Pharmacogn. Mag.
A multifaceted peer reviewed journal in the field of Pharmacognosy and Natural Products
www.phcog.com | www.phcog.net

ORIGINAL ARTICLE

Wild- edible plants of Meghalaya State in India: Nutritional, Minerals, Antinutritional, Vitamin Content and Toxicity Studies

Tapan Seal[1], Kausik Chaudhuri[1], Basundhara Pillai[1], Shrabana Chakrabarti[2], Biswajit Auddy[2], Tanmoy Mondal[3]

[1]Department of Plant Chemistry, Botanical Survey of India, Howrah, [2]Chigurupati Technologies Private Limited, Hyderabad, [3]West Bengal University of Technology, Kolkata, India

Submitted: 13-08-2019 Revised: 18-09-2019 Published: 31-03-2020

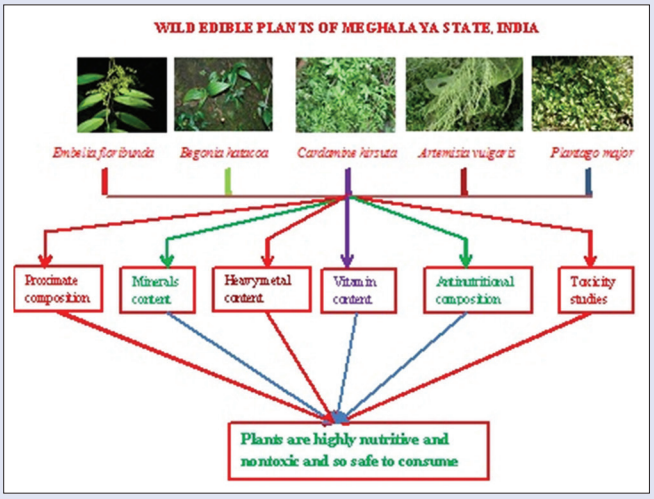
ABSTRACT

Aim: The point of the present investigation planned to assess the nutritive value, minerals content, vitamin content, antinutritional properties, and toxicity studies in five wild-consumable plants, for example, *Begonia hatacoa*, *Embelia floribunda*, *Artemisia vulgaris*, *Cardamine hirsuta*, and *Plantago major*, devoured by the distinctive innate individuals of Meghalaya State in India as their nourishment. **Materials and Methods:** The proximate parameters such as protein, fat, fiber, sugar, minerals, and harmful overwhelming metals were assessed in the chose wild-eatable plants utilizing standard sustenance examination procedures. The cyanogenic glycoside, oxalates, tannins, saponins, and phytate substances were done to decide the counter wholesome properties of the considered plants. The quantitations of water-dissolvable vitamins in these plants were completed by high-performance liquid chromatography. The *in vitro* hemolytic measure of plant concentrates was completed on rodent erythrocytes. Appraisal of cytotoxicity of eatable plants was assessed by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide examine. The genotoxicity of the contemplated plants was tried by the single-cell gel electrophoresis comet assay. **Results:** The consequences of examination demonstrated that these plants are rich wellsprings of protein, sugar minerals, and vitamins, particularly the B gathering of vitamins. The substantial metals lead and chromium were distinguished in exceptionally low sum in all the consumable plants. The largest amount of phytate was found in *P. major* (0.38% ± 0.03%); oxalate was most astounding in *E. floribunda* (0.261% ± 0.06%) though tannin was most elevated in *P. major* (1.04% ± 0.12%). The estimations of antinutrients and overwhelming metals in all above-considered plants are underneath the harmful levels. **Conclusion:** These wild-eatable plants contribute gigantically to sustenance, nourishment security, well-being, and remedial advantages. The aftereffects of poisonous quality of every single eatable plant ensure the security at cell and genomic level and furthermore safe to expend.

Key words: Antinutrients, India, minerals content, nutritional composition, toxicity, vitamin, wild-edible plants

SUMMARY

- The present investigation planned to assess the nutritive worth, minerals content, vitamin content, antinutritional properties, and toxicity studies in five wild-consumable plants devoured by the distinctive innate individuals of Meghalaya State in India as their sustenance
- The proximate parameters of minerals and lethal substantial metals, for example, lead, cadmium, chromium, and mercury, were assessed in the chosen wild-palatable plants utilizing standard sustenance examination systems. The water-solvent vitamin in these plants was completed by high-performance liquid chromatography. The cyanogenic glycoside, oxalates, tannins, saponins, and phytate substances were done to decide the counter wholesome properties of the contemplated plants. The *in vitro* hemolytic measure of plant concentrates was completed on rat erythrocytes. Appraisal of cytotoxicity of eatable plants was assessed by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide test. The genotoxicity of the contemplated plants was tried by the single-cell gel electrophoresis comet test
- The after-effects of examination demonstrated that these plants are rich wellsprings of protein, starch minerals, and nutrients, particularly the B gathering of vitamins. The substantial metals Pb and Cr were recognized in exceptionally low sum in all the consumable plants. The estimations of antinutrients and overwhelming metals in all above-examined plants are underneath the harmful levels
- These wild-consumable plants contribute gigantically to sustenance, nourishment security and well-being, and helpful advantages. The aftereffects of hemolytic harmfulness, cytotoxicity, and genotoxicity of watery concentrates of every single eatable plant ensure the security at cell and genomic level and furthermore safe to expend.



Abbreviations used: MTT: 3-(4,5-Dimethylthiazol-2-yl) -2,5-diphenyltetrazolium bromide; HPLC: High-performance liquid chromatography; Na: Sodium; K: Potassium; Ca: Calcium; Mn: Manganese; Cu: Copper; Mg: Magnesium; Fe: Iron; Zn: Zinc; Pb: Lead; Cr: Chromium; Cd: Cadmium; Hg: Mercury; %: Percentage; nm: Nanometer; mg: Milligram; µg: Microgram; SEM: Standard error of Mean; µM: Micromolar; AAS: Atomic absorption spectroscopy; M: Molar; TFA: Trifluoroacetic acid; EDTA: Ethylenediaminetetraacetic acid; PBS: Phosphate-buffered saline; HBSS: Hank's balanced salt solutions; RPMI: Roswell Park Memorial Institute; FBS: Fetal bovine serum; DMSO: Dimethyl sulfoxide; LMPA: Low-melting point agarose; NMPA: Normal-melting point agarose; OTM: Olive tail moment.

Correspondence:

Dr. Tapan Seal,
Department of Plant Chemistry, Botanical Survey of India, Acharya Jagadish Chandra Bose Indian Botanic Garden, Shibpur, Howrah - 711 103, West Bengal, India.
E-mail: kaktapan65@yahoo.co.in
DOI: 10.4103/pm.pm_369_19

Access this article online
Website: www.phcog.com
Quick Response Code:

Cite this article as: Seal T, Chaudhuri K, Pillai B, Chakrabarti S, Auddy B, Mondal T. Wild- edible plants of Meghalaya State in India: Nutritional, minerals, antinutritional, vitamin content and toxicity studies. Phcog Mag 2020;16:S142-51.

INTRODUCTION

As of late, a great deal of intrigue has been engaged to assess different wild-consumable plants because they fill in as an essential constituent of human-eating regimen recharging the body with minerals, nutrients, and certain hormone forerunners, notwithstanding protein and vitality. Because of the nearness of protein, starch, and different full-scale supplements, the wild-palatable plants assume a significant job to lessen the danger of different sicknesses such as malignant growth, coronary cardiovascular failure, and diabetes. The wild vegetables additionally these days have turned into a business crop with expanding market potential because of the nonappearance of deposits from pesticides or fertilizers.[1] The wild-eatable plants likewise contribute some helpful items such as drug, fiber, grub, and colors. The wild edible plants are traditionally consumed by the tribal and rural people of Meghalaya state in India as nourishment and medicines. But sufficient scientific data on the nutritional and chemical composition of those wild vegetables are still unknown to them, and people do not have adequate knowledge about their beneficial and toxic properties. In the majority of distributed writing, it was told that the nutraceutical estimation of eccentric plant sustenance could be similar to or even at times better than the normal vegetables.[2] In this setting, the examination of wild-consumable plants is critical to distinguish the potential sources, which could be misused as elective nourishment. In spite of the fact that the wild-eatable plants are delightful and nutritious, however, abundance utilization of such plants might be destructive to our body due to having some antinutritional mixes in the plants. The antinutritional factors, for example, phytic acid, tannin, saponin, oxalic acid, and cyanogen glycoside, have antagonistic impact on well-being through restraints of protein assimilation, development, iron, and zinc absorption.[3,4] Phytic acid brings down the bioavailability of minerals;[5] tannins tie to proteins through hydrogen authoritative and hydrophobic associations, along these lines lessening their healthful quality.[6] Since antiquated occasions, plants have been utilized as nourishment and medications, and it is likewise realized that all in all, green plants are an essential wellspring of antimutagens just as normal dangerous agents.[7] Hence, it is fundamental to decide if the wild plants can deliver unfriendly consequences for living being before utilization.

