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RESEARCH ARTICLE

Nutritional composition of the wild variety of edible vegetables consumed by the tribal community of Raipur, Chhattisgarh, India

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Abstract

Humans established relations with food with their existence on earth. In various parts of the world, different types of vegetation are used as food material. Chhattisgarh, where numbers of tribes exist and used a leafy portion of various plants as a food material. The present study evaluated the total protein, total carbohydrate, and total free amino acid content in leafy vegetables used in Chhattisgarh. Total protein was estimated by Lowry method, while total carbohydrate and free amino acid content by Anthrone method and spectrophotometric method. The result showed highest protein contained in *Tamarindus indica* (103.98 ± 2.34 µg/mg) followed by *Moringa olerifera* (99.86 ± 2.32 µg/mg), *Cicer arietinum* (95.53 ± 2.78 µg/mg). The highest carbohydrate content was observed in the leaf of *Amaranthus viridis* (116.26 ± 2.33 µg/mg of plant tissue) followed by *Marsilea vestita* with carbohydrate content (82.35 ± 1.55 µg/mg), C*horchorus olitorius* with carbohydrate content (50.46 ± 2.23 µg/mg), and highest free amino acid content was recorded in the leaves of (232.33 ± 2.05 µg/mg of plant tissue) followed by *Brassica oleracea* (204.94 ± 1.25 µg/mg), *Cucurbita maxima* (85.67 ± 2.35 µg/mg). The study's finding confirmed that wild leafy vegetables utilized by the special community of this area play a significant role in their livelihood as those vegetables contain higher nutrient level compared to conventional crops. As per the data reported, more than one million people of this region suffer from malnutrition so present study is an approach to overcome the health issue of people of this region in a sustainable manner.

Keywords: *Tamarindus indica*, *Moringa olerifera, Amaranthus viridis,* Protein and carbohydrate estimation, Amino acid, Chhattisgarh tribes, Wild leafy vegetable.

Introduction

In order to help people, lead a healthy life, they require a wide variety of nutrients. These nutrients come from a balanced diet, and the amount of supplement an individual requires varies with age, orientation, physiological status, and physical activity. Cereals, millets, legumes, nuts, and seeds are among the common sources of nutrients. Wild food plants (WFPs) naturally growing plants reported in wild areas such as forests, farmLands, fallow land, roadside, and near bodies of water and streams without human care and interference, are used by local people as sources of food (Harisha *et al.* 2021). There is a variety of plants that grow in forest and wild areas having significant contributions to our food system. There is no doubt that wild foods are fundamental to the survival of the tribal population. Wild plants contain essential nutrients, including amino acids, fatty acids, and minerals. There are many tropical countries where tribal people traditionally harvest a variety of wild edible food which are found in different forms such as tuber, fruit, and leafy vegetable. These foods not only provide nourishment to their communities but many tribes are also dependent on them for their livelihood (Guinand and Dechassa 2000, Balemic and Kebebew 2006). In cities, the availability of this natural and wild food is rare. In India variety of such food is preferred by urban residents because of its special taste, and cultural uses. In India Bael (*Aegle marmelos*), AmLa (*Emblica officinalis*), Jamum (*Syzygium cumini*), Ber (*Ziziphus marutiana*), and ImLi (*Tamarandus*

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indica) are famous wild fruit that is used in India since prehistoric times. Many wild varieties of foods are also eaten in different parts of the country. Not only in India even today in Mediterranean Europe, gathering wild fruit is common practice so is picking wild mushrooms in northern Europe (Pardo *et al*., 2007). With the advancement of science and technology, when researchers claim that WFPs contain various medicinal properties and various nutrient availability people have relied on WFPs resources for their subsistence as they can fulfil the micronutrients requirement of the body (Jyotsna and Katewa 2016). It is estimated that thousands of wild foods in India are used by different communities, especially residents of villages (Rathore, 2009). In India many rural communities living which cannot afford cultivated commercial fruits such as apples, grapes, pomegranates or oranges. In such a situation, Forest fruits collected from the wild play a significant role in the food and nutrient security of rural poor and tribes. Some wild fruits have been identified to have better nutritional value than cultivated fruits (Eromosele *et al.* 2009, Maikhuri *et al.* 1994). In recent years, a growing interest has emerged to evaluate various wild edible plants for their nutritional features (Nazarudeen 2010, Aberoumad and Deokule 2009, Musinguzi *et al.* 2007, Nkafamiya *et al.* 2007, Glew *et al.* 2005)

As the trend is shifted toward the evaluation of wild food, various parameters are going to be evaluated which include ethnobotanical information, ethnoveterinary, medicinal and nutritional, and other economic aspects. So that in future these wild plant varieties can be domesticated and cultivated on a large scale for the betterment of society. It may be possible various food supplements and nutrient supplements will comprise wild food just because of nutritional and pharmacological activities.

