International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(Research Article)

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Evaluation of antioxidant activity, nutritional and mineral composition of Moringa (*Moringa Oleifera*) and Ginger (*Zingiber Officinale*) leaves, flowers and rhizome

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International Journal of Science and Research Archive, 2024, 12(02), 2452–2457

Publication history: Received on 14 July 2024; revised on 20 August 2024; accepted on 23 August 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.12.2.1557

Abstract

Two tropical and subtropical plants that are highly prized and well-known for their rich nutritional qualities, numerous medical uses, and overall health advantages are Moringa (*Moringa Oleifera*) and Zinger (*Zingiber Officinale*). This study investigates the antioxidant activity, nutritional composition, and mineral content of *Moringa Oleifera* and *Zingiber Officinale*, focusing on their leaves, flowers, and rhizomes. Utilizing solvent extraction with ethanol and evaluated the antioxidant properties using DPPH radical scavenging and ferric reducing antioxidant power (FRAP) assays, alongside phytochemical analyses for total phenol and flavonoid content. Our results indicate that Moringa leaves exhibit superior antioxidant activity and the highest total phenol and flavonoid content, while ginger rhizome demonstrates significant ferric ion reduction capability. Nutritional analysis revealed that Moringa leaves are rich in protein, ash, and minerals, particularly calcium and iron, surpassing other plant parts and ginger samples. Conversely, ginger rhizome has higher moisture content but lower protein and mineral levels. These findings highlight the distinct health benefits and nutritional superiority of Moringa leaves, suggesting their potential as a valuable dietary supplement, particularly in addressing deficiencies in calcium and iron.

Keywords: *Moringa Oleifera; Zingiber Officinale*; Nutrient analysis; Mineral analysis; Total phenolic content; Antioxidant activity

1. Introduction

Moringa Oleifera, commonly referred to as the "miracle tree," is a perennial plant renowned for its extensive range of applications in nutrition, medicine, and industry. Belonging to the *Moringaceae* family, this plant thrives in tropical and subtropical climates and has been traditionally utilized in various cultures for centuries (Anwar et al, 2007). The leaves of *Moringa Oleifera* are particularly valued for their rich nutritional profile, which includes vital amino acids, carotenoids, and other nutraceutical compounds (Fahey, 2005). These components contribute to its role in addressing malnutrition, supporting cardiovascular health, and providing relief from several ailments such as diabetes, hypertension, and stress (Anwar et al, 2007).

In addition to its nutritional benefits, *Moringa Oleifera* has been recognized for its medicinal properties, including antioxidant, anti-inflammatory, and anti-cancer activities. The plant's diverse applications also extend to water purification and livestock feed fortification, demonstrating its value in improving overall quality of life, particularly in developing regions. This broad spectrum of uses underscores the importance of further research into the plant's efficacy and potential (Moyo et al., 2011).

Another significant plant in the realm of herbal medicine is *Zingiber Officinale*, commonly known as ginger. A member of the *Zingiberaceae* family, ginger has been utilized for over 2000 years for its wide array of therapeutic benefits (Khan and Rauf, 2020). Its active compounds, such as gingerol, paradol, and shogaols, are responsible for its anti-inflammatory,

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anti-emetic, and chemo-protective properties (Samir Malhotra and Amrit Pal Singh, 2003). Historically used in traditional medicine systems like Ayurveda and Arabian medicine, ginger's therapeutic potential is now being validated through modern scientific research (Rahman and Morshed, 2016).

The increasing interest in herbal plants like *Moringa Oleifera* and *Zingiber Officinale* highlights the need for ongoing research to fully understand their health benefits and optimize their use in various applications. This paper aims to Evaluate the Antioxidant Activity, Nutritional and Mineral Composition of Moringa (*Moringa Oleifera*) and Ginger (*Zingiber Officinale*) Leaves, Flowers and Rhizome.

