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Profiling of proximates and mineral composition in horsegram genotypes (*Macrotyloma uniflorum* (Lam,) Verdc)

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Abstract
Micronutrients are important growth promoting elements not only for crops but also for human being. More than two billion of the global populations are malnourished. For developing countries like India, micronutrient malnutrition among the people of every age is very common. Horse gram one of the important food legume is the cheapest sources of proteins, vitamins and micronutrients and can be supplied to the people through daily diet. In this connection profiling of the proximate composition and mineral contents in seeds of twenty two diverse horsegram genotypes was done at Seed Unit, UAS, Dharwad. A total of thirteen nutritional parameters were recorded across twenty two genotypes. The results revealed significant difference for different of proximate and mineral contents. Highest protein content of 20.19% and fibre content of 6.3% was observed. Iron (Fe) content in horse gram genotypes was found to be the highest (1183 ppm) than the rest of minerals *viz.,* Zinc (197.1 ppm) and manganese content (127.3 ppm) among the genotypes indicating that horse gram is good sources of iron (Fe), zinc, potassium and calcium. Outcome of the study would be of wide interest to farmers and researchers working on nutraceutical including commercial exploration by exploring the nutraceutical properties of *M. uniflorum*.

Keywords: Horsegram, minerals, proximate composition, malnutrition

Introduction
The World Health Organization (WHO) report estimates over 820 million people are hungry, two billion have micronutrient deficiencies and nearly another two billion are obese or overweight, indicating a paradigm shift toward nutritional security (UNEP 2021) [11]. During the COVID-19 pandemic period also, importance of micronutrients in the well-functioning of immune system was well established and efforts to increase bioavailability of micronutrients through dietary supplementation, food fortification and dietary diversification have been made to reduce micronutrient malnutrition. However, the potential method for reducing global micronutrient deficiency has been anticipated through the production of nutri-rich staple food crop cultivation.

Arid legumes are important group of crops having special significance in sustainable farming and nutritional security as they provide excellent source of protein, minerals, vitamins and crude fibre. They are considered as healthy food, which offer nutritional security to millions of people, especially in South Asia and Africa (Masood Ali, 2007) [7] and are valued as relatively cheaper source of protein and energy as compared to animal proteins. Legumes also contain several nutritional factors whose beneficial effects on human health need to be fully exploited. Horsegram (*Macrotyloma uniflorum* (Lam.) Verdc.*),* is one of the minor or lesser known/ neglected food legume mainly cultivated in Asian and African countries for food and fodder. It is one of the best climate resilient legumes as it is well known for its drought hardiness and has suitable agronomic features for cultivation on dry lands under low input condition of marginal lands (Gowda *et al.* 2007) [11]. Its nutritional value is comparable with other commonly consumed pulses and serves as a cheap source of nutrition for unprivileged rural communities residing in inaccessible areas. Horsegram also is also known to have many therapeutic effects which have been recommended in ayurvedic medicine to treat kidney stones, edema etc., as well as posses anti-diabetic, anti-ulcer and anti-obesity activity due to the presence of beneficial bioactive compounds. Moreover, it is the rich source of protein, iron, calcium and molybdenum, polyphenols and minerals including Na, K, Ca, Mg, S, P, and Cl as well as the micro-nutrients *viz.*, Fe, Zn, Cu, Mn, Se, Mo, Co. Many of them are essential for human life

(Kadam and Salunkhe 1985, Bouis and Welch 2010, Morris *et al.* 2013) [5, 3, 8]. Considering horsegram as protein source, rich minerals and polyphenol content and many therapeutic effects horsegram can be included in the diet on regular basis. In India traditionally it is (whole grains and sprouts) used for preparing various region specific dishes. Across the country efforts are being made by scientists to study grain nutritional and biochemical composition in promising varieties of horsegram to expedite the genetic genetic improvement of this indigenous food legume.

Material and Methods

The experiment was carried out with 22 horsegram genotypes collected from diverse sources (Table 1.) in a randomized complete block design (RCBD) with three replications during the year *kharif* 2020-21at Seed Unit, University of Agricultural Sciences, Dharwad. Each genotype was sown in a plot size of 4 x 2.25 m^2 having 6 rows. Row to row and plant to plant distance were maintained at 45 and 10 cm respectively. All the recommended agronomic practices were followed to raise a healthy crop. At maturity crop was harvested and recorded observations on yield and its component traits and further cleaned seeds were taken for nutritional parameter analysis.