Meghalaya is a little state in northeastern region in India. An enormous part of the district is naturally underinvestigated or even unfamiliar. The timberlands of Meghalaya give countless plants whose organic products, seeds, tubers, and shoots make a significant commitment to the eating routine of the ancestral individuals. Along these lines, this examination was led with the intent to assess the healthy benefit, nutrient substance, antinutritional properties, and harmfulness investigations of five wild-palatable plants, *viz*., leaves of *Begonia hatacoa*, *Embelia floribunda*, *Artemisia vulgaris*, *Cardamine hirsuta*, and *Plantago major*, allegedly devoured by the ancestral individuals of Meghalaya.

MATERIALS AND METHODS

Collection of plant materials

The edible parts of five plant materials, e.g., *B. hatacoa* Buch-Ham ex D. Don (Begoniaceae), *E. floribunda* Wall. (Primulaceae), *A. vulgaris* L. (Compositae), *C. hirsuta* L. (Brassicaceae), and *P. major* L. (Plantaginaceae), were collected from different places of Meghalaya, India, and identification was authenticated in our office. The voucher specimens were preserved at the Plant Chemistry Department of our office under Registry No. BSITS 91, BSITS 92, BSITS 93, BSITS 94, and BSITS 95, respectively. The edible parts of the investigated plants were sheddried, pulverized, and stored in an airtight container. The proximate composition, mineral contents, antinutritional properties, vitamin content and toxicity studies with these plants were carried out in our laboratory.

Estimation of nutritional composition

The nutritional composition of the powdered vegetable sample was analyzed as follows in our research facility adhering to the standard sustenance investigation techniques portrayed in the Association of Official Analytical Chemists (AOAC).[8]

Ash content was assessed by heating plant sample in a muffle furnace for about 5–6 h at 500°C, whereas moisture content was dictated by heating plant sample in an air oven at 100°C–110°C. The crude fat was extracted from moisture-free sample with petroleum ether (60°C–80°C) in a Soxhlet apparatus for about 6–8 h. Estimation of crude fiber content in the plant materials was carried out by treating the fat and moisture-free materials with 1.25% dilute acid and 1.25% alkali followed by washing with water and ignition of the residue. The crude protein was determined using micro-Kjeldahl method as described in AOAC procedures.[8] The total carbohydrate content was assessed as portrayed in the technique for Hedge and Hofreiter in 1962.[9] The energy content of each plant samples was determined by multiplying the values obtained for protein, fat, and available carbohydrates by 4.00, 9.00, and 4.00, respectively, and adding up the values.[8]

Estimation of minerals

Plant material was taken in a cleaned and preweighed silica crucible and heated in a muffle furnace at 400°C till there was no evolution of smoke. The crucible was cooled at room temperature in a desiccator, and ash was soaked with concentrated sulfuric acid and heated on a heating mantle till fumes of sulfuric acid stopped to evolve. The crucible with ash was then heated in a muffle furnace at 600°C till the weight of the content was persistent (~2–3 h). One gram of sulfated ash achieved above was dissolved in 100 ml of 5% hydrochloric acid (HCl) to get the solution ready for the estimation of minerals through atomic absorption spectroscopy (AAS) (AA 800, Perkin-Elmer Germany). Standard solution of each mineral was prepared, calibration curves were drawn for each element, and minerals were determined by AAS.[10]

Estimation of water-soluble vitamins by high-performance liquid chromatography

Preparation of mixture standard vitamin solutions

The stock standard solutions of Vitamin C, B_1, B_3, B_5, and B_6 were prepared by dissolving 25 mg of each standard in 1 ml 0.1M HCl in 25 ml standard volumetric flask. For preparation of standard stock solutions of Vitamin B_9 and B_2, 25 mg of each standard was dissolved in 1 ml 0.1M sodium hydroxide (NaOH) in 25 ml standard volumetric flask. The standard solution was stored in amber-glass bottles in the refrigerator at 4°C. The working standards were prepared by diluting with phosphate buffer (1M, pH 5.5).

Preparation of sample solution

Plant materials were washed with distilled water. The washed plant materials were cut into very small pieces, frozen in liquid nitrogen, and kept at −20°C until analysis. One gram each of freeze-dried sample was soaked in 10 ml water and extracted with 1 ml 0.1M NaOH, and 10 ml phosphate buffer (1M, pH 5.5) was added to it and kept in the dark for 24 h. The solution was first filtered through a Whatman No. 1 filter paper, and the resulting filtrate was taken in a 25 ml volumetric flask and the solution was topped up to the mark with high-performance liquid chromatography (HPLC) grade water. The sample solution was filtered through 0.45 mm membrane filter before injection into LC system. The stock solutions of sample were kept in a refrigerator for further use.

Chromatographic analysis of water-soluble vitamins

The chromatographic analysis was carried out following the method as described by Seal *et al.*, 2018.[11] The mobile phase contains acetonitrile (Solvent A) and aqueous trifluoroacetic acid (TFA, 0.01% v/v) (Solvent B), the column was thermostatically controlled at 22°C, and the injection volume was kept at 20 ml. Gradient elution was performed by varying the proportion of Solvent A to Solvent B. Total analysis time per sample was 35 min. HPLC chromatograms of all vitamins were detected using a photodiode array ultraviolet (UV)/detector at four different wavelengths (210, 245, 275, and 290 nm) according to absorption maxima of analyzed compounds. Each compound was identified by its retention time and by spiking with standards under the same conditions. The quantification of the vitamin was done by the measurement of the integrated peak area and the content was calculated using the calibration curve by plotting peak area against concentration of the respective standard sample. Each vitamin in the plant extracts were identified by its retention time and by spiking with standards under the same conditions. The data were reported as means ± standard error of means of three independent analyses.

Estimation of antinutritional composition

Oxalate contents of edible plants were determined using the method described by Munro and Bassir. One gram each of ground plants (in triplicate) was extracted thrice by warming (50°C) and stirring with a magnetic stirrer for 1 h with 0.3M HCl. The combined extracts were diluted to 100 ml with water and used for total oxalate estimation following the method of Munro and Bassir in 1980.[12] Phytate was determined using the method introduced by Reddy and Love in 1999.[13] One gram of the ground plants was soaked in 100 ml of 2% HCl for 5 h and filtered. Five-milliliter 0.3% ammonium thiocyanate solution was added to 25 ml of the filtered; the mixture was then titrated with ferric chloride solution until a brownish-yellow color that persisted for 5 min was obtained. Saponin was determined using the method of Hudson and El-Difrawi in 1979.[14] Tannins were assayed in accordance with the modified vanillin-HCl method of Price *et al.* in 1978,[15] and tannic acid was used as the reference standard. Cyanogenic glycoside contents of the sample were determined by alkaline titration method where the end-point was noted as permanent turbidity against a black background.[8]

Toxicity studies of wild-edible plants

Preparation of plant extracts

Five grams of powdered plant materials was soaked 50 ml distilled water at room temperature for 24 h and afterward sieved through cotton fleece. The plant materials were macerated again in a similar dissolvable for another 24 h, and the concentrates got from the first and the subsequent extractions were pooled and focused utilizing a rotary evaporator under reduced pressure to acquire thick separates which were additionally dried utilizing a freeze-drier. The dry concentrates were put away at −20°C until use.

Ten milligrams of every unrefined concentrate was dissolved in 10 ml phosphate-buffered saline (PBS, pH 7.4) to make 1000 μg/ml. The example arrangements were gone through 0.22 μm syringe-adjusted channels to dispense with any particulate issue and put away at −20°C until use.

Hemolytic toxicity study

Aqueous extracts of ten wild-palatable plants were completed after the strategy for Malagoli, 2007.[16] The blood samples were gathered from healthy rodents, mixed with EDTA, and centrifuged at 5000 rpm for 5 min. The 10% erythrocyte suspension was set up in sterile PBS (pH 7.4) for hemolytic investigation.

The different fixations (100, 200, 300, 500, and 1000 μg/ml) of plant concentrates were added to 10% suspension of rodent erythrocytes. The mixture was incubated for 1 h at 37°C temperature, cells were centrifuged, and the supernatant was utilized to quantify the absorbance of the freed hemoglobin at 540 nm in a UV-visible (VIS) spectrophotometer (Model Shimadzu, UV 1800). Two controls were set up without concentrates; negative control got sterile PBS, while hydrogen peroxide (H_2O_2, 50–200 μM) was taken as positive control. The average value was determined from triplicate tests. The cell viability for each sample was determined by dividing sample's absorbance on negative control absorbance multiplied by hundred.