2. Materials and methods

2.1. Collection of Moringa and Ginger (Leaves, Flowers, Rhizome)

Moringa and Ginger (Leaves, Flowers, rhizome) were collected from the Hyderabad, Telangana. Mature and healthy leaves and flower was collected from various branches of selected Moringa trees and Ginger plant, which were free from any signs of pests and diseases. The rhizome of Ginger was collected from the market of Shahpur Nagar, Hyderabad.

2.2. Solvent Extraction (Ethanol Extraction)

To prepare the extraction solution, 6 g of material was diluted with 70% ethanol in 100 mL volumetric flasks. The flasks were placed on a magnetic stirrer and maintained at 25 °C for one hour to ensure thorough mixing. Following this period, the solutions were subjected to vacuum filtration to remove any insoluble particles (do Nascimento et al., 2017).

2.3. Determination of Antioxidant Activity and phytochemical study

For the analysis of antioxidant and phytochemical content in leaf samples, the following procedures were employed. First, the leaf samples were prepared by drying and grinding to a fine powder. The DPPH radical scavenging activity was assessed by preparing serial dilutions of the extract and measuring the IC50 value in parts per million (ppm), which indicates the concentration required to inhibit 50% of the DPPH radicals. To evaluate the ferric reducing antioxidant power (FRAP), the sample extract was analyzed for its ability to reduce Fe^{3+} to Fe^{2+}, expressed in mmol Fe^{2+}/g of sample. The total phenol content was quantified using the Folin-Ciocalteu method and reported as gallic acid equivalents (GAE) per gram of sample. Finally, total flavonoid content was determined using a colorimetric assay and expressed in milligrams of quercetin equivalents (QE) per gram of sample (do Nascimento et al., 2017).

2.4. Nutrient Analysis of Moringa and Ginger (Leaves, Flowers, Rhizome)

The nutritional analysis of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome was conducted to determine their moisture, protein, ash, fiber, fat, and carbohydrate contents. Samples of each plant part were first dried to constant weight at 105 °C to determine moisture content. Protein content was quantified using the Kjeldahl method, while ash content was measured by incinerating the samples at 550 °C until a constant weight was achieved. The fiber content was analyzed using the AOAC method, which involves acid and alkali digestion of the sample. Fat content was determined by Soxhlet extraction with petroleum ether. Carbohydrate content was calculated by difference, subtracting the sum of moisture, protein, ash, fiber, and fat from 100 g (AOAC method, 2019).

2.5. Mineral Analysis of Moringa and Ginger (Leaves, Flowers, Rhizome)

For the mineral analysis of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome, samples were first dried and ground into a fine powder. The powdered samples were then subjected to dry ashing at 550 °C to eliminate organic matter. The ash was dissolved in dilute hydrochloric acid, and the solution was filtered and prepared for analysis. Calcium and iron contents were determined using Atomic Absorption Spectroscopy (AAS). Calcium concentrations were measured by comparing the absorbance of the sample solutions to that of a calcium standard, while iron levels were determined similarly using an iron standard (AOAC method, 2016).

3. Results and discussion

3.1. Antioxidant Activity and phytochemical study of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome

The total antioxidant activity and phytochemical content of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome were analyzed and are summarized in Table 1. The DPPH radical scavenging activity, indicated by IC50 values, revealed that Moringa flowers had the lowest IC50 value of 192 ppm, suggesting the highest antioxidant activity among the samples. Moringa leaves and ginger rhizome exhibited moderate antioxidant activity with IC50 values of 275 ppm and 260 ppm, respectively, while ginger leaves showed the least antioxidant activity with an IC50 value of 344 ppm.

In terms of ferric reducing antioxidant power (FRAP), ginger rhizome had the highest reducing power at 2.6 mmol Fe^2+/g, indicating superior electron-donating capability compared to Moringa leaves (1.5 mmol Fe^2+/g), Moringa flowers (1.2 mmol Fe^2+/g), and ginger leaves (1.4 mmol Fe^2+/g). The total phenol content, expressed as gallic acid equivalents (GAE/g), was highest in Moringa leaves at 182.10 GAE/g, followed by ginger rhizome at 140.60 GAE/g. Moringa flowers and ginger leaves contained lower phenol levels, with 71.09 GAE/g and 60.35 GAE/g, respectively. The total flavonoid content, measured in quercetin equivalents (QE/g), was also highest in Moringa leaves at 6.25 mg QE/g, whereas ginger rhizome had a slightly lower flavonoid content of 5.92 mg QE/g. Moringa flowers and ginger leaves had lower flavonoid contents, with 3.10 mg QE/g and 2.70 mg QE/g, respectively.