Estimation of nutritional parameters

The different nutritional parameters were estimated by performing biochemical analysis as per the standard protocols given by the Association of Official Analytical Chemistry (AOAC), 2005 by using analytical grade chemicals and reagents. Protein, carbohydrates, ash, fat and minerals were estimated in seed samples of 22 diverse horsegram genotypes. The data recorded was summarized as the means of three replicates with standard deviation as the measures of variability. Statistical analysis was performed for 13 nutritional parameters and minimum, maximum, range and mean were calculated for each nutritional trait and variation within group expressed as coefficient of variation.

Results and Discussion

The result obtained for 13 different nutrient components in 22 genotypes and minimum, maximum, mean and range are presented in the Table 1. The results revealed the presence of variation for each one of the nutrient components. Among various genotypes evaluated, protein content ranged from 11.53% to 20.19% and highest content of protein was recorded in Dharwad local-1 (20.19%), while least in GHG-07 (11.53%). Ash content varied from 2.89% to 3.86% with highest ash content in CRHG-6 (3.86%). Fibre content is very important in digestion process and highest fibre content of 6.3% was recorded in GHG-07. Carbohydrate concentration was also showed range of variation (49.99% - 55.61%) while wherein genotype Dharwad local-1 recorded highest value of 55.61%. Similar results were obtained by Shivanna and Venkateswaran, 2016 [10], Bhartiya *et al.* 2015 [1] and Marimuthu and Krishnamoorthi, 2014 [6].

Horsegram grains are an excellent source of Fe, Ca and Zn, which are highly desirable from a nutritional perspective (Kadam and Salunke, 1985; Bouis *et al.*, 2010) [5, 3]. Present study also recoded a large variation for these nutrients in horsegram grains. For different nutrient parameters the range varied from 11.0-197.1 ppm for Zinc (Zn), 21.9 -1183.0 ppm for Iron (Fe), 10.2-127.3 ppm for Manganese (Mn) and 0.75-8.6% for Patassium (K), the most abundant minerals in horsegram grains. The report by Shivanna and Venkateswaran, 2016 [10], Bhartiya *et al.* 2015 [1] and Marimuthu and Krishnamoorthi, 2014 [6], Bolbhat and Dhumal, 2014 [2] supported such wide variation observed in the present investigation.

From the study it is evident that Iron (Fe) content in horse gram was found to be the highest (1183 ppm) than the rest of minerals, Zinc (197.1 ppm) and manganese content (127.3 ppm) among 22 horsegram indicating that horse gram is good sources for these micronutrients and identification of genotypes with high concentration of Fe and Zn could contribute significantly to improve the micronutrient status of the diet of consumers. These results are in accordance with the findings of Patangere *et al.* 2019 [9]. Though wide range of variation for different proximates and mineral contents was recorded among diverse genotypes, none of the horsegram genotype recorded highest concentrations for more than one mineral components together except Dharwad local genotype for protein and carbohydrate.