Cytotoxicity study

Aqueous concentrates of ten wild-palatable plants were assessed out by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) test on isolated goat liver cells utilizing the convention as portrayed by Mosmann, 1983.[17]

Fresh goat livers purchased from local market and were perfused in PBS (pH 7.4) with collagenase and the liver was then minced in minute pieces and cells were isolated utilizing cell strainer having 40 μl pore size (Genetix cell strainer, South Korea). The cells were then washed with Hank's balanced salt solution and axis at 800 g to take out fine debris. The cell reasonability extends somewhere in the range of 85% and 95% as dictated by the trypan blue exclusion test. The immaculateness of hepatocytes was analyzed by phase-contrast microscopy. The isolated cells were taken in an Eppendorf tube containing 0.5 ml Roswell Park Memorial Institute (RPMI) and 10% fetal bovine serum. The various focuses (100, 200, 300, 500, and1000 μg/ml) of aqueous concentrates (100 μl) of eatable plants were added to the freshly separated hepatocytes and incubated for 2 h at 37°C in a CO_2 incubator. Medium control (blank medium) and cell control (cells without concentrate treatment) were likewise taken and incubated under the same test condition. All the tubes were then centrifuged and supernatant was disposed of. Five milligrams/milliliter MTT (in PBS, pH 4.5) was added into tube to accomplish a final concentration of 0.5 mg/ml and hatched for 1 h at 37°C until intracellular purple formazan crystals are noticeable under microscope. After 1 h, the culture medium with MTT was deliberately expelled by centrifugation and 100 μl dimethyl sulfoxide (DMSO) was added to it and incubated for 30 min to 1 h to disintegrate formazan crystals. The UV absorbance of resulting purple solution was spectrophotometrically estimated at 570 nm in UV-VIS spectrophotometer (Model Shimadzu, UV 1800), and the level of cell reasonability was determined to decide the hepatotoxicity of plant concentrates.

Genotoxicity study

The genotoxic potential, assuming any, of the concentrates, was assessed by single-cell gel electrophoresis comet test as portrayed by Singh *et al.*, 1988.[18] One milliliter blood was collected from tail vein of a healthy rodent, and 100 μl of heparinized entire blood was incubated with 100 μl plant concentrates of various focuses (100, 200, 300, 500, and 1000 μg/ml) and incubated at 37°C for 2 h in a CO_2 incubator. The negative and positive controls were incorporated. 100 μl cell suspensions were inserted in 100 μl of 0.5% low-melting point agarose (LMPA) and after that spread on a slide precoated with a film of 1% normal-melting point agarose (NMPA). Three slides were set up for each concentration and agarose cell suspensions were permitted to solidify at 4°C. After solidification, slides were submerged to cold lysis buffer (2.5 M NaCl, 100 mM EDTA, 10 mM Tris buffer, 10% DMSO, Triton X-100 0.8%, pH 10) for 1 h. The slides were removed from lysis buffer and set on a horizontal gel electrophoresis chamber and loaded up with alkaline electrophoresis buffer (1 mM EDTA, 0.3N NaOH, pH 13.0) for 20 min for unwinding up of DNA. At that point, electrophoresis was performed for 30 min at

25V/300 mA, and electrophoresis slides were neutralized (multiple times) and stained with ethidium bromide solution (20 mg/ml). The stained nuclei were visualized under fluorescent microscopy and photographed. Olive tail moment (OTM) of individual stained nuclei was determined utilizing comet test programming. A higher rate tail DNA demonstrated a larger amount of DNA harm and more elevated amount of genotoxicity of plant separate.

Statistical analysis

All the investigation was completed utilizing triplicate tests. Test results were exposed to univariate analysis of variance, trailed by Tukey test ($P \leq 0.05$) utilizing the Statistical Package for the Social Sciences (SPSS variant 7.5) (SPSS Inc, International Business Machines (IBM), USA).

RESULTS AND DISCUSSION

Proximate composition of wild-edible plants

The palatable parts of fresh plant materials, e.g., *B. hatacoa*, *E. floribunda*, *A. vulgaris*, *C. hirsuta*, and *P. major*, collected from different places of Meghalaya were taken for the investigation of proximate piece. The proximate creation of these plants is exhibited in Table 1. The aftereffect of examination demonstrated that the moisture substance was discovered most elevated (82.56% ± 0.23%) in *C. hirsuta* and most reduced in the leaves of *B. hatacoa* (77.45% ± 0.11%). The moisture content in nourishment includes the measure of water present in the sustenance and decides the genuine nature of the nourishment before utilization. The moisture content in a food involves the amount of water present in the food and regulates the actual quality of the food before consumption. Moisture content affects the physical, chemical features of food which relates with the freshness and stability for the storage of the food for a long period of time.[19] The assurance of moisture content additionally is important to ascertain the substance of other sustenance constituents consistently. The moisture content , estimated in these wild edible plants were comparable to the moisture content reported to some regular vegetables such as spinach (92.1%), cabbage (91.9%), and broad beans (82.4%), cultivated in India.[20]

Estimation of ash content in nourishment is especially significant for a few reasons. It is a piece of proximate examination for wholesome assessment of sustenance. Ash content speaks to the absolute mineral substance in sustenances. In spite of the fact that minerals speak to a little extent of dry matter, regularly under 7% of the aggregate, they assume a significant job from a physicochemical, mechanical, and dietary purpose of view.[21] The ash content of the vegetables was discovered most noteworthy (9.49% ± 0.17%) in *A. vulgaris* and obvious amount was evaluated in different plants which demonstrate that the vegetables were wealthy in minerals and could give a lot of mineral components in our eating routine.

Fat is a significant part of eating routine and gives basic unsaturated fats, which are not made by the body and should be acquired from nourishment. The fundamental unsaturated fats are linoleic acid and linolenic acid which are significant for controlling aggravation, blood coagulating, and mental health. It likewise fills in as the capacity substance for the body's additional calories. Aside from these, the nearness of fat in the eating regimen is significant for the retention of fat dissolvable nutrients such as Vitamin A and carotene in the body.[20] The noteworthy measure of fat was recognized in *E. floribunda* (3.26% ± 0.14%) alongside great amount in different plants under scrutiny.

Vegetables are rich wellsprings of fiber which assumes a significant job in diminishing the dangers of numerous clutters, for example, overweight, obstruction, diabetes, serum cholesterol, heart maladies, bosom and colon malignant growth, and hypertension.[22] The World Health Organization (WHO) has suggested admission of 22–23 kg of fiber for each 1000 kcal of eating regimen which is important for processing and viable evacuation of squanders.[23,24] The unrefined fiber substance of the wild vegetables spoke to in Table 1 was found between 9.98% ± 0.06% and 14.50% ± 0.17%, which was most minimal in *C. hirsuta* and most elevated in *P. major* and like business leafy foods such as apple (3.2%), wide beans (8.9%), cabbage (2.8%), potato (1.7%), and spinach (2.5%).[20] Hence, these wild vegetables utilized could be utilized in the human eating routine to satisfy the WHO recommendation.[24]

The most elevated measure of carbohydrate was identified in the leaves of *E. floribunda* (16.52% ± 0.47%), while the most minimal was found in the leaves of *A. vulgaris* (4.67% ± 0.20%). An excellent measure of carbohydrate was likewise present in other palatable plants and all around contrasted with some regular eatable plants such as apple (13.7%), wood apple (18.1%), potato (20.9%), and ready mango (14.9%).[20] Hence, these eatable plants under investigation could be a decent sustenance wellspring of carbohydrate for human utilization.

Proteins are one of the most significant supplements required by the body and ought to be provided in satisfactory sums in the eating regimen. The dietary proteins are separated into amino acids which are utilized by the body to integrate the protein required by the body for different capacities like, for the best possible working of antibodies opposing contamination, for the guideline of compounds and hormones, for development, and for the fix of body tissue.[20] The measure of unrefined protein substance was recognized most noteworthy in the leaves of *C. hirsuta* (17.71% ± 0.04%) and least in the products of *B. hatacoa* (8.84% ± 0.04%). Different plants under scrutiny, *viz.*, *A. vulgaris*, *P. major* and *E. floribunda*, additionally contained great measure of protein 16.9% ± 0.06%, 12.58% ± 0.05%, and 11.03% ± 0.05%, respectively.