Vegetables are important for human nutrition in terms of proteins, fibers, vitamins, minerals and non-nutritive phytochemical compounds (phenolic compounds, flavonoids, bioactive peptides, etc.), which have proven health-promoting effects (Salvi and Katewa, 2016). Several *in-vitro,* pre-clinical and clinical investigations have revealed an inverse relationship between high consumption of vegetables and the incidence of chronic ailments such as cardiovascular and neurodegenerative diseases, ischemic stroke, arthritis, inflammatory bowel and some forms of cancers (Rathore, 2009) For instance, vegetables such as spinach, broccoli and onion are recognized as rich sources of health-promoting compounds (Eromosele *et al.,* 1991).

In this sense, lyophilization is an adequate technology to deliver high-quality and natural health-boosting green powder supplements. Therefore, green powders as dietary supplements might be advantageous since they can help people to reach suitable daily vegetable intake to boost the immune system, particularly under the current pandemic scenario, where COVID-19 is undermining nutrition across the world (Opazo *et al.* 2021)

Chhattisgarh is known as a herbal state due to the presence of a variety of herbs. Not only herbs, Chhattisgarh is also home to various tribal communities. This led to the consumption of various herbs as food material and promoted ethnobotanical practices. The number of edible wild herbs in this state is not reported. Although these herbs were eaten for a long-time nutritional availability in these herbs has not been reported previously. Leafy portions of most herbs are used as vegetables. As the previous study reported, around 90 different types of wild varieties of food are eaten by the tribal people of the state of Chhattisgarh. In this study, we aim to quantify the nutritional composition of various available leafy vegetables. Previous study listed the wild edible food, ethnobotanical uses, edible parts, and method of consumption but not evaluate nutritional composition.

Many previous studies listing wild edible plants have been done in Chhattisgarh species, but none evaluated their nutritional value. Lal *et al*. conducted a study on Bhoramdev wildlife sanctuary and listed the plant name, local name family description, and the parts and methods of using wild food (Lal *et al.* 2017). In another district of the state, Bastar, a study has been conducted on muniya tribes and a variety of mushrooms, wild food and their method of consumption are listed (Shrivastava, 2016). Another study by Chauhan stated about ethnobotanical uses of edible leafy vegetables but not nutritional composition (Shrivastava *et al.* 2014). In the Pendra Road district, the same study was also conducted on the diversity of leafy vegetables but no information about the nutritional value was provided in their study (Sharma *et al.* 2017). However, none of the studies provides nutritional value.

Materials And Method

Study Area

The total area of Raipur is 226 Km^2. Raipur touches its boundary with Arang, Durg, Kawardha, and Bilaspur districts. Raipur is the capital of Chhattisgarh State. Raipur has a semi-arid environment. The summer period is long starting from March to June. In the month of June, the highest temperature reaches 42–45 ^{o}C. Summer is followed by the rainy season which starts in July and till the month of September. A total of 92 villages come under its premises, where several tribal communities live together. Gond, Kamar, Halba, Bathra, Baiga, Binjhwar, and Korku are the resident tribes of this region. Most of the tribes follow the local slogan Narwa Gadwa, Ghurwa, and Bari. Narwa belongs to the drainage system, Gadwa belongs to a Domestication of animals, Ghudwa to organic fertilizer, and Bari to the home garden. Herbs that were evaluated for nutrient analysis were found throughout Raipur. Map of the study site as depicted in Figure 1. Researchers collected these herbs based on their availability in the forest area, agricultural lands, and home gardens.

