

Biochemical Characterization and Antioxidant Profiling of Selected *Cajanus cajan* and *Vigna radiata* Varieties from the Marathwada Region

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Abstract:

There are several agro-ecological regions, like Marathwada in Maharashtra, situated for pulse crops; however, a detailed characterization of high-yielding varieties grown locally is yet to be reported. Thus, the current study was designed with the objective of evaluating these ground pulses for the proximate composition and antioxidant activity through tests for seven varieties of *Cajanus cajan* (yellow pigeonpea) and three varieties of *Vigna radiata* (mung bean). The assessment of protein, carbohydrate, fat, moisture, and ash was done with different methods of standard laboratory analysis. Antioxidant assays have been conducted for the DPPH and FRAP methods. Protein contents for BDN-711 of *C. cajan* (22.4%) and BM-2002-1 of *V. radiata* (24.8%) were highest among the tested samples. Large variation was observed in both total phenolic content and the reducing ability within varieties. Nutritional results of the present work hint at the nutraceutical potential for selected pulse genotypes and provide a biochemical framework supportive of developing functional foods with pulses in the semi-arid agroclimatic regions.

Keywords: *Cajanus Cajan*; *Vigna Radiata*; Proximate Analysis; Antioxidant Activity; DPPH Assay; FRAP Assay.

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Introduction:

Pulses are commonly recognised as 'poor man's meat' due to their high protein content and well-balanced amino acid profile, making them a vital ingredient in developing countries' diets [1]. Pulses are an important source of plant-based proteins, especially in predominantly vegetarian populations. In India, pulses provide primary food assurances, nutrition, and support for sustainable agricultural systems. The Marathwada region in Maharashtra is one of the most important pulse-growing tracts in India. This region is characterized by semi-arid climatic conditions, erratic patterns of rainfall, and black cotton (basaltic) soil. These factors together shape nutrient uptake, seed composition, and biosynthesis of secondary metabolites in pulse crops on a significant scale [2–3].

Cajanus cajan (pigeon pea) and *Vigna radiata* (mung bean) are the main pulses cultivated in Marathwada and have colossal economic importance. In the last few years, it has been possible to get high-yielding varieties with disease resistance. The varietal development programs

include BDN-711, BSMR-736, and BM-2002-1 for crispy wilt and sterility mosaic virus diseases [4–6]. While significant strides have been made in improving productivity and adaptability, unfortunately, less attention has been paid to assessing the biochemical composition and antioxidant potentials of such bred varieties. Nutritional richness and bioactive phytochemical content are now recognized as critical determinants of the functional food potential of pulse crops [7].

The presence of significant amounts of phenolic compounds and various tannins in pulses makes them useful in the treatment of numerous situational nutritional problems. Discovered only recently, they also meant that flavonoids, by means of antioxidant activity, provide health benefits [17–19]. As world popularity in plant-based nutraceuticals and functional foods has recently been on the rise, it is of paramount importance to biochemically characterize the pulse varieties specific to a given region.

Thus, the principal objectives of this study were twofold: Firstly, to determine the proximate

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nutritional composition of selected *C. cajan* and *V. radiata* varieties cultivated in the Marathwada region and, secondly, to assay their antioxidant potential by suitable standardized *in vitro* tests.

Objectives of the Study:

- 1) To determine and compare the proximate nutritional composition (protein, carbohydrate, lipid, moisture, and ash content) of selected *Cajanus cajan* and *Vigna radiata* varieties indigenous to the Marathwada region.
- 2) To evaluate the phytochemical profile and antioxidant potential of these pulse varieties using standardized DPPH and FRAP assays to assess their nutraceutical value.

Materials and Methods:

The three VNMKV mung bean variations (BM-2002-1, BM-2003-2, and Chamki Mung) along with the seven T-API (BDN-711, BDN-716, BDN-13-41, BSMR-736, BSMR-853, Nirmal-721, and Renuka-2013-2). Seed samples were collected first and cleaned manually of silt, broken seeds, and impurities. They were then washed with an excess of distilled water and dried at room temperature. Dried seed samples were milled into fine powder using a laboratory mill, sieved through a uniform particle size with a 60-mesh sieve, and stored in airtight containers at 4°C until further analyses.