Mineral composition of wild-edible plants

The eatable pieces of all plants under scrutiny contained minerals such as sodium, potassium, calcium, manganese, magnesium, iron, zinc, and copper in varying fixation as appeared in Table 2. High groupings of sodium (Na) were available extending from 4.25 ± 0.18 mg/100 g (*E. floribunda*) to 11.85 ± 0.26 mg/100 g (*B. hatacoa*). The most noteworthy measure of potassium (K) was recognized in the consumable pieces of *C. hirsuta* (794.03 ± 6.44 mg/100 g), while the most reduced

Table 1: Proximate composition of the wild-edible plants collected from Meghalaya state in India

Name of the plant	Parts used	Ash %	Moisture %	Crude fat %	Crude fiber %	Protein % 6.25 × percentage of *n*	Carbohydrate %	Energy content kcal/100 g
Begonia hatacoa	Leaves	5.99 ± 0.13^{d}	77.45 ± 0.11^{e}	1.39 ± 0.04^{b}	10.40 ± 0.15^{d}	8.84 ± 0.04^{e}	7.45 ± 0.20^{c}	77.71 ± 0.17^{e}
Embelia floribunda	Leaves	8.18 ± 0.14^{c}	79.47 ± 0.16^{d}	3.26 ± 0.14^{a}	12.83 ± 0.03^{b}	11.03 ± 0.05^{d}	16.52 ± 0.47^{a}	139.55 ± 1.50^{a}
Artemisia vulgaris	Leaves	9.49 ± 0.17^{a}	81.63 ± 0.21^{b}	1.53 ± 0.17^{b}	10.80 ± 0.04^{c}	16.9 ± 0.06^{b}	4.67 ± 0.20^{e}	100.16 ± 1.85^{d}
Cardamine hirsuta	Leaves	9.05 ± 0.12^{b}	82.56 ± 0.23^{a}	1.52 ± 0.08^{b}	9.98 ± 0.06^{e}	17.71 ± 0.04^{a}	6.95 ± 0.30^{d}	112.38 ± 0.90^{b}
Plantago major	Leaves	5.58 ± 0.22^{e}	80.48 ± 0.19^{c}	0.85 ± 0.03^{c}	14.50 ± 0.17^{a}	12.58 ± 0.05^{c}	11.33 ± 0.58^{b}	103.32 ± 0.47^{c}

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. Statistical analysis were carried out by Tukey's test at 95% confidence level and statistical significance were accepted at the $P<0.05$ level. The superscript letter a, b, c, d and e denotes the significant differences within same parameters of individual plant. SEM: Standard error of the mean

Table 2: Minerals content in the wild-edible plants collected from Meghalaya state in India

Name of the plant	Parts used	Na	K	Ca	Cu	Mg	Zn	Fe	Mn
				mg/100 g dry plant materials					
Begonia hatacoa	Leaves	11.85±0.26^{a}	267.76±4.04^{d}	405.76±10.01^{c}	BDL	198.67±0.31^{d}	2.32±0.033^{bc}	16.21±0.23^{c}	1.95±0.09^{b}
Embelia floribunda	Leaves	4.25±0.18^{d}	200.77±4.28^{e}	181.32±7.18^{e}	BDL	149.90±0.53^{e}	1.75±0.036^{d}	11.12±0.16^{e}	BDL
Artemisia vulgaris	Leaves	4.69±0.19^{c}	741.19±10.24^{b}	331.42±6.92^{d}	0.34±0.003	276.38±0.30^{b}	2.28±0.037^{c}	15.31±0.24^{d}	3.62±0.16^{a}
Cardamine hirsuta	Leaves	4.44±0.23^{d}	794.03±6.44^{a}	603.39±4.48^{a}	BDL	315.17±0.62^{a}	2.43±0.037^{b}	23.38±0.18^{b}	1.28±0.11^{d}
Plantago major	Leaves	9.21±0.44^{b}	473.87±5.82^{c}	569.58±5.24^{b}	BDL	199.40±0.48^{c}	3.48±0.021^{a}	45.84±0.21^{a}	1.53±0.16^{c}

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. Statistical analysis were carried out by Tukey's test at 95% confidence level and statistical significance were accepted at the $P<0.05$ level. The superscript letter a, b, c, d and e denotes the significant differences within same parameters of individual plant. SEM: Standard error of the mean; BDL: Below detection limit

was found in the products of *E. floribunda* (200.77 ± 4.28 mg/100 g). Na assumes a significant job in the vehicle of metabolites and K is significant for its diuretic nature. The K/Na proportion in our body is of incredible worry to avoid hypertension, and the proportion ought to be more prominent than one since K discourages and Na improves blood pressure.[25] The proportion of K/Na was huge in the palatable pieces of *C. hirsuta* (178.83.95), *A. vulgaris* (158.03), and *P. major* (51.45) and especially contrasted and some regular fruits (amla 45, papaya ready 11.5, tomato 11.31, *Castanea sativa* 56.67, and *Punica granatum* 1400.00).[24] And so, the utilization of these vegetables is useful for human and may have the option to control the hypertension of our body.

Calcium (Ca) is a significant full-scale supplement which establishes an enormous extent deep down, human blood and extracellular liquid. It is additionally especially required for the ordinary working of the heart muscles, blood coagulation, milk thickening, and the guideline of cell permeability.[26] The grouping of Ca was most astounding in the leaves of *C. hirsuta* (603.39 ± 4.48 mg/100 g) trailed by *P. major* (569.58 ± 5.24 mg/100 g), *B. hatacoa* (405.76 ± 10.01 mg/100 g), *A. vulgaris* (331.42 ± 6.92 mg/100 g), and *E. floribunda* (181.32 ± 7.18 mg/100 g). The Ca levels of some developed vegetables and fruits differ between 10 and 130.0 mg/100 g.[24] The information demonstrating that the wild vegetables utilized in this investigation are wealthy in calcium and could give a decent wellspring of Ca to our eating routine.

Copper (Cu) is a fundamental follow component that cannot be shaped by the human body. It exists as a significant part of a catalyst that helps the consolidation of iron into red platelets, averting anemia.[27] An adequate measure of Cu was available in the leaves of *A. vulgaris* (0.34 ± 0.003 mg/100 gm). The Cu fixations were underneath the recognition level in other palatable plants.

Zinc (Zn) is a fundamental component in the nourishment of individuals where it works as a vital piece of certain compounds, which assume a focal job in nucleic acid digestion. Furthermore, Zn is a layer stabilizer and a trigger of the safe reaction. Its lack prompts development disappointment and poor advancement of gonadal function.[27] The Zn present in the wild plants under scrutiny was discovered most noteworthy in the leaves of *P. major* (3.48 ± 0.021 mg/100 g) and great amount of Zn was recognized in different plants as referenced in Table 2 and the Zn levels of these eatable plants are like the levels detailed in some wild and verdant vegetables in India.[24]

Manganese (Mn) convergences of the plants concentrated differed between 1.28 ± 0.11 and 3.62 ± 0.16 mg/100 g. Thus, the wild-consumable plants containing Mn assumes a significant job in the digestion of protein, sugar, and lipid and in the generation of steroid sex hormones.[28]

Iron (Fe) is significant in the eating regimen for the arrangement of hemoglobin and typical working of the focal sensory system and in the digestion of sugars, proteins, and fats. It is a part of muscle and blood and is fundamental to bear oxygen the body. Ordinary utilization of iron-rich vegetables can avoid the iron-lack anemia.[28] High centralizations of Fe were available in the leaves of *P. major* (45.84 ± 0.21 mg/100 g) trailed by in *C. hirsuta* (23.38 ± 0.18 mg/100 g), *B. hatacoa* (16.21 ± 0.23 mg/100 g), and *A. vulgaris* (15.31 ± 0.24 mg/100 g), which are very much contrasted with some regular verdant vegetables. These high Fe levels in some wild-consumable plants contemplated could be explained with various soil attributes of the developing territory.

Magnesium (Mg) is especially basic in the human body to keep up typical nerve and muscle work. Mg convergences of the plants considered ran from 149.90 ± 0.53 to 315.17 ± 0.62 mg/100 g. Hence, the customary utilization of these magnesium-rich plants controls the blood glucose levels and bolsters a sound insusceptible system.[28]

The overwhelming metals substance of the wild vegetables under scrutiny is recorded in Table 3. Among overwhelming metals, lead (Pb) is a potential contamination that promptly aggregates in soils and dregs. Although Pb is not a basic component for plants, it gets effectively retained and collected in various plant parts. The utilization of vegetables containing Pb causes both intense and constant harming. It has unfriendly impact on liver, kidney, vascular, and safe system.[29] The convergence of Pb was most minimal (0.005 ± 0.001 mg/100 g) in *P. major* and most noteworthy was recognized in the leaves of *B. hatacoa* (0.019 ± 0.004 mg/100 g). The Pb content in the wild vegetables in our examination was underneath to the WHO reasonable point of confinement of 0.03 mg/100 g. The degree of Pb detailed in this investigation is tantamount to those announced for Indian basil (0.009 mg/100 g), bitter leaf (0.014 mg/100 g), cabbage (0.013 mg/100 g), and waterleaf (0.018 mg/100 g).[28]

Chromium (Cr) is a fundamental follow component that upgrades insulin capacity and impacts sugar, protein, and fat digestion, yet incessant introduction to Cr may harm liver and kidney. The centralization of Cr was least (0.11 ± 0.014 mg/100 g) in the leaves of *P. major* and most elevated was distinguished in *B. hatacoa* (0.19 ± 0.005 mg/100 g). In the present investigation, the Cr content in the vegetables was discovered lower when contrasted with the WHO allowable limit of 0.23 mg/100 g.[28]

Quantifications of water-soluble vitamin by high-performance liquid chromatography

The HPLC strategy was effectively performed for the estimation of water-dissolvable vitamin, e.g., ascorbic corrosive (C), thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), and folic acid (B_9). The amount of all vitamins of all plant materials has been communicated as mg/100 g dry plant material and information is introduced in Table 4.