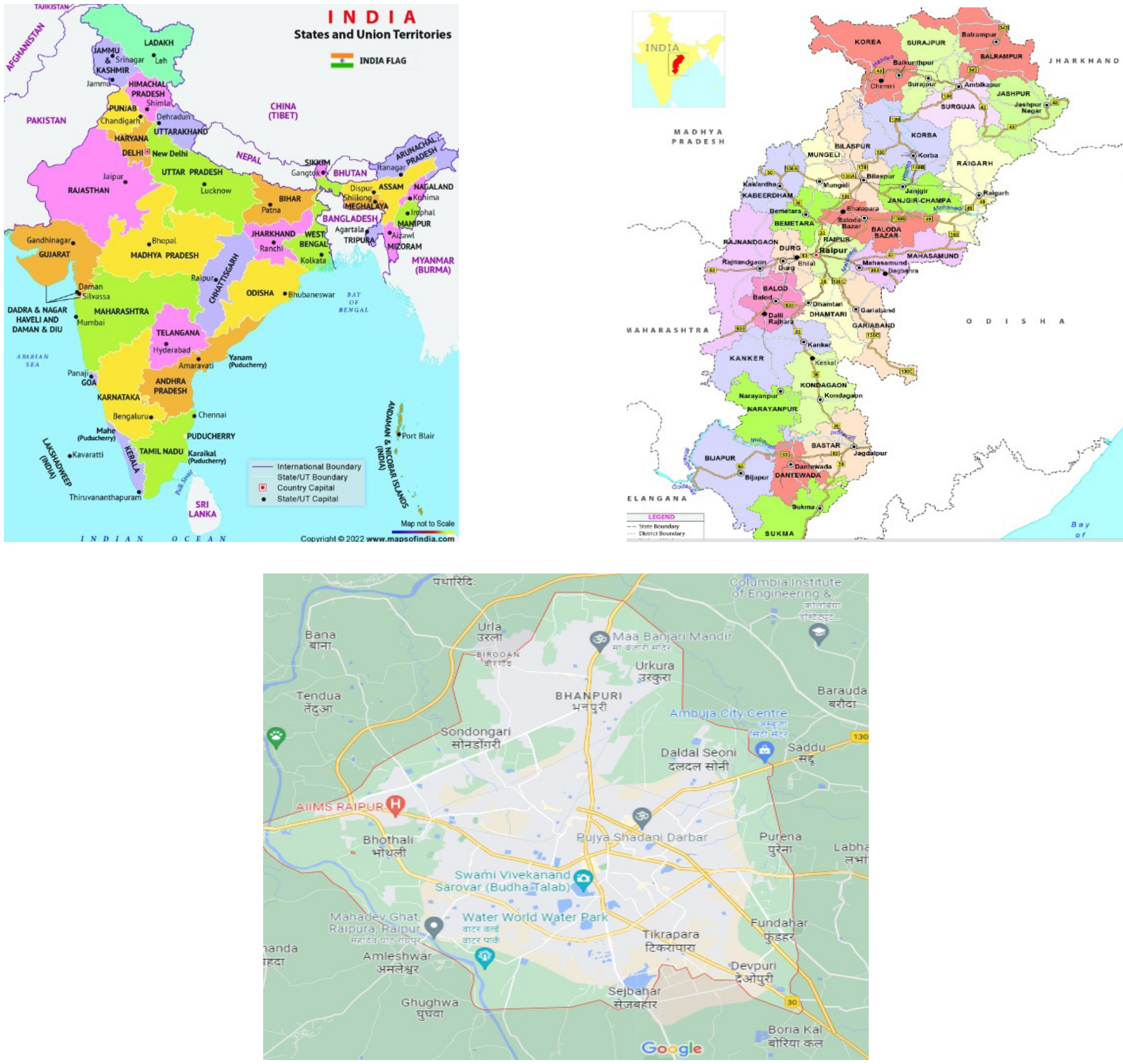

Figure 1: Map of Study area (Source: Maps of India)

Sample Collection

For nutrient analysis, wild plants were brought from the tribal vegetable market some of them were harvested in the tribe's garden and some of them were collected from forest areas. Two specimens were collected from the site one for study purposes and one submitted to the herbaria of Kalinga University. The author identified and cross-verified all the plants with online tools and sites: https://efloraindia.bsi.gov.in/, http://www.theplantlist.org/. Author identified plants and confirmed by Dr R.L.S Sikarwar Professor of the Department of Botany A.K.S University Satna. After identification, all the collected plants were assigned voucher numbers REHKU1 to REHKU40 and submitted to the Department of Botany, Kalinga University Raipur for future reference.

Protein Estimation

The estimation of protein was performed according to the Lowry method (Lowry *et al.* 1951, Santra, 2015). Take 500 mg of fresh plant leaves. Grind with pastel and mortar with the help of 10 mL of phosphate buffer saline and then centrifuged under 14000 RPM for 10 minutes. The supernatant was collected for the determination of protein content. Take 0.1 and 0.2 of supernatant. Make the final volume 1-mL and add 5 mL of Lowry's solution. After 5 minutes, add 0.5 mL of Folin–Ciocalteau reagent into the mixture. After 30 minutes of incubation, the absorbance of samples was recorded with LABTRONICS MODEL LT- 2700 at 660 nm. The same preparation has been done with various concentrations of 40, 80, 120, 160, and 200 µg/mL standard protein solution of Bovine serum albumin. (Lowry *et al.* 1951, Santra, 2015).