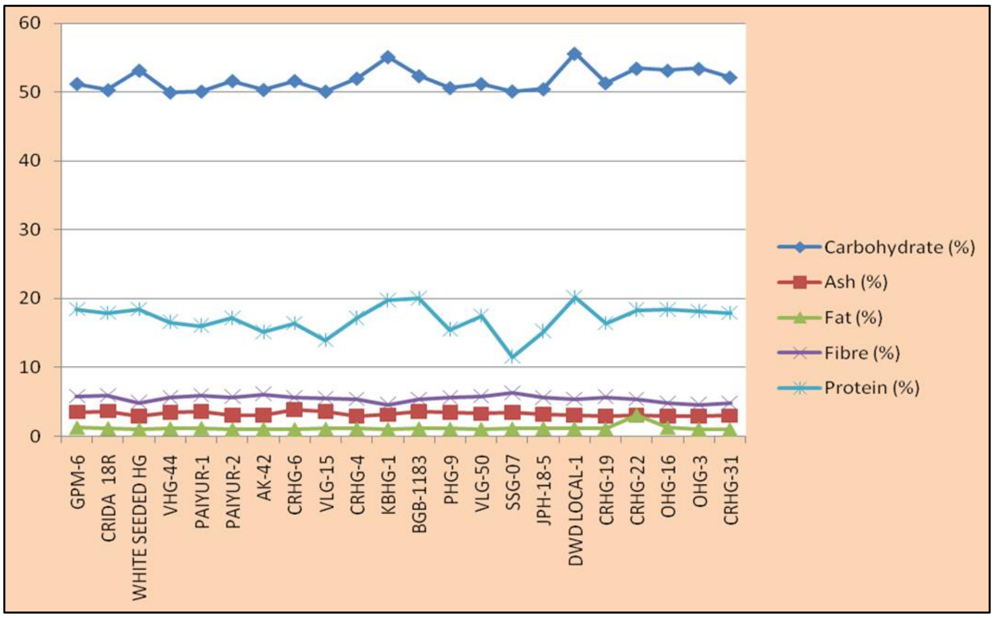

Fig 1: Profile of Proximates among 22 diverse horsegram genotypes

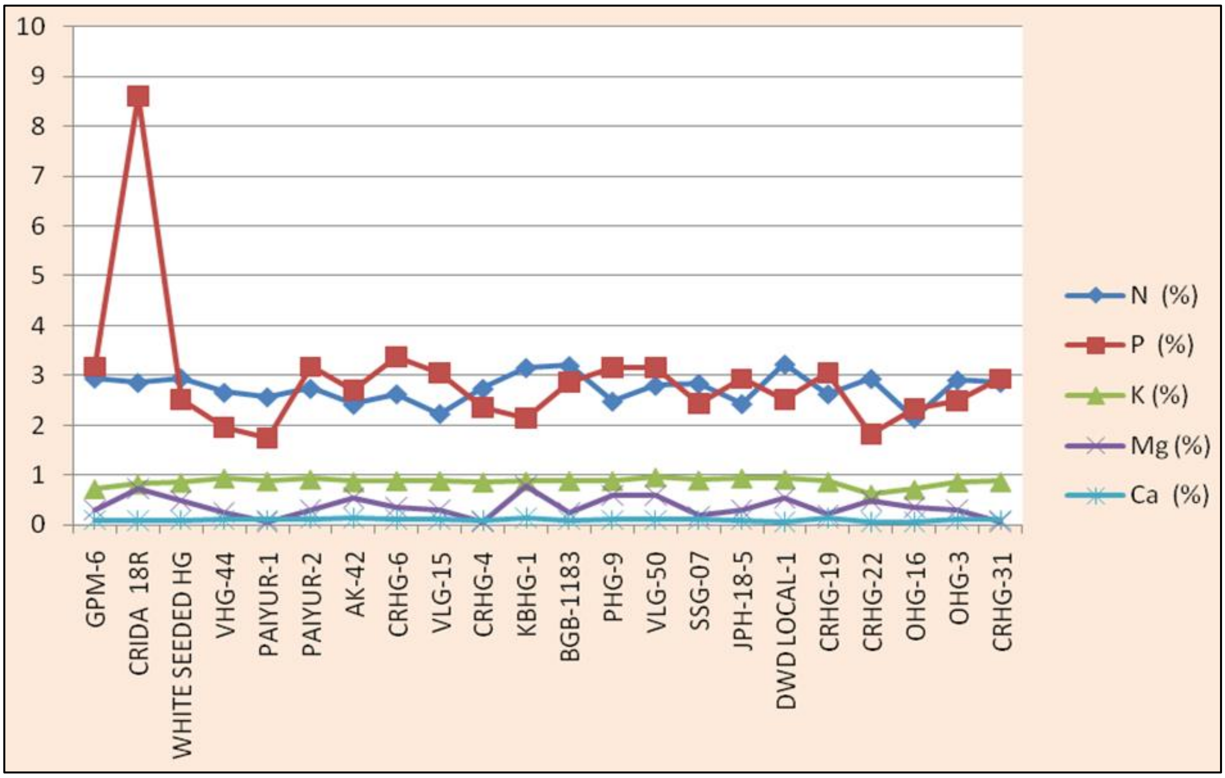

Fig 2: Composition of major