International Journal of Pharmacy and Pharmaceutical Sciences

Print ISSN: 2656-0097 | Online ISSN: 0975-1491 Vol 12, Issue 11, 2020

Original Article

EFFECT OF BOILING AND MICROWAVE COOKING ON NUTRITIONAL, ANTI-NUTRITIONAL AND TOXICITY OF WILD EDIBLE PLANTS OF NORTH-EASTERN REGION IN INDIA

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Received: 29 Jun 2020, Revised and Accepted: 04 Sep 2020

ABSTRACT

Objective: The target of this appraisal was to explore the impacts of various cooking techniques, for example, boiling and microwave cooking on nutritional, antinutritional, minerals content and *in vitro* toxicity of ten wild consumable plants *viz*. *Zanthoxylum acanthopodium*, *Viburnum foetidum*, *Houttuynia cordata*, *Sonchus arvensis*, *Oenanthe linearis*, *Perilla ocymoides*, *Clerodendrum colebrookeanum, Solanum gilo*, *Solanum kurzii*, *Potentilla lineata*, widely consumed by the common individuals of North-Eastern area in India.

Methods: The proximate parameters like ash, moisture, protein, fat, fibre, carbohydrate, energy content, minerals *viz*. sodium, calcium, potassium, iron, magnesium, manganese, copper, zinc and antinutritional parameters like oxalate, phytate, tannin, saponin, cyanogenic glycoside content were evaluated in the selected wild edible plants using standard food analysis techniques. *In vitro* haemolytic toxicity of aqueous extracts (100, 300 and 500µg/cc) of ten palatable wild plants was done with the blood samples were gathered from healthy rat, mixed with Ethylenediaminetetraacetic acid(EDTA) and centrifuged at 5,000 Revolutions Per Minute (rpm) for five minutes. The 10 % erythrocyte suspension was set up in sterile Phosphate buffer saline (PBS, pH 7.4) for haemolytic examination. The genotoxic potential of the concentrates were assessed by a single-cell gel electrophoresis comet test. Cytotoxicity studies were evaluated with fresh goat livers procured from the local market 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.

Results: Both cooking medications diminished the congregations of ash, fat, minerals, antinutritional parts and the destructive nature of the consumable plants while the carbohydrate and fiber substance were expanded. The protein focuses in the wild edibles were expanded fundamentally ($P<0.05$) in the range from 1.26 to 10.45% on microwave cooking while the indistinguishable were exhausted in the range out of 2.20 to11.55% on boiling treatment. The microwave cooking demonstrated lesser misfortunes in minerals in the consumable plants than those cooked by frothing. The microwave cooking also caused the colossal rot ($P<0.05$) of antinutritional parameters and damaging tendency to a more significant degree than the sputtering medications of the wild edibles.

Conclusion: Therefore, the outcomes uncovered that microwaving of appealing plants could be prescribed to expand the supporting quality and to diminish the fat, threatening to dietary structure and lethality. The toxicity assessment of the consumable plants at cell and genomic level showed that these are harmless to consume.

Keywords: Wild edible plants, Nutritive, Minerals, Antinutritional, Toxicity, Effect of cooking

DOI: http://dx.doi.org/10.22159/ijpps.2020v12i11.38892. Journal homepage: https://innovareacademics.in/journals/index.php/ijpps.