Vitamin C is the most significant nutrient in leafy foods. It is outstanding for its cancer prevention agent properties, and it helps the body in hindering viral disease, bacterial contaminations, and poisonous quality. It is required for the avoidance of scurvy and upkeep of solid skin, gums, and veins, and the insufficiency of this nutrient causes wounding, dying, dry skin, and depression.[30] The trial result demonstrated that the

Table 3: Heavy metals content in the wild-edible plants collected from Meghalaya state in India

Name of the plant	Parts used	Heavy metals present (mg/100g dry material)			
		Pb	Cr	Cd	Hg
Begonia hatacoa	Leaves	0.019±0.004[a]	0.19±0.005[a]	Not detected	Not detected
Embelia floribunda	Leaves	0.013±0.001[ab]	0.12±0.014[b]	Not detected	Not detected
Artemisia vulgaris	Leaves	0.011±0.005[ab]	0.16±0.015[ab]	Not detected	Not detected
Cardamine hirsuta	Leaves	0.014±0.004[ab]	0.14±0.005[ab]	Not detected	Not detected
Plantago major	Leaves	0.005±0.001[b]	0.11±0.014[b]	Not detected	Not detected

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. Statistical analysis were carried out by Tukey's test at 95% confidence level and statistical significance were accepted at the $P<0.05$ level. The superscript letter a and b denotes the significant differences within same parameters of individual plant. SEM: Standard error of the mean

Table 4: Water-soluble vitamin content in the wild-edible plants collected from Meghalaya state in India

Name of the plant	Parts used	Water-soluble vitamin content mg/100 g of edible part						
		Vitamin C	Vitamin B_1	Vitamin B_2	Vitamin B_3	Vitamin B_5	Vitamin B_6	Vitamin B_9
Begonia hatacoa	Leaves	3.41±0.01[b]	0.012±0.0001[b]	0.27±0.006[d]	ND	0.074±0.001[d]	0.16±0.003[c]	0.084±0.001[c]
Embelia floribunda	Leaves	0.74±0.016[c]	ND	1.07±0.013[a]	ND	0.28±0.016[b]	0.23±0.014[b]	ND
Artemisia vulgaris	Leaves	0.41±0.006[d]	0.14±0.01[a]	0.94±0.02[b]	ND	0.73±0.016[a]	1.2±0.033[a]	3.37±0.10[a]
Cardamine hirsuta	Leaves	6.23±0.02[a]	0.041±0.001[b]	0.40±0.011[c]	ND	0.096±0.002[c]	0.093±0.003[d]	0.45±0.016[b]
Plantago major	Leaves	0.74±0.02[c]	0.11±0.003[a]	0.10±0.001e	ND	0.012±0.001[e]	0.096±0.003[d]	0.025±0.003[c]

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. Statistical analysis were carried out by Tukey's test at 95% confidence level and statistical significance were accepted at the $P<0.05$ level. The superscript letter a, b, c, d and e denotes the significant differences within same parameters of individual plant. SEM: Standard error of the mean; ND: Not detected

measure of Vitamin C (ascorbic acid) in five wild palatable assessed in all plants under scrutiny ranged from 0.41 ± 0.006 to 6.23 ± 0.02 mg/100 g. Due to having cell reinforcement properties, Vitamin C-rich plant may be useful to decrease the danger of atherosclerosis and a few types of cancer.[31]

Thiamine (B_1) is a basic supplement required by the body for keeping up cell work and thus a wide exhibit of organ capacities. It is fundamental for vitality generation, starch digestion, and nerve cell work. The lack of this vitamin prompts discount degeneration of the body, especially the apprehensive and circulatory frameworks, hypertension, and heart diseases.[32,33]

The thiamine content in these wild-palatable plants extended from 0.012 ± 0.0001 to 0.14 ± 0.01 mg/100 g. The most elevated measure of B_1 was acquired in the leaves of *A. vulgaris* pursued by *P. major* and *C. hirsuta*, and these sums are particularly like the thiamine content in some basic vegetables and fruits such as apple (0.016 mg/100 g), beans (0.132 mg/100 g), cauliflower (0.073 mg/100 g), and spinach (0.076 mg/100 g).[20]

Riboflavin (B_2) is a fundamental vitamin required for legitimate vitality digestion and a wide assortment of cell forms. It is the partner to thiamine utilized in the fortifying of nourishment products.[34]

A huge variety of riboflavin substance was seen among the tried wild-consumable plants. The most elevated measure of B_2 was distinguished in the leaves of *E. floribunda* (1.07 ± 0.013 mg/100 g) and the least sum was identified in *P. major* (0.10 ± 0.001 mg/100 g). The Vitamin B_2 content in these plants is similar with some basic foods grown from the ground such as almonds (1.10 mg/100 g), spinach (0.24 mg/100 g), beet greens (0.41 mg/100 g), green beans (0.12 ± 2 mg/100 g), and potato (0.023 ± 1 mg/100 g).[35]

Vitamin B_3 is a significant nutrient required for handling fat in the body, bringing down cholesterol levels, and managing glucose levels. It is significant in DNA fix, Ca digestion, intracellular breath, and biosynthesis of unsaturated fat and steroids,[36] and in our examination, it was not distinguished in wild edibles.

Vitamin B_5 (pantothenic acid) is a fundamental nutrient required by the body for cell forms and ideal upkeep of fat. The lack of Vitamin B_5 prompts peevishness, weariness, aloofness, deadness, paresthesia, and muscle spasms in human beings.[37]

Pantothenic acid was identified most noteworthy in the leaves of *A. vulgaris* (0.73 ± 0.016 mg/100 g) and the most minimal was assessed in *P. major* (0.012 ± 0.001 mg/100 g). Different plants under scrutiny were additionally found to contain an excellent measure of B_5.

Pyridoxine (B_6) is another water-dissolvable vitamin essential for the best possible upkeep of red platelet digestion, the sensory system, the invulnerable framework, and numerous other substantial capacities. It likewise assumes a job in homocysteine engineered and degradative reactions.[38] This vitamin is found in most sustenance items and furthermore, because of its security, is frequently utilized for invigorating nourishment products;[39] it was evaluated in all the wild-palatable natural products under our examination.

The most noteworthy B_6 was seen in *A. vulgaris* (1.2 ± 0.033 mg/100 g) while the base was recognized in *C. hirsuta* (0.093 ± 0.003 mg/100 g). The measure of B_6 got in these wild-eatable plants was equivalent with some basic vegetable and fruits such as banana (0.37 mg/100 g), avocados (0.29 mg/100 g), spinach (0.24 mg/100 g), broccoli (0.134 mg/100 g), cauliflower (0.115 mg/100 g), and cucumber (0.2 mg/100 g).[24] Hence, the ordinary admission of these plants would supply adequate B_6 important to keep up solid body capacities.

Nutrient B_9 (folic acid) is a water-dissolvable B vitamin with numerous rich regular sources. It is required for various body capacities, including DNA combination and fix, cell division, and cell development. The lack of folate can prompt pallor in grown-ups and more slow advancement in children.[40-43] It assumes a significant job as a cell reinforcement *in vivo*, both by counteracting the unfriendly impact of responsive oxygen species (ROS) and by restraining lipid peroxidation.[44]

The degree of B_9 in five wild-palatable plants extended from 0.025 ± 0.003 to 3.37 ± 0.10 mg/100 g. The huge measure of B_9 was found in *A. vulgaris* and the leaves of *C. hirsuta* contained the second most noteworthy measure of B_9 (0.45 ± 0.016 mg/100 g).

Table 5: Antinutritional properties of the wild-edible plants collected from Meghalaya state in India

Name of the plant	Parts used	Oxalate (%)	Phytate (%)	Saponin (%)	Tannin (%)	Cyanogenic glycoside %)
Begonia hatacoa	Leaves	0.149±0.07^{e}	0.29±0.08^{b}	0.037±0.004^{e}	0.64±0.04^{b}	0.0065±0.0002^{a}
Embelia floribunda	Leaves	0.261±0.06^{a}	0.23±0.04^{c}	0.085±0.006^{a}	0.44±0.02^{d}	0.0028±0.0006^{c}
Artemisia vulgaris	Leaves	0.179±0.03^{d}	0.31±0.07^{b}	0.069±0.003^{b}	0.43±0.05^{d}	0.0058±0.0003^{b}
Cardamine hirsuta	Leaves	0.19±0.02^{c}	0.28±0.09^{bc}	0.062±0.008^{c}	0.56±0.09^{c}	0.0011±0.0008^{d}
Plantago major	Leaves	0.214±0.05^{b}	0.38±0.03^{a}	0.042±0.004^{d}	1.04±0.12^{a}	0.00065±0.00003^{d}

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. Statistical analysis were carried out by Tukey's test at 95% confidence level and statistical significance were accepted at the $P<0.05$ level. The superscript letter a, b, c, d and e denotes the significant differences within same parameters of individual plant. SEM: Standard error of the mean

Antinutritional composition

The after-effects of the antinutrient synthesis of the palatable plants under scrutiny were introduced in Table 5.