Carbohydrate Estimation

100 mg of plant grind with Phosphate Buffer Saline add 5 mL of 2.5N HCL. Kept under the water bath for 3 hours, cool to room temperature, and neutralize it with Na_2CO_3 until effervescence ceases. Add 95 mL of distilled water and

Figure 2: Some edible leafy vegetation of Raipur: (A) *Amaranthus tricolor*, (B) *Chorchorus olitorius*, (C) *Amaranthus graecizans*, (D) *Ipomoea aquatic,* (E) *Coriandrum sativum*, (F) *Butea monoaoperma*, (G) *Marsilea vestita*, (H)*Colocasia antiquarum*, (I) *Raphanus sativus*, (J) *Amaranthus viridis* (K) *Brassica oleracea var capitate*, (L) *Spinacea oleracea*, (M) *Partulaca oleracea*, (N) *Trigonella foenumgraceum*, (O) *Luffa acutangular*, (P) *Momordica charantia*, (Q)*Moringa pterygosperma*, (R) *Ipomoea batatas,* (S) *Hibiscus cannbinus*, (T) *Ipomoea batatas*, (U) *Bauhinia variegate*, (V) *Merremia emarginata Burmf*, (W) *Brassica oleracea Gongylodes*, (X) *Cucurbita maxima*, (Y) *Allium cepa,* (Z)*Cassia tora*, (A1) *Brassica oleracea var. botrytis*, (B1) *Cassia tora*, (C1) *Amaranthus graecizans*, (D1) *Cucumis sativus*, (E1) *Basella rubra*, (F1) *Chorchorus olitorius,* (G1) *Ipomoea aquatic*, (H1) *Cucurbita maxima*, (I1) *Chorchorus trilocularis*, (J1) *Ficus religiosa*, (K1) *Amaranthus tricolour*, (L1) *Tamarindus indica*, (M1) *Phaseolus vulgaris*, (M2) *Cicer arietinum*

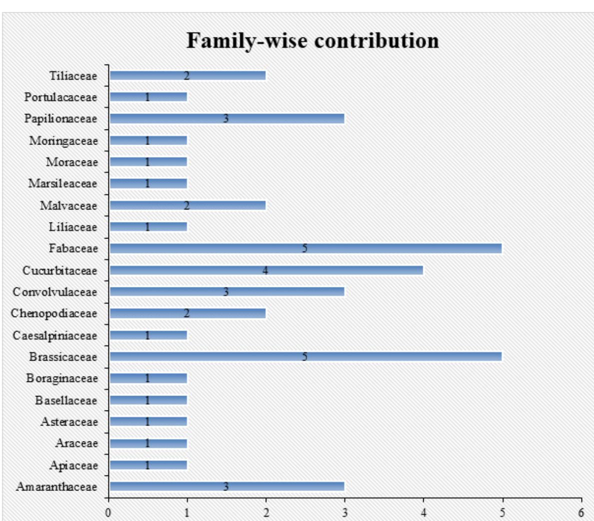

Figure 3: Family contribution of wild edible plant.

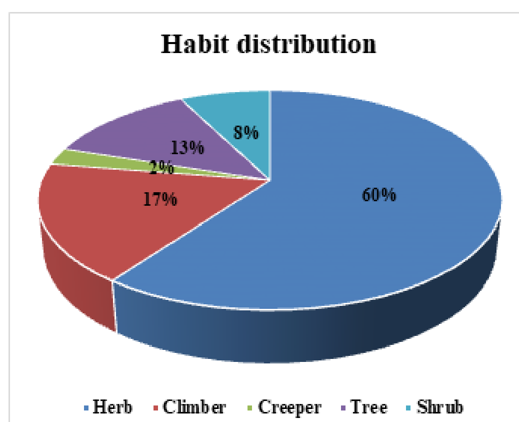

Figure 4: Habit of wild edible plants.

make up the volume of 100 mL. Centrifuge at 3500 RPM for 10 minutes. The supernatant was used for the estimation of carbohydrates. Add 0.5 and 1-mL of supernatant in different test tubes. Make the final volume 1-mL. Add 4 mL of freshly prepared chilled anthrone reagent. Kept these tubes in a water bath for 8 minutes then cool rapidly. Absorbance was taken with the help of Labtronics UV-visible spectrophotometer model LT- 2700 at 630 nm. The same procedure was followed with a standard solution of Glucose

Table 1: List of wild edible plants with calculated nutrient content: Total Protein content (TPC), Total Carbohydrate Content (TCC), Total free amino acid content (TAAC).