INTRODUCTION

Different sorts of wild edible plants are devoured in creating nations as wellsprings of nourishment. Because of the sharp increment in populace, shortage of ripe land at the development and mind-boggling expenses of accessible staples, a few people much of the time gather palatable wild plants and different plants from regular surroundings to meet their satisfactory degree of nourishment. In many tropical countries the rustic rural individuals generally produce a wide number of wild vegetables with no development because of social uses, taste propensities or nourishment deficiency. Distinctive biochemical techniques have been created to develop some ideal plant species in huge scale in the nursery and fields to meet the caloric necessities of individual [1]. In most of the reports, it was informed that the nutraceutical estimation of offbeat plants sustenances could be practically identical to or even now and then better than the common vegetables [2]. It is advantageous to take note of that utilization of various kinds of eatable plants as wellsprings of food could be valuable to a healthfully negligible populace, especially in creating nations where destitution and atmosphere do make ruin the country people [3]. In this setting, the investigation of wild eatable plants is imperative to distinguish the potential sources which could be misused as elective sustenance. In spite of the fact that the wild eatable plants are heavenly and nutritious, yet overabundance utilization of such plants might be hurtful to our body due to having some antinutritional mixes in the plants. The antinutritional factors, for example, phytic acid, tannin, saponin, oxalic acid, cyanogen glycoside, have an antagonistic impact on wellbeing through hindrance of protein assimilation, development, iron and zinc ingestion [4, 5]. Phytic acid brings down the bioavailability of minerals [6], tannins tie to proteins through hydrogen authoritative and hydrophobic cooperations, in this manner, lessening their healthful quality [7]. Since antiquated occasions plants have been utilized as sustenance and meds and it is additionally realized that, all in all, green plants are an essential wellspring of antimutagens just as normal lethal operators [8]. So it is basic to decide if the wild plants can create unfavorable consequences for living being before utilization. Despite the fact that admission of new vegetable is exceptionally suggested, palatable wild plants are seldom expended crude and most normally are eaten in the wake of cooking. Along these lines, it is critical to realize how residential cooking can influence the proximate structure and minerals substance of wild edibles. Moreover, it could be fascinating to recognize, for every species, the cooking strategy like boiling remove the toxicants [9] that can improve the nutritive worth and its wellbeing related properties while exhausting the antinutritive segments, lethality and its wellbeing related dangers. Along these lines, this examination was led with the expect to assess the dietary benefit, antinutritional properties and lethality investigations of ten wild consumable plants *viz*. *Zanthoxylum acanthopodium*, *Viburnum foetidum*, *Houttuynia cordata*, *Sonchus arvensis*, *Oenanthe linearis*, *Perilla ocymoides*, *Clerodendrum colebrookeanum, Solanum gilo*, *Solanum kurzii* and *Potentilla lineata*, gathered from North-Eastern area in India. These plants are generally devoured by the innate

individuals of the North-east area in India. The impact of normal local cooking (boiling and microwave) on complete nourishing quality and lethality were likewise contemplated. The data contributes toward deciding the best cooking technique that holds the vast majority of the supplements and phytochemicals in the wild consumable plants under investigation.

MATERIALS AND METHODS

Plant materials

The fresh edible parts of plant materials *Z. acanthopodium*, *V. foetidum*, *H. cordata*, *S. arvensis*, *O. linearis*, *P. ocymoides*, *C. colebrookeanum, S. gilo*, *S. kurzii* and *P. lineata*, collected from North-Eastern region in India and identifications were authenticated from Botanical Survey of India, Howrah. The voucher specimens were preserved at the Plant Chemistry department of our office under registry no BSITS 1, BSITS 2, BSITS 3, BSITS 4, BSITS 5, BSITS 6, BSITS 7, BSITS 8, BSITS 9 and BSITS 10 respectively. The plant parts were shed-dried, pulverized and stored in an airtight container and proximate composition, and mineral contents and toxicity studies were carried out in our laboratory.

Cooking by boiling

Five grams of each plant was boiled in distilled water (100 °C) in the proportion of 1:10 (w/v) on a hot plate for 1h until they turned out to be delicate and the plant tests were depleted off. The boiled plants were isolated from the water with a sieve and dried in an air oven at 50 °C for 2h and kept for investigation [10].

Cooking by microwave heating

Five grams of each plant were placed in a glass beaker with distilled water (1:10 w/v), then cooked in a microwave oven for 15 min until they became soft. The cooked plants were separated from water and dried in an air oven at 50 °C for 2h and kept for analysis [10].

Estimation of nutritional composition

The edible part of the powdered vegetable example was examined as follows in our research facility following the standard sustenance examination techniques portrayed in the Association of Official Analytical Chemists [11]. Ash content was assessed by heating plant test in a muffle furnace for around 5-6 h at 500 °C though moisture substance was controlled by warming plant test in an air oven at 100–110 °C. The crude fat was extricated from dampness free plant materials with petroleum ether (60-80 °C) in a Soxhlet contraption for around 6-8 h. Estimation of unrefined fiber content in the plant materials was completed by treating the fat and dampness free materials with 1.25% dilute nitric acid and 1.25% sodium hydroxide pursued by washing with water and ignition of the residue. The crude protein was resolved utilizing the micro Kjeldahl strategy as depicted in AOAC methods [11]. The absolute carbohydrate substance was assessed as portrayed in the technique for Hedge and Hofreiter, 1962 [12].

