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Proximate composition, micronutrient and dietary fiber analysis of ten traditional rice varieties of Wayanad District

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More than half of the global population relies on rice (*Oryza sativa* L.) as a dietary staple. In nations such as India, rice features prominently in every meal, serving as a nutrient-dense source. Various reports highlight the nutritional abundance found in traditional rice strains worldwide, emphasizing the need to highlight lesser-known, yet nutrient-rich, traditional rice varieties. Given the myriad factors influencing rice's nutritional profile, our study delved into the nutrient content of ten selected traditional rice varieties across different locations in Wayanad district. Significantly, there were discernible differences in both proximate composition and mineral content among the chosen traditional rice varieties in Wayanad. Furthermore, while proximate composition remained consistent across all rice varieties across different regions of the district, there were notable variations in mineral content among replications. *Chenthadi* exhibited the highest protein content (10.23±0.56) % among the other rice varieties. *Jeerakasala* showcased the highest levels of crude fiber content (1.46±0.09) % and fat content (2.12±0.21) %. *Kodu veliyan* stood out for having the highest dietary fiber content (10.15±0.25) %. Furthermore, *Chennellu*, located at S2, displayed the highest Fe content, while *Kodu veliyan*, at S1, exhibited the highest Zn content. These findings underscore the necessity for further research into the factors influencing the micronutrient absorption of rice varieties.

Keywords: Micronutrients, Nutrition, Proximate composition, Traditional rice, Wayanad

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During the recent COVID-19 pandemic, the importance of a balanced nutritional status in fortifying the immune system became strikingly evident. A robust immune system not only defends against numerous diseases but also proves instrumental in thwarting the virus[1,2]. Essential nutrients like zinc, iron, and a variety of vitamins are critical for sustaining immune function[3]. Therefore, maintaining a healthy diet is paramount for bolstering the immune system.

Rice (*Oryza sativa* L.) serves as the primary food for over half of the global population. Renowned for its nutritive quality and superior protein digestibility, rice is often hailed as the queen among cereals[4]. In nations like India, rice is a staple in every meal, providing a rich array of nutrients[5]. Previous research has underscored the nutritional abundance found in traditional rice varieties across various countries, including India, Thailand, China, Sri Lanka, and Tanzania[4-10], highlighting the importance of shedding light on lesser-known traditional rice strains.

Wayanad, situated on the southern tip of the Deccan plateau, is characterized by its mountainous terrain. Encompassing an area of 2136 sq. km with an average altitude of approximately 750 m, the district stands out for its rich biodiversity and the diverse tapestry of its ethnic cultures. In a survey conducted by the Community Agro Biodiversity Centre-MSSRF, it was reported that Wayanad housed over 105 traditional rice varieties before the onset of commercial agriculture. However, by the year 2000, this number dwindled to a mere 20 varieties. The rise of input-intensive agriculture and the widespread adoption of High Yielding Varieties (HYV) led to the displacement of many traditional rice strains in Kerala[11]. Presently, the cultivation of traditional rice varieties is confined mainly to marginal lands and remote tribal areas.

The primary objective of this study is to evaluate the nutritional composition of ten selected traditional rice

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varieties across different regions of Wayanad. Previous research has focused on specific rice varieties from Wayanad, such as *Gandhakasala* and *Jeerakasala*[10], yet these studies have typically examined samples from a single geographic area. The protein content of rice is known to be influenced by both environmental conditions and genetic factors. Environmental factors, particularly the application of fertilizers like nitrogen, play a significant role in determining grain protein content[12]. Additionally, elevated temperatures can lead to varied responses in grain storage protein[3], suggesting the potential impact of environmental factors on other nutritional elements. Therefore, our study seeks to elucidate the average nutritional profile of each rice variety by analyzing samples collected from diverse geographical regions within the Wayanad district. Furthermore, this research underscores the importance of identifying the factors that influence the absorption of micronutrients in rice.