Botanical Name, Voucher No.	*Common Name*	*Habit*	*Family Name*	*TAAC (µg/mg)*	*TPC (µg/mg)*	*TCC (µg/mg)*
Allium cepa L. REHKU26	Pyaj Bhaji	Herb	Liliaceae	43.72 ± 0.36	27.19 ± 1.32	6.99 ± 0.32
Amaranthus graecizans L. REHKU2	Kheda Bhaji	Herb	Amaranthaceae	37.52 ± 0.57	79.11 ± 2.65	20.68 ± 1.99
Amaranthus tricolour L. REHKU3	Lal Bhaji	Herb	Amaranthaceae	11.41 ± 0.45	43.03 ± 1.75	8.58 ± 0.24
Amaranthus viridis L. REHKU1	Chaulai Bhaji	Herb	Amaranthaceae	2.89 ± 0.60	71.53 ± 3.45	116.26 ± 2.33
Basella rubra L., REHKU7	Poi Bhaji	Herb	Basellaceae	19.65 ± 0.78	29.40 ± 2.36	1.23 ± 0.25
Bauhinia variegate REHKU24	Bahunia Bhaji	Tree	Fabaceae	30.94 ± 0.64	65.57 ± 1.38	49.30 ± 1.32
Brassica compestris L. REHKU12	Sarson Bhaji	Herb	Brassicaceae	Negligible	42.98 ± 1.65	67.57 ± 0.71
Brassica oleracea botrytis L. REHKU9	Gobhi Bhaji (fool gobhi)	Herb	Brassicaceae	204.94 ± 1.25	32.23 ± 2.24	10.90 ± 0.55
Brassica oleracea Gongylodes, REHKU13	Gath gobhi	Herb	Brassicaceae	30.56 ± 0.52	58.48 ± 1.02	46.19 ± 1.23
Brassica oleracea var capitate REHKU10	Patta gobhi	Herb	Brassicaceae	27.43 ± 1.35	7.48 ± 0.56	19.22 ± 0.74
Butea monoaoperma, REHKU25	Palash Bhaji	Tree	Fabaceae	12.61 ± 0.25	43.73 ± 1.62	36.55 ± 0.35
Cajanus cajan, REHKU23	Tivra Bhaji	Shrub	Fabaceae	39.46 ± 0.33	56.69 ± 1.85	58.79 ± 0.65
Carthemnus oxycantha L. REHKU6	Kusum Bhaji	Herb	Asteraceae	37.68 ± 1.02	48.32 ± 1.74	3.58 ± 0.55
Cassia tora L. REHKU14	Charota Bhaji	Herb	Caesalpiniaceae	5.67 ± 0.23	63.56 ± 3.62	48.58 ± 1.45
Chenopodium album L, REHKU15	Bathua Bhaji	Herb	Chenopodiaceae	Negligible	60.11 ± 2.62	22.49 ± 0.85
Chorchorus olitorius L. REHKU36	Chech Bhaji	Herb	Tiliaceae	Negligible	51.61 ± 0.78	16.41 ± 0.36
Chorchorus trilocularis L. REHKU37	Lal chench	Herb	Tiliaceae	20.85 ± 0.74	38.86 ± 2.36	50.46 ± 2.23
Cicer arietinum L. REHKU33	Chana Bhaji	Herb	Papilionaceae	13.46 ± 1.63	95.53 ± 2.78	49.54 ± 1.12
Colocasia antiquarum Schott. REHKU5	Kochai Bhaji	Herb	Araceae	18.72 ± 1.01	23.23 ± 1.32	16.48 ± 0.76
Cordia myxa Roxb, REHKU8	Bohar Bhaji	Herb	Boraginaceae	28.07 ± 0.87	60.07 ± 2.32	10.54 ± 0.67
Coriandrum sativum L. REHKU4	Dhaniya Bhaji	Herb	Apiaceae	232.33 ± 2.05	39.78 ± 4.65	32.49 ± 1.07
Cucumis sativus L. REHKU19	Khira Bhaji	Climber	Cucurbitaceae	33.72 ± 0.67	37.19 ± 1.62	41.77 ± 1.23
Cucurbita maxima Duch. REHKU18	Makhna Bhaji	Climber	Cucurbitaceae	85.67 ± 2.35	81.07 ± 2.67	47.35 ± 2.34
Ficus religiosa L. REHKU30	Peepal Bhaji	Tree	Moraceae	14.09 ± 1.26	49.98 ± 0.78	16.19 ± 1.02
Hibiscus cannabinus L. REHKU28	Patwa Bhaji	Shrub	Malvaceae	1.34 ± 0.13	33.57 ± 1.23	18.36 ± 0.74
Hibiscus sabdariffa L. REHKU27	Amari Bhaji	Shrub	Malvaceae	1.32 ± 0.32	31.19 ± 1.45	20.17 ± 0.55
Ipomoea aquatic Frosk, REHKU17	Karmata Bhaji	Herb	Convolvulaceae	12.24 ± 0.35	54.48 ± 1.78	9.88 ± 0.23
Ipomoea batatas Lam., REHKU16	Kanda Bhaji	Climber	Convolvulaceae	Negligible	91.36 ± 1.34	11.70 ± 1.85
Lablab purpureus L. REHKU34	Semi Bhaji	Climber	Papilionaceae	19.56 ± 0.55	64.90 ± 2.35	23.36 ± 0.41
Luffa acutangular REHKU20	Torai Bhaji	Climber	Cucurbitaceae	6.22 ± 0.12	42.94 ± .155	17.06 ± 1.34
Marsilea vestita Hook and Grev. REHKU29	Chunchunia Bhaji	Herb	Marsileaceae	27.63 ± 1.13	35.03 ± 2.32	82.35 ± 1.55
Merremia emarginata Burmf, REHKU17	Muskeni Bhaji	Creeper	Convolvulaceae	Negligible	28.61 ± 1.67	23.09 ± 0.13
Momordica charantia REHKU17,	Karela Bhaji	Climber	Cucurbitaceae	49.09 ± 0.35	36.02 ± 1.41	32.71 ± 0.75
Moringa oleifera Lam. REHKU31	Munga Bhaji	Tree	Moringaceae	1.25 ± 0.29	99.86 ± 2.32	21.33 ± 0.76
Partulaca oleracea L. REHKU35	Dar bhaji	Herb	Portulacaceae	Negligible	24.88 ± 2.05	5.62 ± 1.08
Phaseolus vulgaris REHKU32	Barbatti Bhaji	Climber	Papilionaceae	14.63 ± 1.89	56.40 ± .35	18.49 ± 0.85
Raphanus sativus L. REHKU11	Mooli Bhaji	Herb	Brassicaceae	45.78 ± 0.85	24.23 ± 0.35	13.65 ± 0.58
Spinacea oleracea L. REHKU16	Palak Bhaji	Herb	Chenopodiaceae	1.59 ± 0.22	16.98 ± 2.15	11.04 ± 1.07
Tamarindus indica, L. REHKU21	ImLi Bhaji	Tree	Fabaceae	48.54 ± 0.25	103.98 ± 2.34	15.10 ± 0.75
Trigonella foenumgraceum L. REHKU22	Methi Bhaji	Herb	Fabaceae	46.89 ± 0.72	41.11 ± 1.05	15.46 ± 1.30