Estimation of minerals

Plant materials were taken in a pre-cleaned and continually gauged silica crucible and heated in a muffle furnace at 400 °C and ash was gotten. One gram of fiery remains was dissolved in 100 ml of 5 % hydrochloric acid (HCl) to get the arrangement prepared for assurance of mineral components through atomic absorption spectroscopy (AAS) (AA 800, Perkin-Elmer Germany). Standard solution of every component was prepared and calibration curves were drawn for every component and minerals were estimated by AAS [13].

Estimation of antinutritional composition

Oxalate substance of consumable plants was settled using the technique delineated by Munro and Bassir 1980 [14]. Phytate was settled using the system Reddy and Love, 1999 [15]. Saponin was estimated using the procedure for Hudson and El-Difrawi, 1979 [16]. Tannins were inspected according to the Vanillin-HCl method for Price *et al.*, 1978 [17] and tannic acid was used as the reference standard. Cyanogenic glycoside substance of test was constrained by acid neutralizer titration strategy where the end-point was noted as an unending turbidity against a dark background following the method of AOAC [11].

Toxicity studies of wild edible plants

Preparation of plant extracts

Five gm of powdered plant materials were macerated in 50 ml distilled water at room temperature for 24h and after that filtered through cotton wool. The plant materials were macerated again in a similar dissolvable for another 24h and the concentrates acquired from the first and the subsequent extractions were pooled and concentrated utilizing a rotary evaporator under reduced pressure to get the concentrates which were additionally dried utilizing a freeze drier. The dry concentrates were put away at-20 °C until use. Five mg of every rough concentrate was dissolved up in 10 ml Phosphate buffer saline (PBS, pH 7.4) to make 500µg/ml. The example arrangements were gone through 0.22 µm syringe-adjusted filters to wipe out any particulate issue and stored at-20 °C until use.

Haemolytic toxicity study

In vitro haemolytic lethality of watery concentrates of ten palatable wild plants was done as described by Gajjar *et al.* 2015 with minor modifications [18]. The blood samples were gathered from a healthy rat, mixed with EDTA and centrifuged at 5,000 rpm for five minutes. The 10 % erythrocyte suspension was set up in sterile Phosphate buffer saline (PBS, pH 7.4) for haemolytic examination. The different focuses (100,300 and 500 µg/ml) of plant concentrates were added to 10% suspension of rat erythrocytes. The mixture was incubated for 1 hr at 37 °C temperature, cells were centrifuged and the supernatant was utilized to quantify the absorbance of the freed haemoglobin at 540 nm in an UV-VIS spectrophotometer (Model Shimadzu, UV 1800). Two controls were set up without concentrates; the negative control got sterile phosphate buffer saline, while hydrogen peroxide (50-200 µM) was taken as positive control. The normal worth was determined from triplicate tests. The cell feasibility for each extracts was determined by dividing sample's absorbance on negative control absorbance multiplied by hundred.

Cytotoxicity study

Watery concentrates of ten wild eatable plants were assessed for cytotoxicity by 3-(4,5-Dimethylthiazol-2-yl)-2,5-Diphenyl-tetrazolium Bromide (MTT) measure on segregated goat liver cells utilizing the convention as portrayed by Mosmann 1983 [19]. Fresh goat livers procured from the local market 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, S. Korea). The cells were then washed with HBSS and axis at 800 rpm to wipe out fine trash. The cell practicality goes somewhere in the range of 85 and 95% as dictated by the trypan blue exclusion test. The immaculateness of hepatocytes was inspected by phase-contrast microscopy. The separated cells were taken in an eppendorf containing 0.5 ml RPMI and 10% FBS. The various focuses (100,300 and 500 µg/ml) of fluid concentrate (100µl) of eatable plants were added to the freshly isolated 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 same test condition. All the tubes were then centrifuged and supernatant was disposed of. Thiazolyl Blue Tetrazolium Bromide, MTT (5 mg/ml, in PBS, pH 4.5) (Sigma, USA) were added into tube to accomplish a final concentration of 0.5 mg/ml and incubated 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 evacuated by centrifugation and 100µl DMSO was added to it and incubated for 30 min to 1 hr to dissolve formazan crystals. The UV absorbance of coming about purple arrangement was spectrophotometrically estimated at 570 nm in UV-VIS spectrophotometer (Model Shimadzu, UV 1800) and the level of cell practicality was determined to decide the hepatotoxicity of plant separates.

