

Quantitative Analysis of Minerals and Antioxidant Potential of (*Clitoria ternatea* L.) FlowerZia Parveen^{1*}, Sunita Mishra², Narendra Kumar² and Kuril Sanjeet³

¹Research Scholar, Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Raebareli Road, Lucknow- 226025(U.P.), India

²Professor, Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Raebareli Road, Lucknow- 226025(U.P.), India

³Research Scholar, Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Raebareli Road, Lucknow- 226025(U.P.), India

***Corresponding Author:** Zia Parveen, Research Scholar, Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Raebareli Road, Lucknow- 226025(U.P.), India.

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Abstract

Butterfly pea (*Clitoria ternatea* L.) is widely used in the development of herbal teas, functional beverages, and culinary products. The objective of this study was to evaluate the mineral composition, elemental profile, and antioxidant potential of *C. ternatea* L. flowers. The ferric reducing antioxidant power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of aqueous flower extracts were determined using spectrophotometric methods. Mineral and elemental analyses were performed using atomic absorption spectrophotometry (AAS), while antioxidant capacity was assessed through DPPH and FRAP assays. Results revealed substantial concentrations of essential minerals and trace elements, along with notable antioxidant activity in the flower powder. These findings suggest that *C. ternatea* flowers represent a valuable natural source of antioxidants with promising applications in functional foods, nutraceuticals, and health-promoting formulations.

Keywords: Quantitative Mineral; Antioxidant; FRAP; DPPH; *Clitoria ternatea*

Graphical Abstract

Introduction

Butterfly pea (*Clitoria ternatea* L.) is a perennial vine native to Malaysia that has spread all over the world, including Sri Lanka. It belongs to the Fabaceae family and thrives on neutral, moist soils [1]. It produces solitary, axillary, and papilionaceous blooms with five petals: one standard, two wing, and two keel petals [2]. This dark blue or white bloom is the significant plant portion, and it has beneficial therapeutic effects due to the presence of essential phytochemicals. The relative concentrations of various components such as proteins, fat, carbs, vitamins, and minerals effect a food's quality. Carbohydrates, lipids and proteins also known as proximate principles, make up the majority of the diet, whereas minerals play a significant role in the control of metabolic activity in the body [3]. The bromatological and mineral study of food plants plays a major role in determining their nutritional value. The plant's element content relates with its nutritional status. Reactive oxygen species (ROS) accumulate in the human body due to biological processes involving superoxide radicals, singlet oxygen, and hydrogen peroxide [4]. Excessive ROS accumulation may damage one's health by oxidizing biological macromolecules such as lipids, proteins, or DNA. This condition may lead noncommunicable diseases such as cardiovascular disease, cancer, and neurodegenerative disease [5]. Antioxidants act as free radical scavengers, metal chelating agents, oxidative enzyme inhibitors, and antioxidant enzyme cofactors to reduce the aforementioned health concerns [6].

Material and Methods

Collection of plant material

Fully opened, undamaged fresh flowers had been collected during the peak blossoming season in September, 2024 from BBAU, University Campus nursery, Lucknow. Local floristic keys were employed to determine the species. The collected material was placed in a polythene bag to prevent moisture loss during transport to the laboratory.

Sample preparation

Flowers were sun-dried using a solar dryer. Dried materials were crushed and sieved using a 1 mm sieve. The powder samples were stored at room temperature in 300-gauge high density polyethylene bags [7]. The *C. ternatea* types employed for the study, weather and soil conditions, and aqueous extracts were made using the methodology defined by [8]. Sieved dried powders of flowers were extracted using a hot water bath at 59.6 °C for 37 minutes

with a flower to water ratio of 3 g/1000 mL. Extracts were filtered via a 0.45 mm nylon filter and stored at -20 °C.

Chemicals and reagents

ferric chloride, 2,4,6-tripyridyl-S-triazine (TPTZ), (DPPH), 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (trolox), and methanol were used. All of the other compounds were analytical grade.

Mineral analysis

The minerals K, Na, P, Mg, Ca, Fe, Mn, Cu, and Zn were determined using the atomic absorption spectrophotometric method. The components were digested in an acid solution including HNO₃ and perchloric acid [9]. were exposed to atomic absorption spectrophotometry (AAS) with different lights and calibrated micronutrients. Potassium and sodium were measured using a flame photometer following acid digestion. The phosphorus was determined spectrophotometrically using the vendates solution [10].