Oxalate is an enemy of supplement and found in nature in certain plants as dissolvable and insoluble salts and as oxalic acid. It ties with supplements in the gastrointestinal tract, rendering them inaccessible to the body.[45] The utilization of palatable plants with higher measures of oxalic acid may prompt the healthful lacks. In the present examination, among five plants, oxalate was most astounding in *E. floribunda* (0.261% ± 0.06%) and least in *B. hatacoa* (0.149% ± 0.07%). The oxalate levels in the examined plant are particularly practically identical with some regular fruits and vegetables such as spinach (0.658%), almond (0.407%), amla (0.296%), and amaranth (0.772%).[20] Oxalate is known to hinder renal calcium assimilation, particularly at centralizations of around 45 g/100 g.[46] However, the oxalate levels in the considered plants are far not exactly the worth that is thought to be destructive.

Phytic acid (myoinositol, 1, 2, 3, 4, 5, 6 hexakis-dihydrogen phosphates) and phytates are the most part found in vegetables and furthermore present in vegetables in low fixation. It ties with minerals, for example, iron, zinc, calcium, and magnesium, and structure-insoluble complex. It additionally structures edifices with proteins and starch.[47] Phytic acid substance in wild-consumable plants extended from 0.23% ± 0.04% in *E. floribunda* to 0.38% ± 0.03% in *P. major*, and the levels are practically such as rice (0.151%) and bean (0.248)[20] and the qualities in this investigation likewise fall inside the scope of 0.37–0.90 mg/g of fruits (guava, mango, orange, and pineapple).[48] The phytate levels acquired in our examination were lower than 10–60 mg/g that has been accounted for to beat the minerals bioavailability problems.[49]

Saponins are a class of synthetic mixes found in different plant species. It has a cleanser-like frothing property when they are added to fluid and interfere with epithelial capacity and make other stomach-related problems. It is additionally in charge of harming red platelets, restraining compounds, and meddling with thyroid function.[50] The amount of saponin in the plants varies in extent with the species. The most astounding measure of saponin was seen in *E. floribunda* (0.085% ± 0.006%) though the leaves of *B. hatacoa* had the most minimal fixation (0.037% ± 0.004%).

Tannin is an important antinutritional factor which exists in most of the vegetables and fruits. It is portrayed because of their harsh polyphenolic exacerbates that quandary or structure hastens with proteins and different other natural mixes, for example, alkaloids and amino acids. These tannins typically present in sustenance items which restrain the enzymatic movement of amylase, lipase, trypsin, and chymotrypsin. Thus, tannin decrease the quality of protein and interfere with iron absorption.[47] The most elevated convergence of tannin was recognized in the leaves of *P. major* (1.04% ± 0.12%) and most reduced sum was seen in *A. vulgaris* (0.43% ± 0.05%) and these low sums may not bring on any hurtful impact on individuals.

Cyanogenic glycosides are optional metabolites that are found in different plant tissues and produce Hydrogen Cyanide (HCN) upon hydrolysis. They are broadly conveyed in the plant kingdom. The capacity of cyanogenic glycosides to discharge HCN is expected to their enzymic hydrolysis, which may cause cyanide harming. In this way, evacuation of cyanogenic glycosides is important to improve the dietary benefit and security of cyanogen-containing foods.[51] This examination uncovered that the cyanide substance of the explored plants run between 0.00065% ± 0.00003% and 0.0061% ± 0.00001% and the centralization of cyanogenic glycosides in these plants was low and safe to devour as nourishment.

Toxicity studies

The results of the toxic quality investigations of consumable plants including the practicality of cells and level of DNA damage using buffer (negative control) and H_2O_2 (positive control) are exhibited in Table 6.

Hemolytic measures were performed in light of the fact that plants demonstrated intense nutraceutical properties, and these may not be devoured on the off chance that they have hemolytic impact. What's more, this information likewise may uncover some data about the component of cytotoxicity.

Hemolytic toxicity studies

In vitro hemolytic exercises on rat erythrocytes of different fixations (100, 200, 300, 500, and 1000 µg/ml) extricates acquired from palatable pieces of wild plants under scrutiny were performed. The 51.75% hemolysis was gotten utilizing H_2O_2 (200 µM) and 100.18% cell practicality was seen with buffer [Figure 1]. The hemolysis instigated by concentrates in red platelets was concentration-dependent; however, all concentrates demonstrated lower hemolytic impact on rat red platelet at all fixations. The feasibility of the hemolytic cell was most extreme (88.84% ± 1.56%) at the most astounding portion of 1000 µg/ml if there should arise an occurrence of *C. hirsuta*, and the most reduced was seen in the aqueous concentrate of *A. vulgaris* (84.37% ± 1.48%) at the same fixation [Figure 1].

Cytotoxicity studies

Hepatocytes were secluded from fresh goat liver, and the impacts of different focuses (100, 200, 300, 500, and 1000 µg/ml) of aqueous concentrates of consumable plants were seen on the feasibility of hepatocytes cell. *C. hirsuta* indicated the most noteworthy practicality (96.93% ± 1.44%) of the hepatocytes cell at the greatest portion of 1000 µg/ml and the least (94.33% ± 1.58%) was seen in *B. hatacoa* at same fixation [Figure 2]. The rate practicality of RBC and hepatocytes cell for all plant separates at all focuses (100–1000 µg/ml) was especially equivalent to the negative control although the rate feasibility of both RBC and hepatocytes cell utilizing H_2O_2 (positive control) at a fixation 200 µM was <50%.

Genotoxicity studies

The genotoxicity investigations of plants included the incubation of rodent lymphocytes in a low-melting-point agarose suspension alongside plant concentrate of various fixations (100–1000 µg/ml), lysis of the cells in alkaline (pH >13) conditions, and the electrophoresis of the suspended

Table 6: Toxicity studies of wild-edible plants collected from Meghalaya state in India

Name of the plant	Concentration of the extract (µg/ml)	Hemolytic toxicity RBC cell viability (%)	Hepatotoxicity hepatocytes cell viability (%)	Genotoxicity tail DNA (%)
Begonia hatacoa	100	88.57±1.34	96.78±1.23	3.75±0.68
	200	87.73±1.24	95.98±1.56	4.04±0.55
	300	85.57±1.04	95.16±1.01	4.36±0.74
	500	85.16±0.78	94.76±1.32	4.79±0.48
	1000	87.10±1.65	94.33±1.58	5.11±0.81
Embelia floribunda	100	91.98±1.74	98.07±1.86	4.36±0.55
	200	90.52±1.13	96.78±1.38	4.75±0.18
	300	89.61±1.18	96.25±106	5.24±0.38
	500	88.95±1.07	95.83±1.09	5.95±0.24
	1000	86.95±1.62	95.41±1.33	6.18±0.34
Artemisia vulgaris	100	90.46±1.11	98.75±1.08	3.87±0.78
	200	89.35±1.26	97.91±1.43	4.12±0.49
	300	87.34±1.07	97.27±1.29	4.47±0.22
	500	86.32±1.14	96.84±1.22	4.89±0.43
	1000	84.37±1.48	96.06±1.07	5.12±0.66
Cardamine hirsuta	100	94.05±1.34	98.87±1.46	4.24±0.68
	200	93.39±1.21	98.23±1.02	4.76±0.32
	300	90.09±1.42	97.81±1.28	5.34±0.57
	500	89.78±1.33	97.24±1.16	5.72±0.66
	1000	88.84±1.56	96.93±1.44	5.98±0.64
Plantago major	100	96.1±1.28	97.05±1.31	4.72±0.88
	200	93.85±1.06	96.14±1.16	5.24±0.34
	300	88.31±1.25	95.78±1.42	5.58±0.26
	500	87.62±1.09	95.35±1.33	6.01±0.49
	1000	85.74±1.11	94.78±1.08	6.38±0.56
Negative control	0	100.88±1.03	99.56±0.56	5.68±1.81
Positive control (H_2O_2) (µM)	50	78.34±1.14	74.0±1.08	25.18±1.06
	100	67.54±1.32	66.20±1.11	55.46±1.44
	200	50.11±1.05	41.25±1.05	76.35±1.48

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±SEM. SEM: Standard error of the mean; RBC: Red blood corpuscles