Genotoxicity study

The genotoxic potential, of the concentrates were assessed by single-cell gel electrophoresis comet test as depicted by Singh *et al.*[20]. One (1) ml blood was gathered from tail vein of a healthy rat and 100 µl of heparinized entire blood was blended with 100 µl plant

concentrates of various focuses (100, 300 and 500µg/ml) and incubated at 37 °C for 2h 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 afterward spread on a slide pre-covered with a film of 1% normal melting point agarose (NMPA). Two slides were set up for each example where agarose cell suspensions were permitted to solidify at 4 °C. After solidification, slides were submerged to cold lysis buffer, (2.5 M NaCl, 100 mmol EDTA, 10 mmolTris buffer, 10% DMSO, Triton X-100 0.8%, pH 10) for 1 h. The slides were expelled from lysis buffer and set on a level gel electrophoresis chamber, loaded up with basic electrophoresis support (1 mmol EDTA, 0.3 N NaOH, pH 13.0) for 20 min for loosening up of DNA. At that point, electrophoresis was performed for 30 min at 25V/300mA and electrophoresis slides was 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 calculated using comet assay software. A higher percentage tail DNA indicated a higher level of DNA damage and a higher level of genotoxicity of plant extract. Olive Tail Moment (OTM) of individual stained nuclei was determined utilizing comet measure programming. A higher percentage tail DNA showed a larger amount of DNA harm and more elevated amount of genotoxicity of plant extricate.

Ethical clearance for performing experiments on rats to get erythrocytes was obtained from the Institutional Animal Ethics Committee (Approval No.-04/P/S/IAEC/2017), Serampore College, West Bengal, India, conforming the CPCSEA guidelines.

Goat liver was procured fresh from a local abattoir and brought on ice within 30 min of death.

Statistical analysis

All the analysis was done using triplicate samples. Experimental results were subjected to univariate analysis of variance (ANOVA), followed by the Tukey test ($p \leq 0.05$) using the statistical package for the social sciences (SPSS version 7.5).

RESULTS AND DISCUSSION

Proximate composition

The proximate arrangements of crude and cooked plants are introduced in table 1. The ash

