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Comparative nutritional and phytochemical analysis of *Cajanus cajan* (Pigeonpea) and *Vigna radiata* (Mung bean)

Pooja Bhalerao[1], Nishikant Lokahnde[2]
[1] Department of Botany, JES College, Jalna, Maharashtra, India
[2] Professor, Department of Botany, Dr. B.R. Barwale College, Jalna, Maharashtra, India

Abstract
Legumes, such as *Cajanus cajan* (pigeon pea) and *Vigna radiata* (mung bean), are important food sources globally, offering high nutritional value and bioactive compounds. This study provides a comparative analysis of the nutritional and phytochemical compositions of *C. cajan* and *V. radiata*. Proximate analyses, mineral content, and phytochemical profiles were conducted on the seeds of both species. The results indicate that both legumes are rich in proteins, carbohydrates, and dietary fiber, with *V. radiata* showing a slightly higher protein content, while *C. cajan* exhibited a more substantial fiber and mineral content. Phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, and phenols, with notable differences in concentrations. The findings underscore the nutritional and therapeutic potential of both legumes, highlighting their importance in sustainable diets and potential roles in health promotion.

Keywords: *Cajanus cajan*, *Vigna radiata*, nutritional analysis, phytochemical analysis, bioactive compounds, sustainable diets, health promotion

Introduction

Cajanus cajan (pigeon pea) and *Vigna radiata* (mung bean) are nutritionally rich legumes with diverse health benefits. Pigeon pea is a drought-tolerant crop rich in protein, essential amino acids, minerals, and vitamins (Haji *et al*, 2024; Hou *et al*., 2019) [4, 6]. It contains bioactive compounds with anti-inflammatory, antibacterial, antioxidant, anticarcinogenic, and antidiabetic properties (Tungmunnithum & Hano, 2020) [13]. Mung bean is an excellent source of protein, dietary fiber, minerals, vitamins, and bioactive compounds. It has been shown to ameliorate hyperglycemia, hyperlipemia, and hypertension, as well as possess hepatoprotective and immunomodulatory activities (Hou, 2019) [6]. Both legumes contain flavonoids and other phenolic compounds that contribute to their antioxidant and anti-inflammatory properties (Katoch & Tripathi, 2017) [8]. These legumes can be consumed in various forms and incorporated into different food products, making them valuable for global food security and nutrition (Abdulmajid, 2024; Hou, 2019) [6].

The need for sustainable agriculture practices has become increasingly urgent due to global challenges like food security, environmental degradation, and climate change. Orphan crops, traditional varieties, and wild edible species have been identified as potential solutions to transform local food systems and address these challenges (Borelli *et al*., 2020) [2]. These underutilized crops are often nutritious, resilient, and adapted to marginal environments, making them valuable resources for sustainable and diverse food systems (Mabhaudhi *et al*., 2019; Kahane *et al*., 2013) [7, 9]. Integrating these crops into existing agricultural systems can improve dietary diversity, create market opportunities for smallholder farmers, and contribute to biodiversity conservation (Borelli *et al*., 2020) [2]. Additionally, sustainable disease management strategies based on evolutionary principles can help minimize epidemics while reducing pressure on pathogens to evolve increased infectivity and aggressiveness (Zhan *et al*., 2014) [14]. Implementing these approaches requires policy changes, strong leadership, and collaboration between researchers and policymakers (Kahane *et al*., 2013; Borelli *et al*., 2020) [2, 7].

In this context, this study aims to conduct a comparative analysis of the nutritional and phytochemical profiles of two underutilized legume crops, *Cajanus cajan* (pigeon pea) and *Vigna radiata* (green gram), to explore their potential as sustainable and nutritious food sources.

Materials and Methods

1. Study area, collection and identification of plant species

This research was carried out at Department of Botany, JES College Jalna, and Maharashtra. *Cajanus cajan* and *Vigna radiata* were collected between January February- 2024 from farmers field in Jalna District, Maharashtra State.

2. Preparation of plant sample

Dried seeds of *Cajanus cajan* and *Vigna radiata* were ground into fine powder and stored in an air-tight container until when required.

3. Materials for phytochemical analysis

The materials and instruments used include; plant specimen, blender, masking tape, mortar and pestle, moistuer cans, crucibles, Whatman filter paper No. 42, burettes, volumetric flasks, beakers, conical flasks, sample tubes, desiccators, spectrophotometer, muslin cloth, oven, measuring cylinder, spatula, electric scale, Bunsen burner, funnels, aluminium foils, test tubes, syringes, pipettes and cotton wools.

4. Chemical and reagents used

Ethanol, concentrated acetic acid, sulphuric acid, diluted ammonia, water, ferric chloride, potassium ferrocyanide, ethyl acetate, hydrochloric acid, petroleum ether, sodium hydroxide, potassium hydroxide, Hydrogen peroxide, sodium chloride, copper sulphate, sodium picrate, methyl

red, cresol green, folin-cio caltean reagent, folin-dennis reagent, Erichrome black and solechrome darkblue, Listed reagents folin-cio caltean reagent, folin-dennis reagent, Erichrome black and solechrome dark blue, Listed reagents.