Materials and Methods

Rice samples

For this study, we selected ten traditional rice varieties namely *Adukkan, Chennellu, Chenthadi, Chomala, Gandhakasala, Jeerakasala, Kalladiaryan, Marathondi, Mullan Kaima,* and *Kodu Veliyan* which are indigenous to the Wayanad district of Kerala, India. The initial batch of samples (S1) was gathered from experimental plots arranged in a randomized complete block design (RCBD) by Community Agrobiodiversity Centre-M S Swaminathan Research Foundation (CAbC-MSSRF) at the location in 11^{0}41'20.5"N latitude and 76^{0}06'12.0"E longitude. Subsequent samples (S2 and S3) were collected from farmer fields located in different geographical areas within the district. All the samples were collected during the *Kharif* season of the year 2019-20. Figure 1 depicts the locations from which the samples were collected. The dehulled rice samples were securely stored in air-tight bottles at room temperature (25°C) until analysis.

Morphological data collection

To ensure the uniformity of the collected seeds, a morphological assessment of rice varieties was performed. This assessment relied on the IRRI (International Rice Research Institute) standard evaluation system of rice[13] for analysis. The seed morphology of the samples obtained from the experimental plots at CAbC-MSSRF served as the reference. Replicated rice varieties were then compared against this reference to confirm seed similarity.

Proximate composition and dietary fiber

The crude ash, moisture content, crude protein, crude fiber, and crude fat contents of the selected rice varieties were assessed following the procedures outlined by the Association of Official Analytical Chemists, 2016. Total carbohydrate content was determined utilizing methods consistent with those employed in previous studies[5,6]. Additionally, the dietary fiber of the rice samples was analyzed using the Englyst method (1978)[14].

Determination of mineral content

Preparation of sample solution

Each powdered rice sample (2.0 g) was digested using a mixture of nitric acid and perchloric acid in a volume ratio of 2:1. Subsequently, the digested rice sample was transferred into a 50 mL volumetric flask and diluted to the mark with distilled water. The resulting solution was then filtered and assessed for mineral contents.

Determination of iron, manganese, magnesium and zinc

Analysis of iron (Fe), manganese (Mn), magnesium (Mg), and zinc (Zn) was carried out using an Atomic Absorption Spectrophotometer (M-Series, Thermo Fischer-Scientific-USA). The appropriate solutions for Fe, Mn, Mg, and Zn were prepared by diluting its standard solutions.

Determination of calcium and potassium

The analysis of calcium (Ca) was performed utilizing the standard titrimetric method. Initially, 25.0 mL of each sample was transferred into a beaker, and the pH was adjusted to 12-13 by adding 1M NaOH solution. A small amount of murexide indicator was then introduced, and the solution was promptly titrated against a 0.01M EDTA solution until reaching the pink to purple end-point. For the analysis of potassium (K), flame photometry (Microprocessor Flame photometer-1381) was employed.

Determination of phosphate

The analysis of phosphate (P) was conducted using the stannous chloride method[15]. To prepare the samples for analysis, 100 µL of each sample was diluted with 7.4 mL of water. Subsequently, 2 mL of molybdate reagent and 0.5 mL of the diluted Chlorostannous reagent were added to each diluted sample. After thorough mixing, the absorbance of each solution was