Table 1: Proximate composition of wild edible plants and the effect of cooking

		Ash (%)	Fat (%)	Fibre (%)	Protein (%)	Carbohydrate (%)
Z. acanthopodium	Raw	7.20±0.24^{a}	1.99±0.08^{a}	5.78±0.49^{b}	28.06±0.14^{b}	5.70±0.53^{c}
	Boiled	7.04±0.09^{b} (-2.22)	1.18±0.12 ^{b}(-40.70)	5.95±0.28^{a}(+2.94)	27.15±1.08 ^{c} (-3.24)	6.03±0.15^{b} (+5.78)
	Microwave cooking	7.15±0.22^{a}(-0.69)	1.17±0.07 ^{b}(-41.20)	6.01±0.34^{a}(+3.97)	29.25±0.18 ^{a} (+4.24)	6.65±0.45^{a}(+16.66)
V. foetidum	Raw	2.20±0.17^{a}	2.96±0.07^{a}	1.04±0.05^{c}	5.45±0.05^{b}	8.84±0.22^{c}
	Boiled	1.85±0.38^{c} (-15.90)	2.15±0.18 ^{b}(-27.36)	1.14±0.24^{b}(+9.61)	4.82±0.39 ^{c} (-11.55)	8.95±0.19 ^{b}(+1.24)
	Microwave cooking	2.07±0.19 ^{b} (-5.90)	0.95±0.09^{c}(-67.90)	1.26±0.08^{a}(+21.15)	6.02±0.18 ^{a}(+10.45)	9.04±0.33^{a}(+6.33)
H. cordata	Raw	6.03±0.20^{a}	2.07±0.06^{a}	2.40±0.37^{c}	12.22±0.22^{b}	7.72±2.11^{c}
	Boiled	5.91±0.45^{b}(-1.99)	1.32±0.14^{b} (-36.23)	2.51±0.18^{b} (+4.58)	11.95±0.33^{c}(-2.20)	8.22±0.16 ^{b}(+6.47)
	Microwave cooking	5.97±0.33^{ab} (-0.99)	0.92±0.38 ^{c}(-55.55)	2.73±0.45^{a} (+13.75)	12.88±0.28^{a} (+5.40)	8.46±0.55 ^{a}(+9.58)
S. arvensis	Raw	9.60±0.33^{a}	2.46±0.04^{a}	6.30±0.45^{c}	19.55±0.30^{b}	6.22±1.25^{c}
	Boiled	9.18±0.25^{b} (-4.38)	1.95±0.14^{b} (-20.73)	6.55±0.58^{b} (+3.96)	18.87±1.14^{c} (-3.47)	6.75±0.65 ^{b}(+8.52)
	Microwave cooking	9.52±0.33^{a} (-0.83)	1.40±0.66^{c} (-43.08)	6.85±0.35^{a} (+8.73)	20.14±0.56 ^{a} (+3.01)	6.92±1.02^{a} (+11.57)
O. linearis	Raw	8.18±0.20^{a}	1.56±0.06^{a}	4.56±0.53^{c}	21.80±0.41^{b}	6.38±2.26^{c}
	Boiled	7.95±0.66^{b} (-2.81)	1.07±0.44^{b} (-31.41)	4.78±0.22 ^{b}(+4.82)	20.16±0.35^{c} (-7.52)	6.52±0.78^{b} (+2.19)
	Microwave cooking	8.05±0.32^{b} (-1.59)	0.87±0.23^{c} (-44.23)	4.96±0.56^{a} (+8.77)	22.12±0.75^{a} (+1.46)	6.96±0.66^{a} (+9.09)
P. ocymoides	Raw	3.26±0.03^{a}	15.16±0.05^{a}	1.60±0.03^{c}	23.86±0.05^{b}	5.61±0.50^{c}
	Boiled	3.05±0.16 ^{b}(-6.44)	14.93±0.44^{b}(-1.52)	1.78±0.06^{b} (+11.25)	22.98±1.55^{c} (-3.68)	5.85±0.45 ^{b}(+4.27)
	Microwave cooking	3.18±0.55^{a} (-2.45)	14.56±1.56^{c}(-3.95)	1.93±0.34^{a} (+20.62)	24.25±1.44^{a} (+1.63)	6.02±1.25^{a}(+7.31)
C. colebrookeanum	Raw	7.23±0.24^{a}	1.73±0.06^{a}	4.73±0.49 ^{c}	27.67±0.42^{b}	5.83±0.26^{c}
	Boiled	6.94±0.78^{c} (-4.01)	1.28±0.04^{b} (-26.01)	4.92±0.08 ^{b} (+4.02)	26.85±1.12 ^{c} (-2.96)	6.05±0.19^{b} (+3.77)
	Microwave cooking	7.08±0.22^{b} (-2.07)	1.02±0.45^{c} (-41.04)	5.12±0.34^{a} (+8.24)	28.02±1.35 ^{a}(+1.26)	6.68±0.65^{a} (+14.58)
S. gilo	Raw	8.05±0.07^{a}	2.75±0.05^{a}	4.22±0.16 ^{c}	15.83±0.06^{b}	6.92±0.34^{c}
	Boiled	7.88±0.19 ^{b}(-2.11)	2.34±0.59^{b} (-14.90)	4.56±0.35^{b}(+8.05)	15.18±0.19^{c} (-4.11)	7.01±0.66^{b} (+1.30)
	Microwave cooking	7.92±0.34^{b} (-1.61)	2.01±0.23^{c} (-12.00)	4.78±0.55 ^{a}(+13.27)	16.41±0.77^{a} (+3.66)	7.56±0.35^{a} (+9.24)
S. kurzii	Raw	3.90±0.11^{a}	2.24±0.11^{a}	1.03±0.06^{c}	14.95±0.06^{b}	7.78±0.36^{c}
	Boiled	3.55±0.09 ^{c}(-8.97)	1.92±0.44^{b} (-14.28)	1.16±0.32 ^{b}(+12.62)	14.12±0.17^{c}(-5.55)	8.01±0.29 ^{b}(+2.95)
	Microwave cooking	3.70±0.12^{b}(-5.13)	1.45±0.64 ^{c}(-35.26)	1.31±0.88^{a}(+27.18)	15.65±0.76^{a} (+2.59)	8.42±0.46^{a} (+8.22)
P. lineata	Raw	7.70±0.16^{a}	0.58±0.01^{a}	2.56±0.55^{c}	9.74±0.42^{b}	7.90±1.75^{c}
	Boiled	7.13±0.88^{c} (-7.40)	0.43±0.09 ^{b}(-22.41)	2.88±0.18 ^{b}(+12.50)	9.08±1.33 ^{c} (-6.77)	8.15±0.56 ^{b}(+3.16)
	Microwave cooking	7.55±0.88^{b} (-1.95)	0.33±0.12^{c} (-43.10)	3.04±0.11 ^{a}(+18.75)	10.56±2.04^{a} (+8.41)	8.45±0.32^{a} (+6.96)
Range of Loss/Increase in %	Boiled	Loss (1.99-8.97)	Loss (1.52-40.70)	Increase (2.94-12.62)	Loss (2.20-11.55)	Increase (1.24-8.52)
Range of Loss/Increase in %	Microwave cooking	Loss (0.69-5.90)	Loss (3.95-67.90)	Increase (3.97-27.18)	Increase (1.26-10.45)	Increase (6.33-16.66)