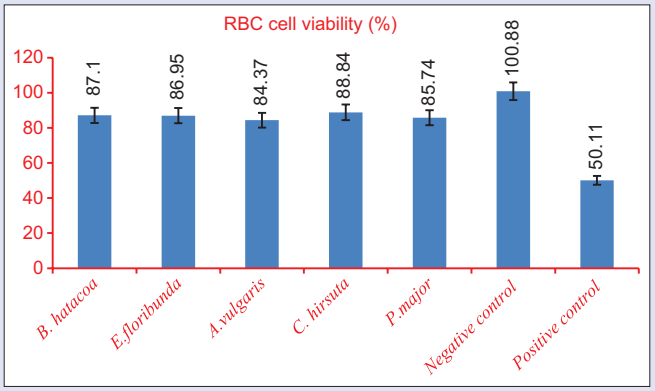


Figure 1: Hemolytic toxicity of plant extracts (1000 µg/ml), negative control and positive control (H_2O_2; 200 µM)

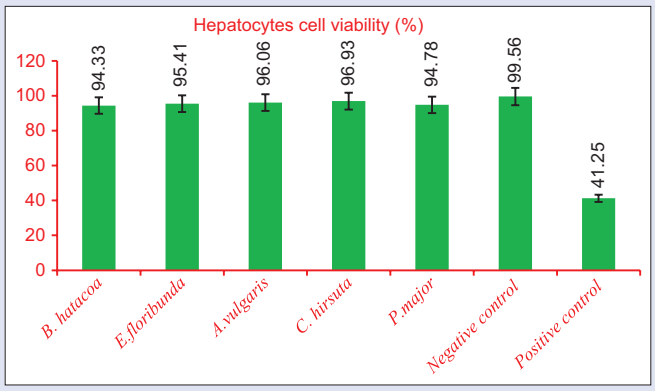


Figure 2: Hepatotoxicity of plant extracts (1000 µg/ml), negative control and positive control (H_2O_2; 200 µM)

lysed cells. This was trailed by quick visual investigation of the slides with staining under fluorescence microscope and calculating fluorescence to decide the degree of DNA damage. OTM of individual stained nuclei was determined utilizing comet measure programming. Negative

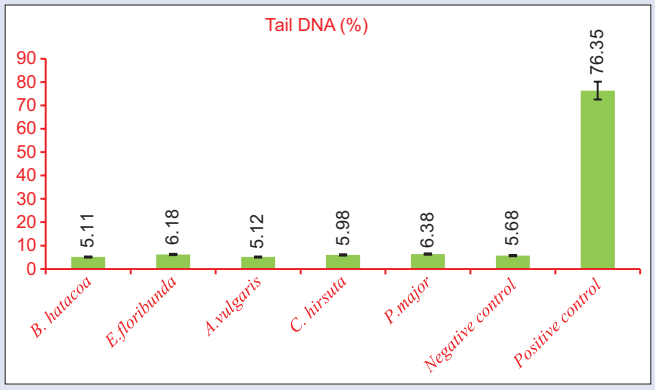


Figure 3: Genotoxicity of plant extracts (1000 µg/ml), negative control and positive control (H_2O_2; 200 µM)

(entire blood and RPMI-1640) and positive controls (entire blood, 50, 100 and 200 µM H_2O_2 and RPMI-1640) were incorporated. A higher rate tail DNA showed a larger amount of DNA harm and more elevated amount of genotoxicity of plant extract. The single-cell gel electrophoresis test (comet examine) is a modest, basic, and quick strategy for estimating DNA strand breaks and, because of its affectability, permits examination at the individual cell level and the utilization of little samples.[52]

The consequence of comet test demonstrated that the aqueous concentrate of *P. major* at a focus 1000 µg/ml had the most astounding rate (6.38% ± 0.56%) of tail DNA while the least rate (5.11% ± 0.81%) was found in *B. hatacoa* at same fixation. The 5.68% of tail DNA was gotten utilizing negative control and positive control (blend of entire blood, RPMI 1640, and 200 µM H_2O_2) indicated 76.35% of tail DNA [Figure 3]. The arrangement of free radicals during organic digestion causes mutagenicity and genotoxicity. Because of oxidative pressure, H_2O_2 showed portion subordinate DNA harm (25.18%–76.35% of tail DNA) which was distinguished by comet test. The consequence of examination uncovered that the degree of DNA harm brought about by the plant removal at various fixations was especially like the negative control. Characteristic mixes, particularly got from dietary sources, give an enormous number of cancer prevention agents. Ongoing investigations in people have demonstrated that supplementation with cell reinforcement mixes, for example, Vitamin E and C, lycopene, and β-carotene, can help lessen levels of free-radical harm apply a defensive impact against degenerative issue, for example, malignancy, by a diminishing in DNA damage.[53] Plants have wide scope of pharmacologically powerful phytochemicals. Huge numbers of them have been accounted for accommodating for the treatment of a few ailments of individual, yet couple of phytochemicals such as saponin, tannin, and cyanogenic glycosides produce hurtful impacts after introduction and can go about as genius oxidants, highlighting most likely in charge of the mutagenicity and genotoxicity.[54]

CONCLUSION

The examination demonstrated that these wild-consumable plants gathered from Meghalaya state in India are wealthy in protein, fat, sugar, and fiber and could give fundamental supplements required to keeping up ordinary bodywork. The dietary properties of these plants were additionally all around looked at and furthermore here and there superior to the basic vegetables. These vegetables were likewise discovered an altogether valuable wellspring of different minerals. The minerals, especially Na, K, Ca, Fe, Cu, Mg, and Zn, were available in obvious amounts. The poisonous substantial metals Cd and mercury were not distinguished in the plant materials, yet Pb and Cr were identified inside as far as possible as recommended by the WHO, and the nearness of the overwhelming metals in the plant probably will not be unsafe for humankind. Reverse phase-HPLC results demonstrated the plants contained a few water Solvent B and C Vitamins in differing sums. The after-effect of examination of nutrient substance in the wild-consumable plants under scrutiny will fill in as a helpful way to compute dietary admission of C and B Vitamins in the all-inclusive community. The antinutritional investigation demonstrated that every one of these plants contained oxalate, phytate, saponin, cyanogenic glycoside, and tannin. In any case, values got for these plants are lower than the set up harmful level. Thus, they can be devoured with no limitation. The after-effects of hemolytic harmfulness, cytotoxicity, and genotoxicity of fluid concentrates of every eatable plant uncovered that these are nonlethal at cell and genomic level and furthermore safe to devour. Hence, we accept that these plants could be utilized for the dietary reason for person because of their great healthful characteristics and sufficient security might be acquired against illnesses emerging from lack of healthy sustenance. The exploratory discoveries additionally uncovered that these wild-consumable plants were the great wellspring of supplement for innate populace. Hence, the development of these wild-consumable species should be embraced in huge scale, which will deliver financial advantages for poor ranchers.

Acknowledgements

We are highly grateful to Dr. A. A. Mao, Director, Botanical Survey of India (BSI), Kolkata, for his encouragement and facilities. We are also thankful to Dr. R. Gogoi, SHRC, Gangtok, BSI, Howrah, and Mr. R Shanpru, Scientist, BSI, Eastern Regional circle, Shillong, Meghalaya, for identifying the plant specimens.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Weng DB, Huang XF, Yang JL. Evaluating protein quality of four kinds of cultivated wild vegetables in Nanjing. J Nat Res 2001;16:288-92.
2. Aberoumand A. Screening of less known two food plants for comparison of nutrient contents: Iranian and Indian vegetables. Funct Foods Health Dis 2011;10:416-23.
3. Liener IE, Kkade ML. Protease inhibitor. In: Liener IE. editor. Toxic Constituents of Plants Foodstuffs. New York: Academic Press; 1980.
4. Larsson M, Rossander-Hulthén L, Sandström B, Sandberg AS. Improved zinc and iron absorption from breakfast meals containing malted oats with reduced phytate content. Br J Nutr 1996;76:677-88.
5. Reddy NR, Sathe SK, Pierson MD. Removal of phytate from great northern beans (*Phaseolus vulgaris* L.) and its combined density fraction. J Food Sci 1988;53:107-10.
6. Hahn DH, Rooney LW, Earp CF. Tannins and phenols of sorghum. Cereal Foods World 1984;29:776-9.
7. Plewa MJ, Wagner ED. Activation of promutagens by green plants. Annu Rev Genet 1993;27:93-113.
8. Association of Official Analytical Chemists. Official Methods of Analysis. 7th ed. Washington DC, Arlington, Virginia, USA: Association of Official Analytical Chemists; 2000.
9. Hedge JE, Hofreiter BT. Determination of reducing sugars and carbohydrates. In: Whistler RL, Be Miller JN, editors. Methods in Carbohydrate Chemistry. New York: Academic Press; 1962. p. 380-394.
10. Gawalko EJ, Nowicki TW, Babb J, Tkachuk R, Wu S. Comparison of closed-vessel and focused open-vessel microwave dissolution for determination of cadmium, copper, lead, and selenium in wheat, wheat products, corn bran, and rice flour by transverse-heated graphite

furnace atomic absorption spectrometry. J AOAC Int 1997;80:379-87.