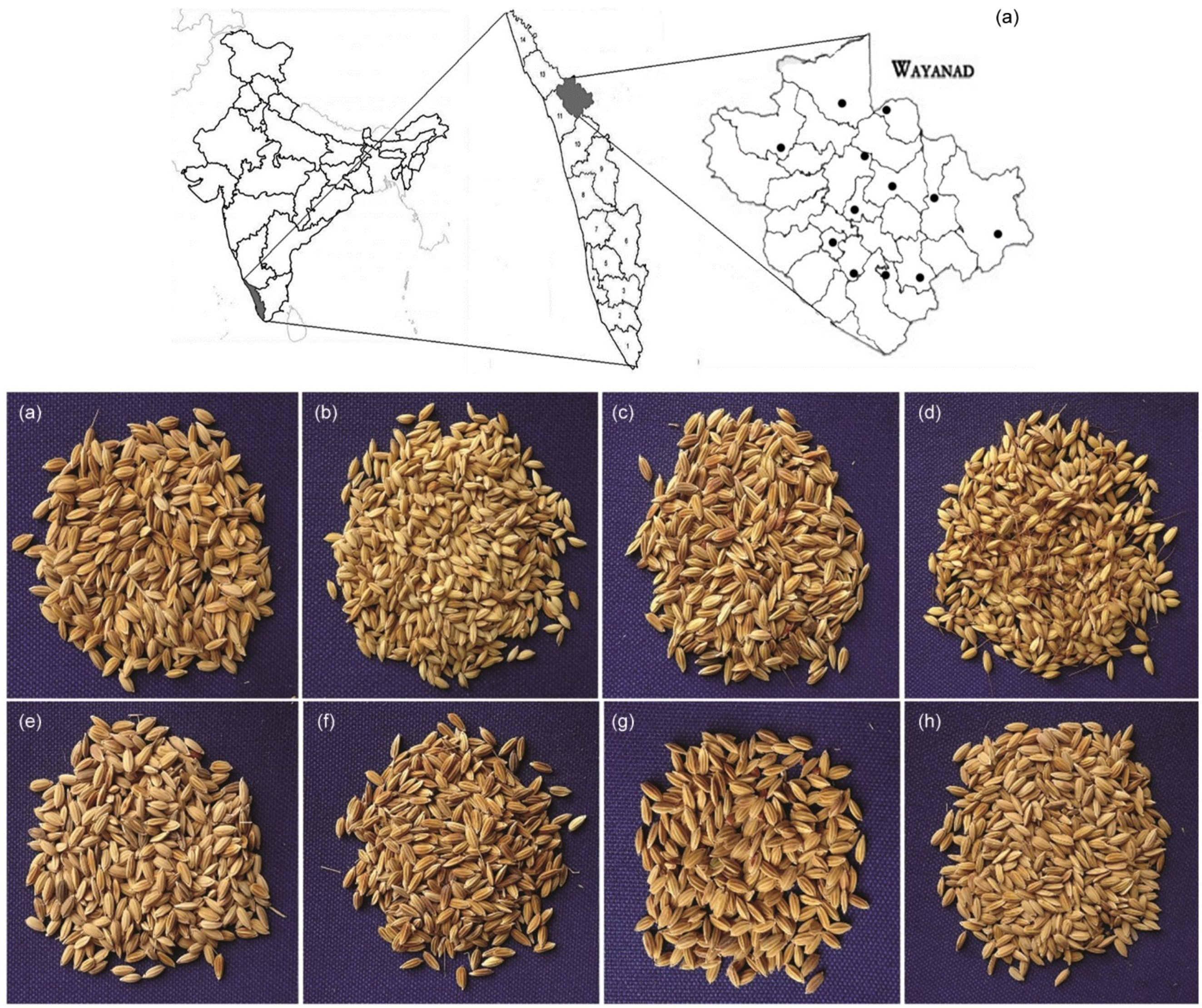

Fig. 1 — (a) Location of Wayanad (*Source*: https://www.mapsofindia.com/maps/india/outlinemapofindia.htm) Geographic locations of the samples collected (b) Traditional rice varieties a- *Marathondi*, b- *Gandhakasala*, c- *Chenthadi*, d- *Mullan Kaima*, e- *Kodu Veliyan*, f- *Chennellu*, g- *Kalladiaryan*, h- *Adukkan*

measured 20 min following the addition of the stannous chloride reagent. Absorbance readings were taken at 704 nm using a spectrophotometer.

Statistical analysis

One-way ANOVA was performed for each experiment to analyse the significant difference between the mean and is calculated by Fisher's test (Post Hoc Test) using R programming.