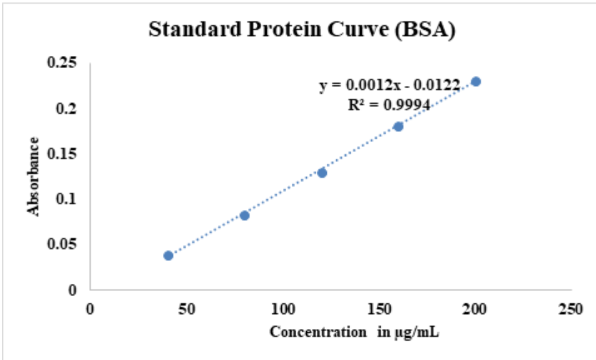

Figure 5: Protein Standard curve.

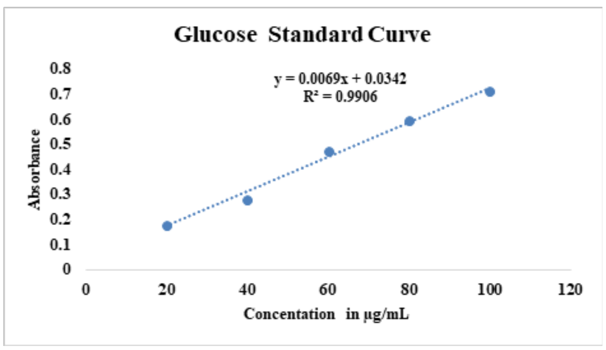

Figure 6: Glucose standard curve.