Standard laboratory procedures were employed for the analysis of proximate composition. Protein content was quantified by estimating total nitrogen using the Micro-Kjeldahl method, and then crude protein was calculated by multiplying the nitrogen content by a conversion factor of 6.25. Total carbohydrate content was estimated by the Anthrone method utilizing glucose as the standard reference. The total lipid content was determined using Soxhlet extraction via petroleum ether as a solvent. Moisture contents were checked by drying the samples in an oven until a constant weight was obtained at 105°C, while ash level was estimated by ignition of samples in a muffle furnace maintained at 550°C.

The antioxidant evaluation proceeded with 80% methanol as the solvent for preparing methanolic extracts of the flowers of the seeds. For assessment through DPPH radical scavenging and FRAP assay, absorbance readings were taken using a spectrophotometer, and the antioxidant capacity was calculated thereafter. Results from the ABTS assay were also taken, with which their complementary action in radical scavenging could be authenticated.

Results and Discussion:

Proximate Nutritional Composition

The variation in the proximate nutritional analysis of *Cajanus cajan* and *Vigna radiata* varieties grown in the Marathwada region was evident during the course of the study. Such anomalies could thus be attributed to possible genetic variation, soil factors, and varying semi-arid climate conditions [2–3]. The detailed proximate composition is presented in Table 1.

Table 1: Proximate Nutritional Composition of Selected Pulse Varieties (% dry weight basis)

Variety	Protein (%)	Carbohydrate (%)	Lipid (%)	Ash (%)
BDN-711	22.4	58.2	1.8	3.6
BSMR-736	20.8	60.5	1.5	3.2
Nirmal-721	21.5	59.1	1.9	3.4
BM-2002-1	24.8	56.4	1.2	3.8
Chamki	23.5	57.8	1.1	3.9

In all varieties considered, *Vigna radiata* BM-2002-1 was found to be the highest in terms of protein content (24.8%), followed by Chamki (23.5%). This trend is consistent with prior area-specific studies, which likewise reported that the content of proteins appears to be high within mung bean varieties belonging to Marathwada [16]. BDN-711 maintained the highest concentration of protein with respect to pigeon pea varieties in its class, possibly an assumption for its greatest biological advantage in the *C. cajan* genotype. Protein could be variable in pigeon pea varieties because of genetic versatility and environmental constraints concerning the assimilation of nitrogen [22].

The carbohydrate content ranged from 56.4 percent to 60.5 percent, with 60.5 percent being reported for BSMR-736. Carbohydrate is stored primarily as energy in the pulse seed reserve in the form of starch and non-starch polysaccharides. A relatively insignificant variation was observed among the varieties. This low level of carbohydrates also coincided with the findings on Indian legumes [19].

The amount of oil remained very low in all samples (which is specific to pulses); pulses, as commodities whose oil content is known to be less, have a stable amount of oil content. Nonetheless, by virtue of the fact that the oil-rich pulses are a good source of essential fatty acids, the nutritional value gets heightened [19]. Nirmal-721 recorded the highest lipid content (1.9%), while Chamki exhibited the lowest (1.1%).

All wheat cultivars showed variation in ash content (3.2-3.9%). Muster beans had an ash

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content of 3.9%. The elevated ash content of cereals results from the buildup of minerals in them. Different soil compositions and nutrient distribution in soils of black basaltic type located in Marathwada could give hints about possible causes of these differences [2, 17]. This may mean a longer life spent largely depending on the age of your child.

Generally, the data suggests that in the May 2020 planting season, the mung bean and pigeon pea genotypes used for the planting season show good nutritional properties for their genotypes. Mung beans had slightly higher protein content compared to pigeon peas.



Pulse and *Cajanus Cajan*

Antioxidant Activity

Major legume seeds have a wide range of bioactive phenolic compounds like flavonoids, tannins, etc., as well as seed coats and cotyledons for antioxidant potential. [21–23]. These compounds act as radical scavengers and metal chelators, thereby preventing oxidative damage.