Table 1 Total antioxidant activity of moringa leaves, flowers and Ginger leaves, rhizome

Assay type	**Moringa leaves**	**Moringa flowers**	**Ginger Leaves**	**Ginger Rhizome**
DPPH (IC50 ppm)	275	192	344	260
FRAS (mmol , Fe2+/g)	1.5	1.2	1.4	2.6
Total phenol content (GAE/g)	182.10	71.09	60.35	140.60
Total flavonoid content (mg QE/g).	6.25	3.10	2.70	5.92

The results highlight notable differences in antioxidant and phytochemical profiles among the plant samples. The superior antioxidant activity of Moringa flowers, as indicated by the lowest IC50 value, suggests a potent capacity to neutralize free radicals, which is consistent with previous findings that flowers of various plants often exhibit strong antioxidant properties (Singh et al., 2019). The high FRAP value in ginger rhizome suggests that it has a greater potential to reduce ferric ions compared to the other samples, aligning with research that shows rhizomes of many herbs exhibit significant antioxidant capacity (Chung et al., 2020).

Moringa leaves demonstrated the highest total phenol content, which is in line with literature reporting that high phenolic content correlates with enhanced antioxidant properties (Moyo et al., 2011). The substantial flavonoid content in Moringa leaves further supports its potential as a source of bioactive compounds with health benefits, as flavonoids are known for their antioxidant, anti-inflammatory, and anticancer activities (Bukhari et al., 2021). Conversely, the lower phenol and flavonoid contents in ginger leaves and Moringa flowers suggest that these parts of the plants may offer different or more specialized benefits compared to the leaves and rhizomes. The findings emphasize the diverse antioxidant and phytochemical profiles of these plant parts, suggesting varied potential applications in health and nutrition.

3.2. Nutrient analysis of leaves, flowers and Rhizome of Moringa and Ginger

The nutrient analysis of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome is summarized in Table 2. Moringa leaves exhibited the highest protein content at 26.34 g/100 g, significantly higher than Moringa flowers (9.08 g/100 g), ginger leaves (1.5 g/100 g), and ginger rhizome (1.8 g/100 g). The moisture content was highest in ginger rhizome at 83% and lowest in Moringa leaves at 50.56%. Moringa leaves also had the highest ash content (8.75 g/100 g) compared to other samples, while Moringa flowers had the lowest (3.4 g/100 g). The fiber content was highest in Moringa leaves (6.9 g/100 g) and lowest in Moringa flowers (1.7 g/100 g). The fat content was highest in Moringa leaves (1.7 g/100 g) and lowest in Moringa flowers (0.41 g/100 g). Carbohydrate content was highest in Moringa flowers (12.80 g/100 g) and lowest in ginger leaves (8.0 g/100 g).

The nutrient analysis reveals significant differences in the nutritional profiles of the different plant parts. Moringa leaves stand out due to their high protein content, which is consistent with existing literature that highlights Moringa as a rich source of protein, essential for various physiological functions (Fuglie, 2001). The high moisture content in ginger rhizome reflects its higher water content, which is typical of rhizomes compared to leaves and flowers (Wang et al., 2020).