Results

Morphological analysis

International Rice Research Institute (IRRI) descriptors for *Oryza Sativa* L. as depicted in Table 1 were used to measure awn colour, lemma and palea pubescence, lemma and palea colour, lemma: anthocyanin colouration of keel, lemma; anthocyanin colouration of area below apiculus, lemma: colour of apiculus, lemma: shape of apiculus, sterile lemma length, longer sterile lemma length, sterile lemma shape, sterile lemma: colour, grain length, grain width, grain thickness, 1000 grain weight, caryopsis length, caryopsis width, caryopsis shape, caryopsis pericarp colour and endosperm type. To ensure accuracy, any mismatched seeds were excluded, and replacements were obtained from a different farmer within the same geographical area. The final collected seeds underwent further analysis to determine their

Table 1 — Morphological parameters used for comparison of rice seeds

Parameter	AD	CL	CD	CHL	GA	JR	KD	MT	MK	KV
Awn color	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Brown	Absent
Lemma and palea pubescence	Hairs on upper portion	Short hair	Hairs on upper portion	Hairs on upper portion	Hairs onupper Portion	Hairs on upper portion	Short hair	Short hair	Hairs on upper portion	Hairs on upper portion
Lemma and palea color	Straw	Brown furrows	Brown furrows	Straw	Straw	Straw	Brown furrows	Straw	Straw	Straw
Lemma: anthocyanin colouration of keel	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Lemma; anthocyanin colouration of area below apiculus	Very weak	Very weak	Very weak	Very weak	Very weak	Very weak	Very weak	Very weak	Medium	Very weak
Lemma: color of apiculus	Brown	Brown	Black	Brown	Straw	Straw	Straw	Brown	Brown	Brown
Lemma: shape of apiculus	Pointed	Curved	Curved	Curved	Pointed	Curved	Pointed	Curved	Pointed	Pointed
Sterile lemma length	Long	Medium	Long	Long	Medium	Medium	Medium	Long	Long	Long
Longer sterile lemma length (mm)	3.5±0.02	3±0.02	3±0.02	3.6±0.02	3±0.02	2.5±0.02	3±0.02	3.5±0.02	4±0.02	3.5±0.01
Sterile lemma shape	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Linear	Triangular
Sterile lemma: color	Straw	Straw	Straw	Straw	Straw	Straw	Straw	Straw	Red	Straw
Grain length mm)	9±0.03	8.5±0.02	8.5±0.03	8.5±0.03	6±0.04	6.5±0.03	8±0.04	8±0.05	7±0.04	8.7±0.03
Grain width mm)	3±0.04	3±0.04	3.2±0.02	3.5±0.04	2.5±0.03	3±0.05	4±0.05	3.5±0.04	3±0.05	3.5±0.03
Grain thickness	2±0.03	2±0.03	2±0.03	2±0.03	2±0.05	2±0.05	2±0.03	2±0.05	2.5±0.04	2.5±0.03
1000 grain weight (g)	31.6	29.3	28.8	31.6	12.5	23.3	30.9	29.3	23.4	30.4
Caryopsis length (mm)	6±0.05	6±0.03	6±0.04	6±0.03	4±0.02	4.5±0.03	6.5±0.03	7±0.03	5.5±0.03	6.5±0.03
Caryopsis width (mm)	2.8±0.03	3.5±0.03	3±0.03	3±0.02	2±0.03	2±0.03	3±0.05	3±0.03	2.5±0.03	3±0.03
Caryopsis shape	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled	Half spindled
Caropsis pericarp color	Red	Red	Red	White	White	White	Red	Red	White	Red
Endosperm type	Waxy	Waxy	Waxy	Non-glutinous	Waxy	Intermediate	Intermediate	Non -glutinous	Intermediate	Waxy

*AD- Adukkan, CL- Chennellu, CD- Chenthadi, CHL- Chomala, GA- Gandhakasala, JR- Jeerakasala, KD- Kalladiaryan, MT- Marathondi, MK- Mullan Kaima, KV- Kodu Veliyan

proximate composition, micronutrient content, and dietary fiber composition.