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±standard error of the mean (SEM). Statistical analysis was carried out by Tukeys test at 95% confidence level and statistical significance was accepted at the p<0.05 level. The superscript letter a, b and c denotes the significant differences within raw and different cooking method of an individual plant. The negative value within bracket indicates a percentage decrease and the positive value within bracket indicates the percentage increase of the test parameters.

Content was discovered most noteworthy in the raw leaves of *S. arvensis* (9.60±0.33 %) and most minimal in the uncooked fruits *V. foetidum* (2.20±0.17%). Fiery debris contains inorganic material of the plant, which incorporates oxides and salts containing anions, for example, phosphates, sulfates, chlorides and different halides and cations, for example, sodium, potassium, calcium, magnesium, iron, and manganese [21]. The fiery debris substance shows the measure of minerals in the nourishment and the cinder substance of these wild vegetables confirms the outcomes announced for some regularly utilized edibles of Bangladesh, Arunachal Pradesh and Meghalaya of India [22-24] and higher than the generally devoured verdant vegetables of Bodo tribe in Assam, India [25]. This variety might be because of environmental factors or age of the plant tests under examination. The most astounding measure of fat (15.16±0.05%) was evaluated in the seeds of *P. ocymoides* while least was found in *P. lineata* (0.58±0.01%). The fat substance of the

plants under examination like various investigations made on palatable wild plants of Bangladesh and India [22-24]. Fats likewise give fundamental unsaturated fats like linoleic and linolenic acid, which must be gotten from sustenance. They are significant for controlling aggravation, blood thickening, and mental health. The ingestion of lipid dissolvable vitamin like vitamin A and carotene in the body is likewise improved by the nearness of fat [21]. Cooking treatments essentially diminished the fiery remains and fat substance. The misfortunes of fiery remains content in the wild plants by boiling method (1.99-8.97%) were more ($p<0.05$) than microwave warming (0.69-5.90%, $P>0.05$) and these declines may be because of their dissemination in boiling water [26]. There were critical abatements (3.95-67.90%, $P<0.05$) in the fat substance in the microwaved consumable plants. The diminishing in fat may be because of an expansion in lipase movement, the denaturation of fat portion and breakdown of the lipids into glycerol and unsaturated fats during microwave cooking treatment [26]. There was additionally consumption of fat substance in the boiled samples (1.52-40.70%) yet not exactly the microwaved treatment eatable plants. The boiling technique held a greater amount of fat than microwaving, which maybe because of the very high temperatures in the microwaving treatment than the boiling temperature. Subsequently, more fats were denatured during the microwaving treatment when contrasted with bubbling [26].

The crude *S. arvensis* had the most noteworthy fiber content (6.30±0.45%) among the wild edibles under examination and least was assessed in the raw fruits of *V. foetidum* (1.04±0.05%). Sustenance filaments are beneficial in expanding dietary mass because of their capacity to ingest water in this way facilitating the intestinal travel [27]. The RDA of dietary fiber for grown-up guys and females is 38 and 25 g/day, separately [28]. Strands can bring down the danger of coronary illness, serum cholesterol, hypertension, diabetes, and bosom and colon malignant growth [29-30]. In this way, the substance of fiber in the wild vegetables utilized in our examination can support their utilization in the human eating regimen to satisfy the fiber RDA.

The protein content in the crude wild edibles ran from 5.45 to 28.06 % and the worth got in this investigation was practically like the estimations of some underutilized green verdant vegetables detailed by [31]. Sustenances which give more than 12 % of their calorific incentive from proteins have been demonstrated to be great wellspring of proteins [32]. Consequently, these plants whenever included as a piece of eating routine can assume a critical job in giving shabby and effectively accessible proteins for country networks.