11. Seal T, Chaudhuri K, Pillai B. A rapid high performance liquid chromatography (HPLC) method for the simultaneous estimation of water soluble vitamin in ten wild edible plants consumed by the tribal people of North-Eastern Region in India. Pharmacogn Mag 2018;14:572-7.
12. Munro A, Bassir O. Oxalate in Nigerian vegetables. West Afr J Biol Appl Chem 1980;12:14-8.
13. Reddy MB, Love M. The impact of food processing on the nutritional quality of vitamins and minerals. Adv Exp Med Biol 1999;459:99-106.
14. Hudson BJ, El-Difrawi EA. The Sapogenins of the seeds of four Lupin species. J Plant Foods 1979;3:181-6.
15. Price ML, Scoyoc SV, Butler LG. A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grain. J Agric Food Chem 1978;26:1214-8.
16. Malagoli D. A full-length protocol to test haemolytic activity of palytoxin on human erythrocytes. Int Surg J 2007;4:92-4.
17. Mosmann T. Rapid colorimetric assay for cellular growth and survival: Application to proliferation and cytotoxicity assays. J Immunol Methods 1983;65:55-63.
18. Singh NP, McCoy MT, Tice RR, Schneider EL. A simple technique for quantitation of low levels of DNA damage in individual cells. Exp Cell Res 1988;175:184-91.
19. Nielsen SS. Determination of Moisture Content, Food Analysis Laboratory Manual. US: Springer; 2010. p. 17-27.
20. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian foods." Hyderabad, India: National Institute of Nutrition, Indian Council of Medical Research; 2004. p. 2-58.
21. Satter MM, Khan MM, Jabin SA, Abedin N, Islam MF, Shaha B. Nutritional quality and safety aspects of wild vegetables consume in Bangladesh. Asian Pac J Trop Biomed 2016;6:125-31.
22. Koca I, Hasbay I, Bostanci S, Yilmaz VA, Koca AF. Some wild edible plants and their dietary fiber contents. Pak J Nutr 2015;14:188-94.
23. Mohan VR, Kalidass C. Nutritional and antinutritional evaluation of some unconventional wild edible plants. Trop Subtrop Agroecosystems 2010;12:495-506.
24. Sundriyal M, Sundriyal RC. Wild edible plants of the Sikkim Himalaya: Nutritive values of selected species. Econ Bot 2004;58:286-99.
25. Saupi N, Zakaria MH, Bujang JS. Analytic chemical composition and mineral content of yellow velvet leaf (*Limnocharis flava* L. Buchenau)'s edible parts. J Appl Sci 2009;9:2969-74.
26. Indrayan AK, Sharma S, Durgapal D, Kumar N, Kumar M. Determination of nutritive value and analysis of mineral elements for some medicinally valued plants from Uttaranchal. Curr Sci 2005;89:1252-5.
27. Ihedioha JN, Okoye CO. Nutritional evaluation of *Mucuna flagellipes* leaves: An underutilized legume in Eastern Nigeria. Am J Plant Nutr Fertil Technol 2011;1:55-63.
28. Saikia P, Deka DC. Mineral content of some wild green leafy vegetables of North-East India. J Chem Pharm Res 2013;5:117-21.
29. Sharma P, Dubey RS. Lead toxicity in plants. Braz J Plant Physiol 2005;17:35-52.
30. Deekshika B, Lakshmi BP, Singuluri H, Sukumaran MK. Estimation of ascorbic acid content in fruits and vegetables from Hyderabad, India – A theoretical assessment of Vitamin C activity. Int J Curr Microbiol Appl Sci 2015;4:96-9.
31. Rekha C, Poornim G, Manasa M, Abhipsa V, Devi J, Kumar H, *et al.* Ascorbic acid, total phenol content and antioxidant activity of fresh juices of four ripe and unripe citrus fruits. Chem Sci Trans 2012;1:303-10.
32. Akah NP, Onweluzo JC. Evaluation of water-soluble vitamins and optimum cooking time of fresh edible portions of elephant grass (*Pennisetum purpureum* L. Schumach) Shoot. Niger Food J 2014;32:120-7.
33. Akyilmaz E, Yasa I, Dinçkaya E. Whole cell immobilized amperometric biosensor based on Saccharomyces cerevisiae for selective determination of Vitamin B1 (thiamine). Anal Biochem 2016;354:78-84.
34. Boyaci BB, Han J, Masatcioglu MT, Yalcin E, Celik S, Ryu G, *et al.* Effects of cold extrusion process on thiamine and riboflavin contents of fortified corn extrudates. Food Chem 2012;132:2165-70.
35. Watada AE. Vitamins C, B9 and B2 contents of stored fruits and vegetables as determined by high performance liquid chromatography, J. Am Soc Hort Sci 1987;112:794-7.
36. Institute of Medicine. Dietary Reference Intakes (DRI) for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin and Choline. Institute of Medicine; 1998.
37. Kelly GS. Pantothenic acid. Monograph. Altern Med Rev 2011;16:263-74.
38. Rivlin RS. Vitamin deficiencies. In: Berdanier CD, Feldman BE, Dwyer J, editors. Handbook of Nutrition and Food. 2nd ed. Boca Raton, Forida, USA: CRC Press (Taylor and Francis Group, LLC); 2007.p. 177-92.
39. Russell LF. Water soluble vitamins. In: Nollet LM, Toldrá F, editors. Food Analysis by HPLC. 3rd ed. Boca Raton, Forida, USA: CRC Press; 2012. p. 325-442.
40. Groff JL, Gropper SS, Hunt SM. Advanced Nutrition and Human Metabolism. 2nd ed. Minneapolis/St. Paul New York Los Angeles San Francisco: West Publishing Company; 1995.
41. Iyer R, Tomar SK. Folate: A functional food constituent. J Food Sci 2009;74:R114-22.
42. McGuire JJ. Folic acid, folates and cancer. In: Awad AB, Bradford PG, editors. Nutrition and Cancer Prevention. Ch. 8. Boca Raton, Forida, USA: CRC Press (Taylor and Francis Group, LLC); 2006.
43. Stover PJ. Folate biochemical pathways and their regulation. In: Bailey LB, editor. Folate in Health and Disease. 2nd ed. Boca Raton, Forida, USA: CRC Press (Taylor and Francis Group, LLC); 2010. p. 49-74.
44. Merola N, Alonso FJ, Ros G, Caston MJ. Antioxidant activity comparison between [6S]-5-methyltetrahydrofolic acid calcium salt and the related racemate form. Food Chem 2013;136:984-8.
45. Ilelaboye NO, Amoo IA, Pikuda OO. Effect of cooking methods on mineral and anti nutrient composition of some green leafy vegetables. Arch Appl Sci Res 2013;5:254-60.
46. Muhammed I, Muh S, Olorunju S, Bale J, Abdullahi U, Lawal R. Response of nutrients and anti-nutritional constituents in the seeds of *Cassia tora* L. To treatments. J Agric Environ 2002;3:225-34.
47. Yasir A, Ahmad A. Impact of processing on nutritional and antinutritional factors of legumes: A review. Ann Food Sci Technol 2018;19:199-215.
48. Nititham S, Komindr S, Nichachotsalid A. Phytate and fiber content in Thai fruits commonly consumed by diabetic patients. J Med Assoc Thai 2004;87:1444-6.
49. Thompson LU. Potential health benefits and problems associated with antinutrients in foods. Food Res Int 1993;26:131-49.
50. Fan Y, Guo DY, Song Q, Li T. Effect of total saponin of aralia taibaiensis on proliferation of leukemia cells. Zhong Yao Cai 2013;36:604-7.
51. Fereidoon S, Wanasundara PK. Cyanogenic glycosides of flaxseeds. Antinutrients and Phytochemicals in Food. Ch. 10. Vol. 662. ACS Symposium Series; 1997. p. 171-85.
52. Behravan J, Mosafa F, Soudmand N, Taghiabadi E, Razavi BM, Karimi G. Protective effects of aqueous and ethanolic extracts of *Portulaca oleracea* L. aerial parts on H_2O_2-induced DNA damage in lymphocytes by comet assay. J Acupunct Meridian Stud 2011;4:193-7.
53. Kumari N, Deshwal RK. Antioxidants and their protective action against DNA Damage. Int J Pharm Pharm Sci 2011;3:28-32.
54. Mohamed AM, Cangiano MA, Alcaraz LE, Satorres SE, Laciar AL, Mattana CM. Comet assay application in evaluation the safe use of medicinal plants. Emirates J Food Agr 2016;28:737-40.