Proximate composition

Table 2 presents the proximate composition of the ten selected traditional rice varieties, calculated on a dry basis. Significant differences ($p<0.05$) in proximate composition were noted among the selected rice varieties, except for moisture content. Additionally, replications of rice varieties from various regions of Wayanad demonstrated consistent results.

Moisture content

The mean moisture levels of the selected ten varieties ranged from (11.18±0.46) % to (12.73±0.2) %. *Marathondi* displayed the highest moisture content among the tested rice varieties, while *Kodu Veliyan* had the lowest moisture content. Four rice varieties, namely *Adukkan*, *Gandhakasala*, *Kalladiaryan*, and *Marathondi*, exhibited moisture content greater than 12%. Notably, there was no significant variation in moisture content among the selected rice varieties.

Protein content

The mean protein content of the ten chosen varieties ranged from (7.55±0.37) % to (10.23±0.56) %. All selected rice varieties demonstrated protein content exceeding 7%. *Chenthadi* exhibited the highest protein content, whereas *Marathondi* had the

Table 2 — Proximate composition and dietary fiber content of the selected rice varieties of Wayanad

Rice Variety	Proximate Composition (%)						Dietary fiber (%)
	Moisture	Crude protein	Crude fiber	Crude ash	Crude fat	Carbohydrate	
Adukkan	12.23±0.65^{a}	8.33±0.06^{cd}	1.22±0.39^{a}	1.30±0.10^{bc}	1.91±0.15^{ab}	76.23±0.24^{ab}	8.83±0.05
Chennellu	11.86±0.52^{a}	9.05±0.65^{abc}	1.19±0.23^{a}	1.57±0.05^{a}	1.68±0.14^{abc}	75.84±0.65^{bc}	8.39±0.09
Chenthadi	11.33±0.59^{a}	10.23±0.56^{a}	1.09±0.10^{ab}	1.58±0.04^{a}	1.54±0.06^{bc}	75.32±0.59^{c}	8.53±0.07
Chomala	11.94±0.19^{a}	8.77±0.16^{bcd}	1.25±0.11^{a}	1.44±0.03^{ab}	1.41±0.11^{c}	76.44±0.19^{ab}	8.24±0.11
Gandhakasala	12.02±1.02^{a}	9.45±0.33^{abc}	0.95±0.12^{abc}	1±0.06^{d}	1.57±0.35^{bc}	75.96±0.66^{bc}	8.32±0.26
Jeerakasala	11.76±0.44^{a}	9.4±0.68^{abc}	1.46±0.09^{a}	1.16±0.05^{cd}	2.12±0.21^{a}	75.56±0.68^{bc}	8.35±0.05
Kalladiaryan	12.27±0.31^{a}	9.42±0.54^{abc}	0.58±0.25^{bcd}	1.44±0.11^{ab}	1.5±0.04^{bc}	75.37±0.57^{bc}	8.42±0.11
Marathondi	12.73±0.2^{a}	7.55±0.37^{d}	0.48±0.06^{cd}	1.35±0.01^{b}	1.48±0.10^{bc}	76.89±0.39^{a}	8.45±0.12
Mullankaima	11.84±0.53^{a}	9.06±0.48^{abc}	0.40±0.06^{d}	1.35±0.06^{b}	1.9±0.13^{ab}	75.85±0.63^{bc}	8.56±0.51
KoduVeliyan	11.18±0.46^{a}	9.99±0.48^{ab}	0.60±0.04^{bcd}	1.55±0.01^{a}	1.8±0.08^{abc}	75.48±0.40^{c}	10.15±0.25
LSD	1.71	1.39	0.52	0.18	0.47		

Data was expressed in Mean ± SE (n = 3). Mean values in a column with different superscripted letters are significantly different at $p<0.05$.

lowest. Seven rice varieties, namely *Chennellu*, *Gandhakasala*, *Jeerakasala*, *Kalladiaryan*, *Mullan Kaima*, *Kodu Veliyan*, and *Chenthadi*, showcased protein content exceeding 9%. Notably, all selected rice varieties exhibited significant variation in protein content.