The carbohydrate content in the crude plants extended from 5.70 to 8.84%. The carbohydrate substance of some verdant green vegetables of Sonitpur locale of Assam, India announced by Saha *et al.*, 2015 [33] ranged from 5 to 11% and carbohydrate content from wild edibles devoured by Bodo tribe of Assam, India, likewise demonstrated comparable carbohydrate content ran between 4 to 12% [25], which are near the qualities gotten in this examination. The crude fiber content in consumable plants was fundamentally ($P<0.05$) expanded by cooking treatments. This expansion could have been because of protein–fiber edifices [34] shaped after conceivable synthetic adjustment prompted by the dousing and cooking of palatable plants. The aftereffect of the present examination uncovered that the expansion in fiber content after microwaving (3.97-27.18%) were relatively more than boiled cooking (2.94-12.62%). The present examination showed the critical increment (1.26-10.45 %, $P<0.05$) in protein substance of the palatable wild plants after microwave treatment yet there were an immaterial reduction (2.20-11.55%, $P>0.05$) in the boiled test. The abatement in the boiled plant test may be because of solubilization and filtering out of the nitrogenous substances during the boiling treatment. The expansion in rough protein with microwaving maybe because of increment in protein accessibility because of catalyst hydrolysis of insoluble protein. A comparative pattern was seen in concentrates done by Bliss [35], who announced that the expansion in protein could be an aftereffect of enzymatic hydrolysis, which may cause the appearance of free amino acids [26]. There was a noteworthy increment ($P<0.05$) in carbohydrate content with all the cooking strategies. The microwaved edibles had a higher yield in starches (6.33-16.66%) trailed by boiling (1.24-8.52%). The expansion in sugar content with cooking maybe because of the decimation of cell dividers of plants that causes an expansion in the dissolvability of starches in water. A little increment of sugars in boiled test maybe because of the way that when the cell dividers are crushed, the starches may have filtered into the boiling water before the extraction for examination [26].

Minerals content

The minerals substance of crude and cooked plants are displayed in table 2. The sodium (Na) concentration in the plants under scrutiny went between 22.33±1.85 to 54.66±2.33 mg/100 g of an eatable bit of uncooked plants. The sodium levels of some developed vegetables and natural products shift between 3.0-124.9 mg/100g [21]. The potassium (K) content in the crude plants ran between 162.33±1.66 to1252.00±15.27 mg/100g. Na and K keep up the ionic equalization of the human body and keep up tissue edginess. Na assumes a significant job in the vehicle of metabolites and K is significant for its diuretic nature. The proportion of K/Na in any nourishment is a significant factor related with hypertension and arteriosclerosis. Na improves and K discourages blood pressure [36]. The Ca levels in the crude plants shifted inside 44.66±1.66 to 454.66±4.33 mg/100g while that in of some developed vegetables (lettuce, cabbage and spinach) fluctuates between 39 to 73 mg/100 g [21]. The outcomes from this examination were practically like the wild verdant vegetables devoured in Bangladesh [22]. The outcome demonstrates that these wild plants could give a decent wellspring of Ca to our eating routine. It is likewise significant for blood coagulation and the ordinary working of the heart muscles [37]. The iron (Fe) substance of these plants extended between 0.234 to 68.55 mg/100g, which contrasted positively with the greater part of the qualities revealed from 21.30 mg/100 g to 33.40 mg/100 g for some regularly and uncontrollably devoured verdant vegetables [38], and 24.00 to 139.6 mg/100g for wild verdant vegetables of Meghalaya, India [23]. Iron is basic in oxygen authoritative to hemoglobin and furthermore goes about as an impetus for some chemicals like cytochrome oxydase [39]. Along these lines, the chose plants of this examination could be prescribed in eating regimens for lessening iron deficiency. Magnesium (Mg) averts muscle degeneration, development impediment, cardiomyopathy, immunologic brokenness, weakened spermatogenesis and draining issue [40]. The most elevated measure of Mg was recognized in uncooked *S. arvensis* (20.02±0.009 mg/100 gm) though most reduced was assessed in *S. kurzii* (10.72±0.02 mg/100 gm). Manganese (Mn) goes about as the cofactor for the catalysts like arginase and glycosyltransferase. There are different chemicals like phosphoenolpyruvate carboxykinase and glutamine synthetase, which are actuated by Mn particles. Mn is additionally fundamental for hemoglobin development [41]. The Mn focus in the uncooked plants ran between 0.20 to 5.45 mg/100g. Zinc (Zn) has a job in balancing out macromolecular structure and amalgamation. The job of Zn in the DNA and RNA union is all around archived and both DNA and RNA polymerases are zinc-subordinate chemicals. Zn fixation went between 0.64 to 8.84 mg/100g, which is like the levels detailed in some wild and verdant vegetables in India [42], Bangladesh [22] and Nigeria [38]. Copper (Cu) goes about as a significant piece of copper protein. Cytochrome C oxidase, lysyl oxidase and tyrosine oxidase are the significant Cu containing metalloenzymes.

