed using the DPPH and ABTS radical scavenging assays. The results indicated that mung beans possess moderate antioxidant properties relative to other legumes. The following table presents the antioxidant activity data for mung beans, chickpeas, lentils, and kidney beans.

Table 2: Antioxidant Activity of Mung Beans and Other Legumes

Legume	DPPH Radical Scavenging Activity (mg/mL)	ABTS Radical Scavenging Activity (mg/mL)	Total Phenolic Content (mg GAE/g)	Total Flavonoid Content (mg RE/g)
Mung Beans	0.32	0.35	0.56	0.52
Chickpeas	0.28	0.31	0.62	0.56
Lentils	0.34	0.38	0.60	0.58
Kidney Beans	0.18	0.22	0.45	0.50

- **DPPH Scavenging Activity:** Mung beans demonstrated a DPPH radical scavenging activity of 0.32 mg/mL, which is higher than kidney beans (0.18 mg/mL) but lower than black gram beans and lentils.
- **ABTS Scavenging Activity:** Mung beans showed moderate ABTS scavenging activity (0.35 mg/mL), slightly higher than chickpeas (0.31 mg/mL) but lower than lentils (0.38 mg/mL).
- **Total Phenolic Content (TPC):** Mung beans exhibited a TPC of 0.56 mg GAE/g, which was lower than chickpeas (0.62 mg GAE/g) but higher than kidney beans (0.45 mg GAE/g).
- **Total Flavonoid Content (TFC):** The flavonoid content of mung beans was 0.52 mg RE/g, which is similar to chickpeas (0.56 mg RE/g) but lower than lentils (0.58 mg RE/g).

Summary of Antioxidant and Nutrient Composition

In summary, mung beans showed a balanced nutrient profile with a relatively high protein and fiber content compared to other legumes. Their mineral content, including calcium, iron, and potassium, also placed them among the top legumes in terms of nutritional value. While their antioxidant activity was moderate, mung beans exhibited

noteworthy levels of phenolic and flavonoid compounds, contributing to their overall health benefits. These results suggest that mung beans are a valuable dietary component, providing essential nutrients and antioxidant protection when consumed as part of a varied diet. However, to maximize antioxidant benefits, it is recommended to include a variety of legumes, each offering distinct nutritional and antioxidant profiles.

Discussion

This study aimed to compare the antioxidant properties and nutrient composition of mung beans (*Vigna radiata*) with other commonly consumed legumes such as chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and kidney beans (*Phaseolus vulgaris*). The results indicated that mung beans are a highly nutritious legume with moderate antioxidant properties, offering a balanced composition of protein, fiber, and essential minerals. However, their antioxidant activity was found to be lower than some other legumes, particularly lentils and black gram beans, which are known for their high antioxidant capacity.

In terms of protein content, mung beans were found to be the highest among the legumes analyzed, with 24.89%, which is consistent with previous studies that have highlighted the rich protein content of mung beans. For instance, a study by Ullah *et al*. (2014) [1] also found that mung beans contained high levels of protein, making them an excellent source of plant-based protein, especially beneficial in vegetarian and vegan diets. Mung beans' protein content is comparable to that of lentils (23.75%) and chickpeas (22.64%), both of which are also high-protein legumes, further supporting the role of these legumes in plant-based nutrition (Wang *et al*., 2021) [2].

The fiber content in mung beans (7.79%) was higher than that of kidney beans (5.32%) but lower than lentils (8.12%) and chickpeas (7.6%). The dietary fiber content in mung beans is beneficial for digestive health, contributing to improved gut health, reduced cholesterol levels, and better blood sugar regulation. Similar findings were reported by Lee *et al*. (2011) [4], who showed that mung beans, chickpeas, and lentils are significant sources of dietary fiber, making them valuable for digestive health and metabolic diseases such as diabetes.

Mung beans also exhibited notable mineral content, with levels of calcium (0.48 mg/100g), iron (2.22 mg/100g), and potassium (0.29 mg/100g), placing them in the mid-range compared to the other legumes. These minerals are essential for bone health, oxygen transport, and maintaining healthy blood pressure levels. Mung beans' calcium and iron content are slightly lower than chickpeas but are still significant in terms of their overall nutritional contribution. Previous studies by Sangsukiam *et al*. (2017) [5] have emphasized that legumes like mung beans provide a good source of these essential minerals, especially for populations who rely on plant-based diets.