nutrients in horsegram genotypes

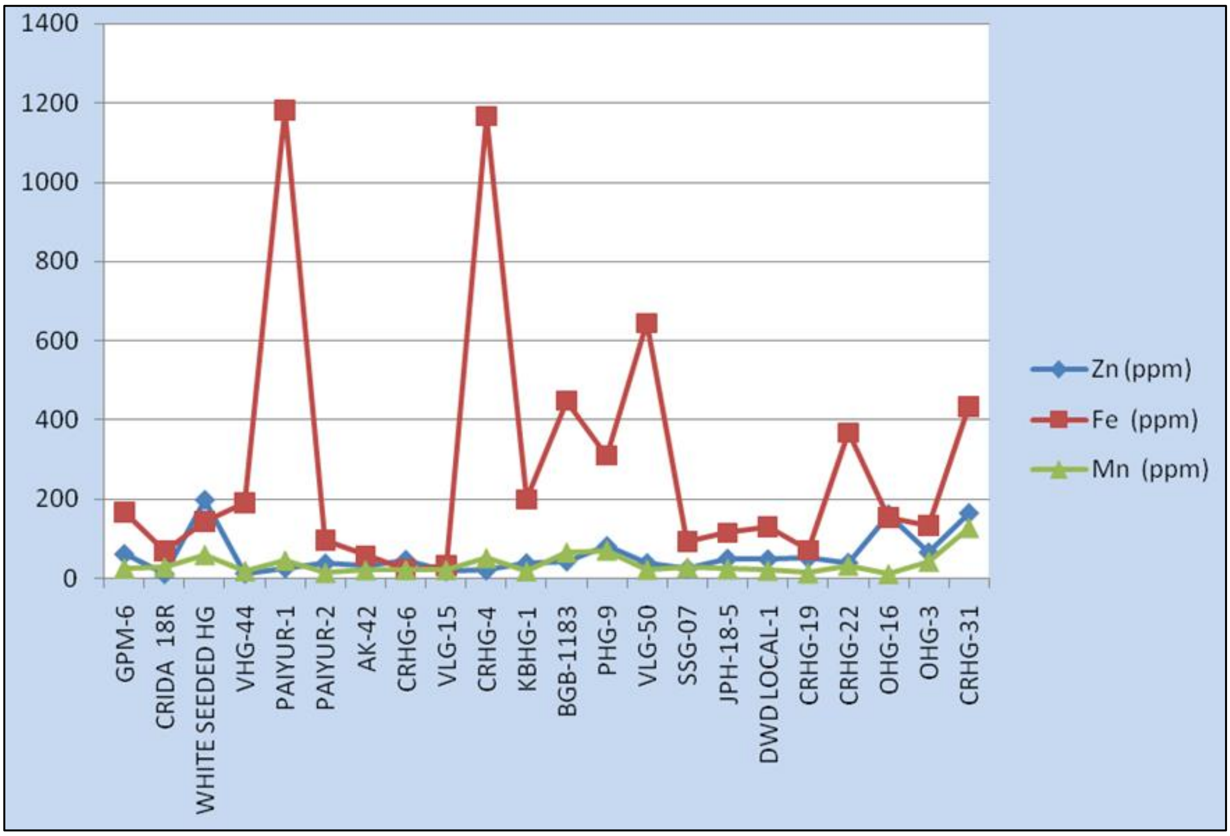

Fig 3: Mineral contents in horsegram genotypes

Table 1: Proximate profile in diverse horsegram genotypes.