Crude fiber and dietary fiber content

The mean crude fiber content among the ten varieties ranged from (0.40±0.06) % to (1.46±0.09) %. *Jeerakasala* exhibited the highest crude fiber content, while *Mullan Kaima* had the lowest. All varieties fell within the standard range of crude fiber content for well-milled rice (0.05% to 1.00%)[16]. Except for four varieties—*Adukkan*, *Chennellu*, *Chomala*, and *Jeerakasala*—all others showed significant variation in fiber content.

The selected traditional rice varieties displayed dietary fiber values ranging from (8.24±0.11) % to (10.15±0.25) %. *Kodu Veliyan* boasted the highest dietary fiber content at (10.15±0.25) %.

Ash content

The mean ash content for the selected varieties ranged from (1±0.06) % to (1.58±0.04) %. *Chenthadi* exhibited the highest ash content, while *Gandhakasala* had the lowest. *Chennellu*, *Chenthadi*, and *Kodu Veliyan* did not show significant variation in ash content.

Fat content

The mean fat content ranged from (1.41±0.1) % to (2.12±0.21) %. *Jeerakasala* exhibited the highest fat content at (2.12±0.21) %, followed by *Adukkan* (1.91±0.15) % and *Mullan Kaima* (1.9±0.13) %. Conversely, *Chomala* displayed the lowest fat content at (1.41±0.1) %. Importantly, all rice varieties showed significant differences in fat content.

Carbohydrate content

The carbohydrate content ranged from (75.32±0.59) % to (76.89±0.39) %, with all values showing significant differences. *Marathondi* exhibited the highest carbohydrate content at (76.89±0.39) %, while *Chenthadi* displayed the lowest at (75.32±0.59) %.

Mineral content

The highest average Fe content was observed in the variety *Chomala* (39.75 mg/kg). *Jeerakasala* exhibited the highest average Mn content (67.25 mg/kg), while *Kodu Veliyan* had the highest average Zn content. *Chennellu* showed the highest average phosphate content (21.25 mg/kg) (Table 3). Average values of K, Ca, Mg, and phosphate (PO_4^{3-}) largely fell within the range reported by previous studies[5,10]. However, noticeable variations were observed in mineral contents among the replications, unlike proximate composition. For instance, in the variety *Chomala*, Fe content varied from 11.25 mg/kg to 55.75 mg/kg. Similarly, in *Kalladiaryan*, Fe ranged from 20 to 40.75 mg/kg (Supplementary Table S1). Perceptible variations were visible in Fe, Mn, Zn, and PO_4^{3-} contents of samples of the same rice variety at different locations. Additionally, all mineral contents showed significant variation among the varieties and between the replications. Variation in Fe content at different locations is illustrated in Figure 2. It was noted that seven rice varieties—*Kodu Veliyan*, *Kalladiaryan*, *Jeerakasala*, *Gandhakasala*, *Adukkan*, *Chomala*, and *Marathondi*—exhibited an increased amount of Zn at the S1 region compared to other locations. In *Chomala*, the amount of K, Ca, Mg, and Mn was highest in the sample selected from the S2