Mineral analysis through Energy-dissipative X-ray system

The mineral analysis of flowers samples was carried out using an energy-dissipative X-ray system (Quantax, Bruker Nano GmbH) at 10 kV and an X-flash 5010 detector (silicon drift detector). The samples were pressed (3 Bar) to remove liquids and pellets measuring 50 mm × 50 mm × 20 mm were molded. The resulting spectra were used for determining sodium (Na), manganese (Mn), magnesium (Mg), calcium (Ca), potassium (K), iron (Fe), and zinc (Zn).

Ferric reducing antioxidant power (FRAP)

FRAP was tested using the methods outlined by [11]. with certain modifications. TPTZ (10 mM) in 40 mM hydrochloric acid, acetate buffer solution (300 mM, pH 3.6), and FeCl₃. To prepare the working FRAP reagent, 6H₂O solution (20 mM) was mixed in a ratio of 1:10:1. It was prepared for testing and incubated at 37°C for 10 minutes. 20 microliters of aqueous floral extract (concentrations: 3.00, 1.50, 0.75 mg/mL; n = 3), In a 96-well micro plate, combine 150 µL of working FRAP reagent with 30 µL of acetate buffer to create a 200 µL reaction volume. Incubate for 8 minutes at room temperature. Trolox acts as the standard (assay concentrations): 0.49, 0.98, 1.96, 3.91, 7.82, 15.63, 31.25 and 62.50 µg/mL; n = 3) The results were represented as milligrams of trolox equivalents per one gram of flower dry weight.

DPPH radical scavenging assay

DPPH scavenging activity was determined using the techniques outlined in [12]. Fifty microliters of *C. ternatea* extracts (concentrations of 250, 125, 62.5, and 32.25 µL/mL in methanol; n = 3). In a 96-well microplate, a 200 µL reaction volume was prepared using a 125 µM radical DPPH solution in methanol. The mixture was incubated at room temperature for 15 minutes before measuring absorbance at 517 nm. Trolox was selected as the standard. Assay concentrations were 0.78, 1.56, 3.13, 6.25, and 12.5 µg/mL (n = 3). The results were expressed in mg of Trolox per 1 g of floral dry weight.

Result and Discussion

Calcium and magnesium are critical elements for growth, skeletal development, and other important physiological functions [13]. In the present study, iron content was observed at 6.32 ± 0.35 mg/100g DW. Iron is essential for the prevention of anemia and other hematological disorders [14]. Copper content was recorded at 2.22 ± 0.12 mg/100g DW. Zinc is essential for protein synthesis, healthy body development, and recovery from sickness. In the present investigation, zinc content was 4.42 ± 0.15 mg/100g DW, respectively. Manganese contributes to energy production and immune system support. It also functions synergistically with vitamin K in blood clotting and with B-complex vitamins in stress response modulation [15]. In this study, manganese content was $(0.57 \pm 0.03$ mg/100g DW [16] investigated the nutritive value of leguminous plants, including *C. ternatea*, and reported Ca (1.2%), K (18.7%), Na (1.1%), Mg (6.9%), and P (0.4%). The present investigation shows slight variations in mineral values compared to those reported by the previous authors. Kapoor and Purohit [17] evaluated mineral contents in several fabaceous plant species from the Rajasthan desert, including *C. ternatea*. They reported Ca ($1.01 \pm 0.06\%$), P ($0.44 \pm 0.14\%$), K ($0.78 \pm 0.69\%$), and Na ($0.94 \pm 0.67\%$). The present work shows mineral values for calcium, phosphorus, potassium, and sodium that differ slightly from those reported by previous authors.

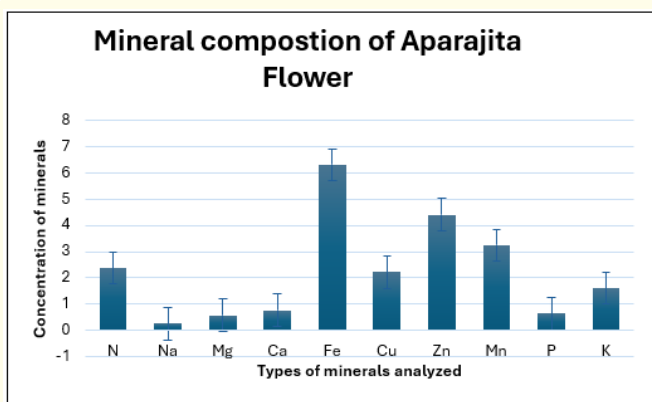


Figure 1: Graphical representation of Mineral Composition.