Table 2 Nutrient analysis of leaves, flowers and Rhizome of Moringa and Ginger

Parameter	**Moringa leaves**	**Moringa flowers**	**Ginger Leaves**	**Ginger Rhizome**	**Units**
Moisture	50.56	72.60	78.80	83	(g /100 g)
Protein	26.34	9.08	1.5	1.8	(g /100 g)
Ash	8.75	3.4	6.30	1.3	(g /100 g)
Fibre	6.9	1.7	5.65	2.0	(g /100 g)
Fat	1.7	0.41	0.7	1.2	(g /100 g)
Carbohydrates	8.65	12.80	8.0	10.75	(g /100 g)

The relatively low protein content in ginger leaves and rhizome suggests they are not as nutrient-dense in terms of protein as Moringa leaves, which may affect their use as a dietary supplement. The higher ash content in Moringa leaves indicates a greater mineral content compared to other samples, aligning with previous studies that emphasize Moringa's mineral-rich profile (Moyo et al., 2011). The lower fiber content in Moringa flowers compared to Moringa leaves might impact its potential as a dietary fiber source.

The fat content in Moringa leaves is notably higher than in the other samples, which may contribute to its higher energy value. The carbohydrate content being highest in Moringa flowers could be beneficial for energy supply, but it contrasts with the lower carbohydrate levels found in Moringa leaves and ginger rhizome. These findings suggest that Moringa leaves are nutritionally superior to Moringa flowers and ginger samples in terms of protein and mineral content, while Moringa flowers offer higher carbohydrates. the variations in nutrient profiles suggest that each plant part has distinct nutritional advantages and potential applications.

3.3. Mineral analysis of Moringa leaves, flowers and Ginger leaves, rhizome

The mineral analysis of Moringa leaves, Moringa flowers, ginger leaves, and ginger rhizome. Moringa leaves exhibited the highest calcium content at 2100.10 mg/100 g, significantly surpassing Moringa flowers (728.45 mg/100 g), ginger leaves (592.40 mg/100 g), and ginger rhizome (70.50 mg/100 g). Similarly, Moringa leaves also had the highest iron content at 40.42 mg/100 g, compared to Moringa flowers (17.34 mg/100 g), ginger leaves (28.60 mg/100 g), and ginger rhizome (25.30 mg/100 g) (Table 3).

The results shows that Moringa leaves as a superior source of calcium and iron compared to other plant parts. The remarkably high calcium content in Moringa leaves supports previous research indicating that Moringa is an excellent source of this essential mineral, which is crucial for bone health and various metabolic functions (Fuglie, 2001). The iron content in Moringa leaves is also notably high, which is consistent with literature suggesting that Moringa can be a valuable dietary source for combating iron deficiency (Moyo et al., 2011).

Table 3 Mineral analysis of Moringa leaves, flowers and Ginger leaves, rhizome

parameter	**Moringa leaves**	**Moringa flowers**	**Ginger Leaves**	**Ginger Rhizome**
Calcium (mg/100 g)	2100.10	728.45	592.40	70.50
Iron (mg /100 g)	40.42	17.34	28.60	25.30

The lower mineral content in ginger rhizome and ginger leaves aligns with previous studies indicating that while ginger is beneficial for other health aspects, it is not as high in calcium and iron as Moringa (Basu et al., 2016). The findings suggest that while ginger rhizome has other potential health benefits, its mineral content is lower compared to Moringa, which could influence its application in dietary supplements focused on calcium and iron intake. The mineral analysis highlights the nutritional superiority of Moringa leaves in terms of calcium and iron content, supporting its potential role in addressing nutritional deficiencies. These findings suggest that incorporating Moringa leaves into the diet could provide significant benefits, particularly in regions where calcium and iron deficiencies are prevalent.

4. Conclusion

This study highlights the exceptional nutritional and therapeutic benefits of *Moringa Oleifera* and *Zingiber Officinale*, emphasizing their important contributions to health and nutrition. Moringa leaves emerged as exceptionally rich in essential nutrients, including high levels of protein, calcium, iron, and antioxidants, positioning them as a potent resource for combating malnutrition and micronutrient deficiencies. Conversely, ginger, while demonstrating notable antioxidant and anti-inflammatory properties, exhibited lower levels of calcium and iron compared to Moringa. The diverse applications of both plants ranging from dietary supplementation to therapeutic uses, their importance in promoting health and well-being. The findings advocate for the inclusion of Moringa and ginger in dietary regimes, particularly in regions facing nutritional deficits.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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