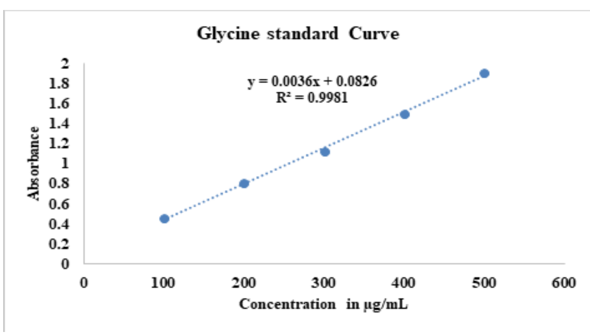

Figure 7: Glycine standard curve for amino acid.

of various concentrations of 20, 40a, 60, 80 and 100 µg/mL (Dreywood 1946, Santra 2015).

Free Amino Acid Estimation

The stock solution prepared by using 0.0570mg of glycine dissolves in 57 mL of distilled water. From the stock solution, 1-mL of this solution and dissolve it into 9 mL of distilled water to prepared the standard. In separate test tubes pipette out 1, 2, 3, 4, 5 mL of working standard. In 3 test tubes, 2mL of plant samples were also taken. Add 0.5 mL of acetate buffer and 0.5 mL of Ninhydrin solution to each test tube. Place these test tubes in a hot water bath for 20–30 minutes until a purple color is developed. Then the mixture is transferred to a 50 mL volumetric flask. Makeup to a volume of 50 mL by adding distilled water. Reading was recorded at 570 nm with the help of a UV-spectrophotometer (LABTRONICS: MODEL LT- 2700) as per Santra, 2015.

Result and Discussion

The results of the present study are given in Table 1. All the edible leafy vegetables are arranged alphabetically. Total protein, carbohydrate and amino acid content were evaluated in µg per mg of plant part.

In this study, we listed the wild food famous in this area with their nutritional value. A total of 40 plant species belonging to 21 families were screened for nutritional availability. A total of 41 wild edible plant leaves were evaluated for nutritional analysis. The highest number of plants belonging to the family Brassicaceae (5) and Fabaceae (5) followed by Cucurbitaceae (4) and Convolvulaceae (3) as shown in Figure 3. Previously most of the edible plants were found in the forest region but due to changing scenarios such as deforestation and urbanization, communities were forced to be cultivated these herbs in their home gardens and agricultural lands.

Most of the edible leafy vegetables are herbs (60%), followed by climbers (17%), Trees (13%), shrubs (8%), and 2% belong to creepers as already shown in Figure 4. In an earlier study, it is reported around 90 leafy vegetables are edible in this region. But due to seasonal restrictions, all are not evaluated for nutrient content. Methods of consumption are also different. Some leafy vegetables are consumed in the fresh form, some are cooked, some are fried and roasted and some leafy edible vegetables are consumed in the dried form (Kumari and Solanki, 2019).

Combinations of plant proteins can provide a full and balanced source of amino acids to meet physiological needs in humans (Young and Pellett, 1994). It is also observed that plant protein is associated with potential health benefit intakes of plant-based diet (Hertzler *et al.* 2020). Approximately 65% of the global protein supply per person comes from plant-based foods. These protein sources are discussed in relation to their amino acid composition, human amino acid requirements, and dietary protein quality. In the present study, total protein content was evaluated by the Lowry method. Total protein contents' value was calculated using the formula ($y = 0.0012x - 0.0122$), ($R^2 = 0.9994$) as shown in Figure 5. The highest protein content was recorded in *Tamarindus indica* (103.98 ± 2.34 µg/mg) followed by *Moringa olerifera* (99.86 ± 2.32 µg/mg), *Cicer arietinum* (95.53 ± 2.78 µg/mg), *Ipomoea batatas* (91.36 ± 1.34 µg/mg) and *Cucurbita maxima* (81.07 ± 2.67 µg/mg). however, the lowest protein content was recorded in *Brassica oleracea* (7.48 ± 0.56 µg/mg of plant tissue). Previous study conducted in the eastern Chhattisgarh region reported that *Ipomoea aquatica, Chenopodium album, Centella asiatica*, and *Moringa olerifera* contain a good amount of crude protein (Vishwakarma and Dubey 2011) but in this study *Tamarindus indica, Moringa olerifera*, and *Ipomoea batatus* contain a significantly greater amount of protein content. Previously study also shows that *Moringa olerifera* and *Tamarindus* *indica* contain significant protein (Harum and Rike 2021, Yusuf *et al.* 2007). A study has been conducted in south Odisha to evaluate the nutritional content of green leafy vegetables and reported that *Murraya koenigii, Tamarindus indicus, Cleome viscosa, Alternanthera sessilis*, and *Senna tora* showed nearly 5% or more protein content (Sibangini and Malaya, 2014). Another study conducted in Kolkata where 33 plants were evaluated for protein content showed that *Psidium guajava* (98.51 mg/g) contain maximum amount of protein followed by *Amaranthus viridis* (97.43mg/g) and *Justicia adhatoda* (86.37 mg/g).(Sarkar *et al.* 2020)