Sl. No	Genotype	Carbohydrate (%)	Ash (%)	Fat (%)	Fibre (%)	Protein (%)	N (%)	P (%)	K (%)	Mg (%)	Ca (%)	Zn (ppm)	Fe (ppm)	Mn (ppm)
1	GPM-6	51.23	3.51	1.2	5.8	18.44	2.95	3.18	0.72	0.30	0.10	60.8	167.3	24.6
2	CRIDA 18R	50.33	3.64	1.11	5.9	17.89	2.86	8.60	0.82	0.72	0.09	11.0	70.4	27.2
3	WHITE SEEDED HG	53.16	2.95	0.97	4.9	18.44	2.95	2.52	0.85	0.48	0.10	197.1	144.6	59.0
4	VHG-44	49.99	3.46	1.10	5.6	16.60	2.66	1.96	0.94	0.24	0.11	12.1	190.7	17.7
5	PAIYUR-1	50.13	3.58	1.13	5.9	16.04	2.57	1.75	0.88	0.06	0.11	25.0	1183	44.2
6	PAIYUR-2	51.66	3.01	0.97	5.7	17.15	2.74	3.18	0.92	0.3	0.13	37.5	97.6	13.1
7	AK-42	50.36	3.01	0.99	6.1	15.12	2.42	2.71	0.87	0.54	0.15	30.8	58.3	19.7
8	CRHG-6	51.66	3.86	0.98	5.6	16.41	2.63	3.38	0.89	0.36	0.12	46.2	21.9	20.8
9	VLG-15	50.13	3.55	1.03	5.5	13.92	2.23	3.06	0.89	0.30	0.11	18.1	32.6	20.6
10	CRHG-4	52.01	2.89	1.05	5.4	17.15	2.74	2.37	0.86	0.06	0.09	19.8	1183.0	50.3
11	KBHG-1	55.13	3.11	0.98	4.6	19.73	3.16	2.16	0.88	0.78	0.15	37.5	200.2	17.0
12	BGB-1183	52.36	3.56	1.08	5.4	20.01	3.20	2.87	0.89	0.24	0.10	42.7	448.7	64.7
13	PHG-9	50.64	3.41	1.04	5.6	15.49	2.48	3.17	0.89	0.60	0.11	80.9	310.4	70.4
14	VLG-50	51.23	3.25	1.01	5.8	17.52	2.80	3.16	0.96	0.60	0.11	37.9	644.9	21.5
15	SSG-07	50.16	3.44	1.06	6.3	11.53	2.84	2.45	0.90	0.18	0.11	24.2	93.8	26.7
16	JPH-18-5	50.46	3.13	1.12	5.6	15.21	2.43	2.94	0.94	0.30	0.10	49.1	115.1	22.8
17	DWD LOCAL-1	55.61	2.99	1.06	5.4	20.19	3.23	2.52	0.92	0.54	0.06	47.6	130.4	19.3
18	CRHG-19	51.34	2.89	1.04	5.7	16.41	2.63	3.06	0.87	0.21	0.15	50.4	71.3	12.4
19	CRHG-22	53.46	3.02	3.02	5.4	18.35	2.94	1.84	0.61	0.48	0.07	39.1	368.5	31.8
20	OHG-16	53.16	2.93	1.20	4.8	18.37	2.14	2.34	0.71	0.36	0.07	160.9	154.1	10.2
21	OHG-3	53.42	2.91	0.99	4.6	18.16	2.91	2.50	0.86	0.30	0.12	65.3	134.2	41.7
22	CRHG-31	52.16	2.96	0.96	4.8	17.89	2.86	2.94	0.87	0.06	0.11	164	434.5	127.3
	Mean	51.81	3.23	1.14	5.47	17.09	2.74	2.94	0.86	0.36	0.11	57.18	283.59	34.68
	Minimum	49.99	2.89	0.96	4.6	11.53	2.14	1.75	0.61	0.06	0.06	11	21.9	10.2
	Maximum	55.61	3.86	3.02	6.3	20.19	3.23	8.6	0.96	0.78	0.15	197.1	1183.0	127.3
	Range	49.99-55.61	2.89-3.86	0.96-3.02	4.6-6.3	11.53-20.19	2.14-3.23	1.75-8.6	0.61-0.96	0.06-0.78	0.06-0.15	11.0-197.1	21.9-183.0	10.2-127.3

Conclusion

The present study has thrown light on presence of wide range of variation for different nutritional parameters. Presence of high concentration of protein, Fe and Zn in different horsegram genotypes implies ample opportunity for its genetic improvement. Thus, in the present climate change scenario, to meet the nutritional security along with food security, genetic enhancement in horsegram crop is of appropriate choice. In order to combat the malnutrition and hunger, we need to work toward “more nutrition per bite.” The nutrition rich genotypes identified in the present study will be a promising material for plant breeders in feature. Furthermore, there are still immense possibilities exist for horsegram crop to be explored for its innate health-promoting aspects and many undiscovered phytochemicals to make the most use of this indigenous legume to address food and nutritional security issues.

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