Table 3 — Micronutrient analysis of the selected traditional rice varieties

Rice	K (%)	Ca (%)	Mg (%)	Fe (mg/Kg)	Mn (mg/Kg)	Zn (mg/Kg)	PO_4^{3-} (mg/Kg)
Adukkan	0.08^{bcd}	0.24^{ab}	0.06^{b}	17.75^{a}	29.75^{c}	16.75^{c}	8.75^{b}
Chennellu	0.08^{d}	0.30^{ab}	0.06^{b}	32.25^{a}	35.75^{c}	18.5^{bc}	21.25^{ab}
Chenthadi	0.03^{a}	0.32^{a}	0.15^{a}	33.75^{a}	57.75^{ab}	23^{ab}	14^{ab}
Chomala	0.08^{bcd}	0.05^{c}	0.08^{b}	39.75^{a}	26.5^{c}	16.75^{c}	17^{a}
Gandhakasala	0.08^{cd}	0.23^{ab}	0.09^{b}	30.25^{a}	64.5^{a}	16.75^{c}	12.25^{ab}
Jeerakasala	0.10^{bcd}	0.25^{ab}	0.06^{b}	20.25^{a}	67.25^{a}	17.5^{c}	12^{ab}
Kalladiaryan	0.09^{bcd}	0.24^{ab}	0.09^{b}	30.25^{a}	35.25^{c}	18.5^{bc}	12^{a}
Marathondi	0.09^{bcd}	0.20^{b}	0.06^{b}	21.75^{a}	30.5^{c}	16.25^{c}	14.5^{ab}
Mullankaima	0.12^{ab}	0.25^{ab}	0.11^{ab}	33.75^{a}	61.25^{a}	20^{bc}	14.25^{ab}
Kodu Veliyan	0.10^{abc}	0.29^{ab}	0.08^{b}	29.25^{a}	50.75^{b}	25.25^{a}	12.75^{ab}
LSD Value	0.0251	0.1111	0.0524	23.0361	11.5911	5.3142	7.0785

Mean values (n=3) in a column with different superscripted letters are significantly different at $p<0.05$.

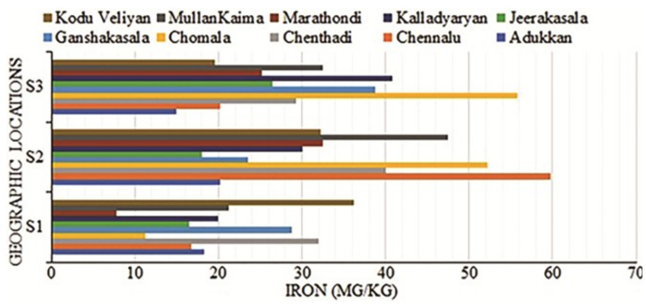

Fig. 2 — Fe content of the ten rice varieties at three locations

region. Similarly, in *Adukkan*, Ca, Mg, Fe, and Zn were highest in samples collected from the S2 region, while PO_4^{3-} was found in the lowest quantity compared to other samples from different regions. Conversely, in *Gandhakasala*, samples from the S1 region expressed an increased range in K, Ca, Mn, and PO_4^{3-} compared to other samples. In *Mullan Kaima*, a sample from the S2 region had the highest amount of Ca, Mg, Fe, Mn, and PO_4^{3-} compared to other samples.

Discussion

Since the onset of the COVID-19 pandemic, immunity has emerged as the primary defense mechanism for individuals. Nutritional status has been recognized as a crucial determinant of resilience against destabilization[2]. In countries like India, where rice is a staple food, nutrient-rich rice plays a pivotal role[3,4]. Research indicates that pigmented rice offers health benefits compared to non-pigmented rice[6-8]. Additionally, studies on the health benefits of traditional rice varieties have shown that bran from red rice possesses high antioxidant, anti-diabetic, anti-inflammatory, and cytotoxic properties compared to bran from white rice[8,17]. Similarly, traditional rice varieties from Kerala are rich in fiber and micronutrients[10].

Proximate composition

The consumption of whole grains is associated with various health benefits compared to polished grains. Therefore, the properties of moisture, protein, fiber, ash, fat, and carbohydrate were analyzed for the whole grains[6,18-21]. The moisture levels exhibited by the ten varieties were within a range lower than the safe moisture content (14%) recommended for storing processed rice[22]. Among the ten rice varieties, six had moisture levels below 12%, a value suggested for long-term storage to prevent insect infestation and microbial growth[23,24,25].

The nutritional quality of rice is impacted by its protein content[6]. The protein content range of the ten rice varieties exceeded the desired range of 7%-8%[22]. Consistently, most studies have reported rice protein content to be below 13%[6,22,26-28], which aligns with our findings.