Carbohydrate content was evaluated through the Anthrone method. With help of the standard curve of glucose and formula ($y = 0.0069x + 0.0342$) value of carbohydrates in a sample has been calculated (R= 0.9906). The leaves of *Amaranthus viridis* contained the highest amount of carbohydrate (116.26 ± 2.33 µg/mg) followed by *Marsilea vestita* with carbohydrate content (82.35 ± 1.55 µg/mg), *Chorchorus trilocularis* with carbohydrate content (50.45 ± 2.23 µg/mg), *Bauhinia variegata* with carbohydrate content (49.30 ± 1.32 µg/mg), *Cucurbita maxima* with carbohydrate content (47.35 µg/mg of plant tissue). The leaves of *Carthemnus oxycantha* contain the lowest amount of carbohydrates (3.58 µg/mg). Previously study reported that the fruit of *Aegle marmelos* contains a good amount of carbohydrate (90.01 ± 0.797%) content which was followed by tuber of *Dioscorea bulbifera* (79.03 ± 0.805%), leaves of *Oxalis corniculata* (69.59 ± 2.805%), *Barella rubra* (65.51 ± 0.151%), *Cissus quadrangularis* (71.01 ± 1.158%), *Hibiscus sabdiriffa and Cassia tora* (Vishwakarma and Dubey 2019). In previous studies, it has been also found that nutrient content in the plant may also differ due to seasonal change (Kadam 2016). Another study was conducted to the evaluation of carbohydrate content and reported that three different leafy vegetables *Blumia lanceoria, Amorphophallus paeniifolius and Houttuynia cordata* contain 34, 29.4 and 36 mg in 1-g of it, respectively (Sarkar *et al.* 2016) which was not higher than carbohydrate content of *Amaranthus viridis* which was about 116.26 mg/g of plant sample.

A study conducted to evaluate the carbohydrate content of edible leafy vegetables demonstrated that *Murraya koenigii* (18.7%) contains the highest total sugar content followed by *Tamarindus indicus* (18.1%), *Corchorus aestuans* (15%) (Arowora *et al.* 2021)

The free amino acid was determined by using a standard curve of glycine as Figure 7 and values were calculated by the given formula ($y = 0.0036x + 0.0826$) The highest amino acid content was recorded in the *Coriandrum sativum* (232.33 µg/mg of plant tissue) followed by *Brassica oleracea* (204.94 µg/mg of plant tissue), *Cucurbita maxima* (85.67 µg/mg of plant tissue), *Momordica charantia* (49.09 µg/mg of plant tissue), *Tamarindus indica* with amino acid content (48.54 µg/mg of plant tissue). The lowest amino acid content was recorded in *Brassica compestris* (0.67 µg/mg of plant tissue). In another study of leafy vegetables, where estimation of amino acids was carried through high-performance liquid chromatography and found the range of essential amino acids lies between 1.07 ± 0.01 to 5.95 ± 0.01 and the range of non-essential amino acids starts from 0.99 ± 0.01 to 7.83 ± 0.01% (Opoza *et al.* 2021).

Conclusion

The present study reported that leafy edible vegetables contain significant nutrient content. According to the National Family, Health Survey-5 around 1.70 lakh children are affected by the malnutrition problem in the Chhattisgarh state. Proper and sustainable use of these vegetables can overcome this problem. Their proper cultivation and conservation are necessary for the state's growth and the development of tribal communities. The result highlighted the significance of wild edible leave as an important source of nutrients for rural and tribal people of Chhattisgarh. The present work evaluated the nutritional content in terms of total protein, carbohydrate, and free amino acid content in non-cultivated indigenous forest species. Much more research should be done in this area as lots of variety is still untouched because of seasonal restrictions in this study. When there is more study in the direction, we will be able to select some plants with good nutritional value. By doing commercial cultivation and making nutritional supplements, malnutrition in this area will be eradicated. This will also provide economic benefits to the local farmer as well as tribe communities.

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