When it comes to antioxidant activity, mung beans demonstrated moderate potential in both the DPPH and ABTS radical scavenging assays, with values of 0.32 mg/mL and 0.35 mg/mL, respectively. These findings align with previous research indicating that mung beans have moderate antioxidant properties. For example, Ullah *et al*. (2014) [1] reported that mung beans possess a considerable amount of antioxidants, although their activity was not as high as that of other legumes like black gram or lentils.

In comparison, lentils showed higher antioxidant activity in both the DPPH (0.34 mg/mL) and ABTS (0.38 mg/mL) assays. Lentils are known to have a strong antioxidant profile, which has been linked to their high polyphenolic content (Wang *et al*., 2021) [2]. This could explain why lentils exhibited higher radical scavenging activity than mung beans. Chickpeas also demonstrated a slightly higher antioxidant capacity than mung beans, with a DPPH scavenging activity of 0.28 mg/mL and an ABTS activity of 0.31 mg/mL, which is consistent with findings by Lee *et al*. (2011) [4], who reported that chickpeas have moderate antioxidant properties due to their phenolic and flavonoid content.

Mung beans, in this study, had a total phenolic content (TPC) of 0.56 mg GAE/g and a total flavonoid content (TFC) of 0.52 mg RE/g, which are moderate levels compared to other legumes like chickpeas (TPC = 0.62 mg GAE/g, TFC = 0.56 mg RE/g) and lentils (TPC = 0.60 mg GAE/g, TFC = 0.58 mg RE/g). The phenolic compounds in mung beans, primarily flavonoids and phenolic acids, contribute to their antioxidant capacity. This is supported by previous research, which has shown that legumes are rich in phenolic compounds that offer protection against oxidative damage (Sangsukiam *et al*., 2017) [5].

While mung beans did not exhibit the highest levels of antioxidant activity in this study, they still contribute significantly to antioxidant intake. The moderate levels of phenolic and flavonoid content in mung beans suggest that they play a role in combating oxidative stress when consumed as part of a balanced diet. However, to achieve optimal antioxidant intake, it is essential to include a variety of legumes with different antioxidant profiles, as no single legume can provide all the necessary bioactive compounds.

Mung beans, due to their nutrient composition and moderate antioxidant activity, are valuable for improving general health. The high protein content makes mung beans an excellent option for vegetarians and vegans seeking plant-based protein sources. Their fiber content also supports digestive health, while the presence of essential minerals like calcium, iron, and potassium contributes to bone health, oxygen transport, and blood pressure regulation.

The moderate antioxidant activity of mung beans also highlights their potential role in reducing oxidative stress and preventing diseases associated with aging and chronic inflammation. While they may not possess the highest levels of antioxidants compared to other legumes, their inclusion in the diet can still contribute to overall health. This is particularly important in populations at risk of oxidative stress-related diseases, such as cardiovascular disease, diabetes, and cancer.

Conclusion

This study provides a comprehensive comparison of the antioxidant properties and nutrient composition of mung beans (*Vigna radiata*) with other commonly consumed legumes, including chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and kidney beans (*Phaseolus vulgaris*). The findings highlight that mung beans are a highly nutritious legume, offering a rich source of protein (24.89%), fiber (7.79%), and essential minerals such as calcium, iron, and potassium. Their nutrient composition places them among the top legumes for promoting overall health, particularly for those following plant-based diets.

Although mung beans exhibited moderate antioxidant activity, as assessed through the DPPH and ABTS assays, their total phenolic content (0.56 mg GAE/g) and total flavonoid content (0.52 mg RE/g) suggest they contribute to antioxidant protection in the body. While they did not display the highest antioxidant capacity compared to lentils or chickpeas, mung beans remain an important source of bioactive compounds that can help combat oxidative stress, a key factor in the development of chronic diseases like cardiovascular disease, diabetes, and cancer.

The moderate antioxidant activity of mung beans, coupled with their high protein and fiber content, supports their role as a valuable food source for maintaining health and preventing disease. However, to achieve optimal health benefits, it is recommended to incorporate a variety of legumes in the diet, as each legume provides a unique array of nutrients and antioxidants.

In conclusion, mung beans should be recognized for their nutritional value and moderate antioxidant properties. They can be considered a key component of a balanced diet aimed at enhancing health and reducing the risk of chronic diseases. Future research into the specific bioactive compounds in mung beans, along with clinical trials, would further elucidate their potential health benefits and broaden their applications in dietary recommendations and functional foods.

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