S. No	Mineral Elements	Mean ± SD value
1.	N (g/100g DW)	2.38 ± 0.08
2.	Na (g/100g DW)	0.26 ± 0.005
3.	Mg (g/100g DW)	0.57 ± 0.03
4.	Ca (g/100g DW)	0.77 ± 0.026
5.	Fe (g/100g DW)	6.32 ± 0.35
6.	Cu (mg/100g DW)	2.22 ± 0.12
7.	Zn (mg/100g DW)	4.42 ± 0.15
8.	Mn (mg/100g DW)	3.25 ± 0.12
9.	P (g/100g DW)	0.64 ± 0.02
10.	K (g/100g DW)	1.61 ± 1.41

Table 1: Mineral Composition of *Clitoria ternatea* Flower.

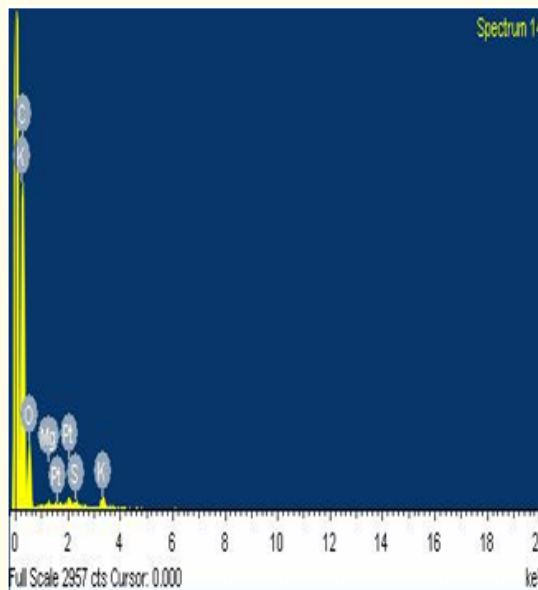


Figure 2: EDX graph and composition of Aprajita Flower.

Element	Weight %	Atomic %
C K	54.74	62.82
O K	42.22	36.37
Mg K	0.22	0.13
S K	0.43	0.18
K K	1.17	0.41
Pt M	1.21	0.09
Totals	100.00	

Table 2: Elemental Composition of *Clitoria ternatea*.

The graph displays an Energy Dispersive X-ray (EDX) spectrum labeled "Spectrum 14" with energy (keV) on the x-axis ranging from 0 to 20 keV and intensity counts on the y-axis up to 2957 counts per second. The spectrum shows several distinct peaks concentrated primarily in the low energy region below 4 keV. The most prominent peak appears at approximately 0-1 keV, which typically corresponds to light elements such as carbon, nitrogen, or oxygen. Additional smaller peaks are visible between 1-3 keV, suggesting the presence of other elements in lower concentrations. The baseline of the spectrum remains relatively flat beyond 4 keV, indicating minimal presence of heavier elements with higher characteristic X-ray energies. The full-scale setting of 2957 counts indicates the maximum intensity recorded during the analysis. This EDX spectrum pattern is characteristic of organic or biological materials that are predominantly composed of lighter elements, which aligns well with the analysis of plant material like *Clitoria ternatea* discussed earlier.

Sample	DPPH	FRAP
<i>Clitoria ternatea</i>	11.95 ± 0.37	14.55 ± 2.10

Table 3: DPPH and FRAP vale of sample.

The antioxidant activity of *Clitoria ternatea* was evaluated using two different assays: DPPH and FRAP. The DPPH assay assesses free radical scavenging capacity, showed a value of 11.95 ± 0.37 for *Clitoria ternatea*. Meanwhile, the FRAP (Ferric Reducing Antioxidant Power) assay, which assesses the ability to reduce ferric ions, yielded a higher value of 14.55 ± 2.10. The FRAP value demonstrates greater variability, as indicated by its larger standard deviation, suggesting more variation in the ferric reducing capacity compared to the DPPH scavenging activity. Both assays confirm

that *Clitoria ternatea* possesses antioxidant properties, though the FRAP assay indicates a relatively stronger reducing power than its radical scavenging ability. These results suggest that *Clitoria ternatea* could be a valuable source of antioxidants with potential applications in health and nutrition. *Clitoria ternatea* flowers' antioxidant capabilities are assumed to be responsible for the blue pea flower's capacity to protect cardiovascular and neurological diseases, cancer, and diabetes [18].

Conclusion

The present study indicates that *Clitoria ternatea* flower showed significant value of mineral composition thus flower may be used in the production of pharmaceutical and functional food products' and FRAP values of flower shows significant amount of Antioxidant potential.it also implies that The possibility of much larger amounts of free radical scavenging activity in flower samples is responsible for a certain sort of biological activity inside the human body, such as enhancing immunity, reducing inflammation, and angiogenesis.

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Conflict of Interest

There is no conflict of interest between the authors.

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