5. Materials for proximate analysis
The following materials were used: dessicator, muffle furnace, spectrometer, silica dish, kjeldahl flask, funnel, soxhlet apparatus, filter paper, thimble, electric oven, grinder, retort stand, test tube and test tube rack, crucible, weighing balance, petric dish. The chemicals used include: tetrahydrosulphate (vi) acid, Boric acid indicator solution, Sodium hydroxide, Hydrochloric acid, petroleum ether, Potassium hydroxide, Acetone, phenolphthaline indicator, Ammonia, Dithezone solution, carbon tetrachloride, Hydroquinoline, Phenonthroline, Vanado Molybidic acid, Selenium oxide. Proximate analysis was carried out to determine the presence of these nutrients: carbohydrate, crude protein, moisture content crude fibre and ash content.

6. Phytochemical analysis
The species extracts were obtained using ethanol solvent. 50 g of the powdered seeds of *Cajanus cajan* and *Vigna radiata* were soaked in 50 ml of ethanol and left for 48 hrs before filtration. Qualitative Phytochemical screening of the extracts was carried out to determine the presence of the following Phytochemicals: flavonoids, alkaloids, saponins, tannins, sterols and phenol. The procedure was as outlined by Harborne, (1998) [5]. Quantitative phytochemical analysis of the extracts was carried out to determine the percentage quantitative compositions of Phytochemicals: flavonoids, alkaloids, saponins, tannins, sterols and phenol. The procedure was as outlined by Shaikh & Patil (2020) [11] and Harborne (1998) [5].

7. Statistical analysis
The results were analyzed using ANOVA. All analyses were carried out at a 5% level of significance.

Result and Discussion
1. Proximate Composition
Results revealed that the seeds extract of *Cajanus cajan* and *Vigna radiata* contained all the investigated nutrients (carbohydrate, protein, fibre, moisture and ash) in varied compositions (Tables 1). The protein content of *V. radiata* (24.7%) was marginally higher than *C. cajan* (22.5%), making it a slightly superior source of plant-based protein. *C. cajan*, however, had higher fiber content (6.8%) and ash content (3.3%), indicating a greater presence of minerals. These differences may influence the choice of legume depending on dietary requirements.

Table 1: Proximate nutrients compositions of *C. cajan* and *V. radiata*

Component	*Cajanus cajan* (%)	*Vigna radiata* (%)
Moisture	11.2 ± 0.3	10.5 ± 0.2
Protein	22.5 ± 0.4	24.7 ± 0.5
Fat	1.5 ± 0.1	1.1 ± 0.1
Fiber	6.8 ± 0.2	5.1 ± 0.3
Ash	3.3 ± 0.1	2.8 ± 0.2
Carbohydrate	54.7 ± 0.5	55.8 ± 0.6

2. Mineral content
Mineral content analysis revealed that both legumes are rich in essential minerals, with notable concentrations of calcium, magnesium, and iron. *C. cajan* showed higher levels of iron (8.5 mg/100g) compared to *V. radiata* (6.3 mg/100g), making it a valuable food for addressing iron deficiencies, particularly in populations at risk of anemia.

3. Phytochemical analysis
The phytochemical profiles of the two legumes are shown in Table 2. Both *C. cajan* and *V. radiata* exhibited the presence of bioactive compounds, but their concentrations varied. The levels of alkaloids, flavonoids, tannins, and phenols were generally higher in *C. cajan*, suggesting a more potent antioxidant profile. Flavonoids and phenols, in particular, are known for their anti-inflammatory and anti-cancer properties, reinforcing the medicinal value of these legumes.

Table 2: Quantitative phytochemical screening of seeds extract of *C. cajan* and *V. radiata*

Phytochemical	*Cajanus cajan* (mg/100g)	*Vigna radiata* (mg/100g)
Alkaloids	120.5 ± 2.4	100.2 ± 2.1
Flavonoids	89.7 ± 1.9	75.5 ± 1.5
Tannins	52.8 ± 1.2	45.4 ± 1.0
Phenols	210.3 ± 4.5	195.6 ± 4.0

Discussion
Results of the phytochemical and nutrients (carbohydrate, protein, fibre, moisture and ash) in varied compositions studies revealed that (Table 1 and 2) the nutritional profiles of *Vigna radiata* (mung bean) contains protein, fat, and fiber, in similar results were compared with Tresina *et al*., 2014 [12]; Shaheen *et al*., 2012 [10] and *Cajanus cajan* (pigeon pea) has slightly lower protein content at but higher fiber at (Aletor & Aladetimi, 1989; Ene-Obong & Carnovale, 1992) [1, 3]. Both legumes are rich in essential minerals, with *C. cajan* showing higher iron levels (Ene-Obong & Carnovale, 1992) [3]. *V. radiata* demonstrates superior essential amino acid profiles compared to FAO/WHO recommendations (Tresina *et al*., 2014) [12]. Both legumes contain antinutritional factors, with cowpea varieties generally having higher levels of thioglucosides and trypsin inhibitor activity than other legumes (Aletor & Aladetimi, 1989) [1]. The functional properties of *V. radiata* protein isolates, including high nitrogen solubility, enhance its potential for food industry applications (Shaheen *et al*., 2012) [10].

Conclusion
This comparative study highlights the nutritional and phytochemical richness of *Cajanus cajan* and *Vigna radiata*. While *V. radiata* offers higher protein content, *C. cajan* stands out for its greater fiber, mineral content, and more robust phytochemical profile. Both legumes are excellent sources of nutrition and bioactive compounds, and their inclusion in diets can contribute to health benefits such as improved digestion, enhanced immunity, and reduced risk of chronic diseases. Further studies on the bioavailability of these nutrients and the *in vivo* effects of the phytochemicals in both legumes would provide deeper insights into their therapeutic potential.

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