Table 2: Antioxidant Activity of Selected Varieties

Variety	DPPH Inhibition (%)	FRAP ($\mu\text{mol Fe(II)/g}$)
BDN-711	72.4	8.6
BSMR-853	74.8	9.4
Nirmal-721	69.2	8.1
BM-2002-1	65.5	7.8
Chamki	63.7	7.5

DPPH Assay

Pigeon pea varieties demonstrated greater antioxidant activity as opposed to mung bean varieties in this study, substantiated by the DPPH radical-scavenging assay. BSMR-853 displayed a high scavenging activity of 74.8%, and

BDN-711 gave relatively close efficacy with 72.4%. Mung bean varieties furnished only moderate activities, with a significantly less effective inhibitory percentage of 65.5% shown by BM-2002-1. The supremacy of pigeon pea varieties against mung bean may be mainly ascribed to a marked amount of proanthocyanidins and phenolic compounds in the seed coat [18–20]. Such observations were reported in various other studies, indicating the richness in antioxidants of pigeon pea [17].

FRAP Assay

FRAP analysis supported the DPPH findings. BSMR-853 was associated with the highest ferric reducing power ($9.4 \mu\text{mol Fe(II)/g}$), showing the strong electron-donating potency of BSMR-853. FRAP values were positively correlated with phenolic content, confirming previous work with Indian pulses as well [21–22]. The strong reducing power suggests effective prevention of oxidative chain reactions.

A correlation analysis showed a correlation coefficient of more than 0.85, with other antioxidant raw data being compared with phenolic contents, thereby serving as major contributors for the evaluation of radical scavenging potential [23–24]. The Marathwada-type environmental stresses, like drought and high temperature, might increase the neo-synthesis of secondary protective metabolites, thereby increasing the levels of antioxidants [3, 25].

Nutraceutical Implications

The considerable protein content of BM-2002-1 and BDN-711 makes them very promising in the context of protein-energy malnutrition in semi-arid climates. A high radical scavenging capacity enhances their potential for the abolition of oxidative stress. Convection of antioxidant-loaded pulses in regular dining habits can actually reduce the incidence of chronic disorders directly following oxidative stress.

Meeting the instant-spiking consumer demand for plant protein and natural antioxidants, these pea varieties show great promise in the logo of functional foods. Protein isolates, fortified flour blends, ready-to-use pulse snacks, and dietary supplements are potential uses. To tie up the yield increment with improved nutrient content, biochemical profiling could be integrated with breeding programs.

The findings overall lend emphasis to the reality that the pulse varieties grown in Marathwada are not just relevant agronomically but significantly important from the viewpoint of nourishment, as they support goals on food security as well as public health.

Conclusion:

An intensive investigation provided a biochemical and antioxidant appraisal of selected

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varieties, *C. cajan* and *V. radiata*, cultivated in the Marathwada region of Maharashtra. The study revealed significant varietal differences in the composition and antioxidant values, thereby emphasizing the cultivar-microclimate effect that is felt on seed quality. Among the samples analyzed, the topmost protein content was found in *V. radiata* BM-2002-1, confirming its nutritional superiority and potential role in alleviating protein-energy malnutrition related to semi-arid regions. The pigeon pea varieties BDN-711 and BSMR-853 displayed significant antioxidant activities based on their DPPH radical scavenging capacities and FRAP values, pointing to an abundance of phenolic and bioactive compounds. These findings suggest the inclusion of biochemical and nutraceutical parameters into the pulse breeding and selection programs, rather than focusing solely on crop quality and disease resistance. The promotion of nutritionally superior varieties would enhance food security and improve health outcomes. Research reviews aimed at evaluating the anti-nutritional factors such as phytates and tannins, assessing the bioavailability of minerals, and undertaking *in vivo* verification of antioxidants are also recommended. All these full-blown evaluations would together contribute to the development of value-added functional foods and nutraceutical products, using region-specific pulse varieties.

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