Consumption of whole grains, which are rich in dietary fiber, has been shown to have enhanced effects in reducing blood cholesterol[29]. Additionally, dietary fiber reduces the likelihood of bowel illnesses and constipation[30]. Among the varieties examined, *Adukkan, Chennellu, Chenthadi, Chomala*, and *Jeerakasala* exhibited crude fiber content exceeding 1%. For the majority of varieties, crude fiber content was higher than the range reported by Diako *et al.* (2011)[31], Saikia *et al.* (2012)[32], and Verma *et al.* (2017)[4], and fell within the range of other studies by Shayo *et al.* (2006)[9], Ibukun (2008)[33].

Dietary fiber (DF) is an indigestible essential nutrient derived from plant materials, capable of undergoing partial or complete fermentation in the large bowel[34]. It's important to note that crude fiber represents only a portion of insoluble fiber, and the value of dietary fiber can be 3 to 5 times higher than the crude fiber value[35]. As evidenced by our results, crude fiber content ranged from (0.40±0.06) % to (1.46±0.09) %, while dietary fiber content ranged from (8.24±0.11) % to (10.15± 0.25) %.

The ash content of rice plays a crucial role as it reflects the mineral components of the food sample[36]. Juliano (1985)[22] identified the normal range of ash content to be between 0.3% and 0.8%. However, all the rice varieties used in the present study exhibited ash content exceeding 1.3%, indicating a good mineral content in these varieties.

Fat in rice does not contain cholesterol; instead, it serves as a source of linoleic acid and other essential fatty acids[37]. Studies indicate that rice bran contains relatively high amounts of mono- and polyunsaturated fatty acids, making it a high-quality dietary fat[22]. The reported fat content in the analysis is higher than the ranges reported by Chen *et al.* (2020)[38], Cameron and Wang (2005)[39], Shayo *et al.* (2006)[9], Yadav *et al.* (2014)[40], Ibukun (2008)[33], Diako *et al.* (2011)[31], and Fari *et al.* (2011)[41].

Carbohydrate in rice mainly consists of starch, which is composed of amylose and amylopectin. The carbohydrate content for all the varieties fell within the range reported by previous studies[5,28].

Mineral content

In rice, the absorbance level of mineral content is influenced by genetic characteristics and environmental factors[41,42]. This was evident in the results of the mineral content analysis of the ten rice varieties, as significant differences were observed among the varieties and the replications. Iron and zinc are crucial nutrients for the human body, and essential for maintaining the immune system[42,43], and both nutrients were found to be comparatively high in all the selected varieties. While many mineral values at different locations fell within the range reported by other studies[3,5,10] a few mineral values at different locations exceeded the normal range. Environmental factors may have influenced this variation[44]. Factors such as water supply, management practices, fertilizer application affecting soil nitrogen availability, environmental stressors like salinity, alkalinity, temperature, diseases, as well as location and growing conditions, all play roles in influencing the protein availability and micronutrient content of different rice varietie[44,45].

Conclusion

There was a notable difference in both proximate composition and mineral content among the selected ten traditional rice varieties of Wayanad. Interestingly, while proximate composition remained consistent across replications in different regions of the district, mineral contents significantly varied among these replications. *Chenthadi* exhibited the highest protein content (10.23±0.56) %, while *Jeerakasala* had the highest crude fiber content (1.46±0.09) % and fat content (2.12±0.21) %. *Kodu Veliyan* stood out for having the highest dietary fiber content (10.15±0.25) %. Furthermore, *Chennellu* showed the highest Fe content at location S2, while *Kodu Veliyan* exhibited the highest Zn content at location S1. These findings underscore the importance of traditional rice varieties in terms of nutrition and immunity. They also emphasize the necessity for further research into the factors influencing the micronutrient absorbance of rice varieties.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_23(05)(2024) 489-497_SupplData.pdf

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Conflict of Interest

Authors should declare no competing or conflict of interest

Author Contributions

ML- Conceived the research question, morphology analysis, and manuscript preparation; VS- Research supervision and manuscript review; AT- Biochemical analysis and manuscript review; CHA- Statistical analysis and manuscript review.

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