The Cu substance found in the uncooked plants under investigation went between 0.079 to 0.146 mg/100 gm. So every one of these plants under investigation contributes significantly in improving the eating regimen regarding mineral necessity. The boiling medications of the palatable plants caused the scope of misfortunes of minerals viz. Na (1.12-4.89), K (4.41-33.55), Ca (3.07-33.88), Cu (0.0005-0.044), Mg (0.27-3.75), Zn (0.03-0.72), Fe (0.015-7.27) and Mn (0.02-1.23 mg/100 gm) while, the reductions of minerals in the microwaved plants were relatively immaterial. The minerals drained from the palatable plants into the distillated water at various rates during cooking medications. Be that as it may, microwave cooking brought about the more noteworthy maintenance of all minerals than by boiling treatment.

Table 2: Minerals content of wild edible plants and the effect of cooking

		Minerals content (mg/100 gm of Edible portion)							
		Na	**K**	**Ca**	**Cu**	**Mg**	**Zn**	**Fe**	**Mn**
Z. acanthopodium	Raw	35.66±1.76[a]	664.0±10.00[a]	283.66±3.33[a]	0.119±0.003[a]	11.84±0.02[a]	8.84±0.019[a]	12.12±0.05[a]	5.45±0.16[a]
	Boiled	31.27±1.09[c] (-12.31)	630.45±9.56 [c] (-5.05)	261.48±4.33[c] (-7.82)	0.110±0.002[c](-7.56)	10.61±0.18[c] (-10.38)	8.24±0.72[c] (-6.78)	10.99±0.36[c] (-9.32)	4.95±0.09[c] (-9.17)
	Microwave cooking	33.45±1.18[b] (-6.19)	655.32±2.34[b] (-1.30)	272.34±2.12 [b](-3.99)	0.116±0.004[b] (-2.52)	10.92±0.34[b] (-7.77)	8.47±0.68 [b] (-4.18)	11.68±0.25 [b] (-3.63)	5.28±0.65[b](-3.12)
V. foetidum	Raw	27.00±1.52[a]	323.66±2.33[a]	153.67±2.66[a]	0.05±0.002[a]	12.53±0.02[a]	0.539±0.02[a]	0.49±0.003[a]	1.51±0.04[a]
	Boiled	25.30±1.18[b] (-6.29)	319.25±1.39[c](-1.36)	146.18±1.44[c] (-4.87)	0.043±0.003[b](-14.0)	11.51±0.11[b] (-8.14)	0.509±0.03[b] (-5.56)	0.44±0.001[c] (-10.20)	1.24±0.09[c](-17.88)
	Microwave cooking	26.35±1.03[a] (-2.40)	320.14±1.08[b] (-1.08)	151.25±1.89 [b](-1.57)	0.048±0.002[a] (-4.0)	12.20±0.48[a] (-2.63)	0.52±0.06 [a](-3.52)	0.47±0.007[b] (-4.08)	1.43±0.34[b] (-5.29)
H. cordata	Raw	26.00±1.15[a]	963.00±15.27[a]	166.33±1.33[a]	0.084±0.002[a]	10.02±0.09[a]	1.02±0.009[a]	9.97±0.019[a]	0.82±0.012[a]
	Boiled	23.11±0.85[c] (-11.11)	941.71±9.88[c] (-2.21)	157.76±1.28 [c] (-5.15)	0.077±0.003[b] (-8.33)	9.42±0.09[c] (-5.98)	0.99±0.002[b] (-2.94)	9.79±0.09 [b](-1.80)	0.76±0.006[b] (-7.31)
	Microwave cooking	25.32±0.09[b] (-2.61)	958.25±2.56 [b] (-0.49)	161.55±1.02 [b] (-2.87)	0.081±0.004[a] (-3.57)	9.85±0.06[b] (-1.69)	1.00±0.005 [ab](-1.96)	9.82±0.07[b] (1.50)	0.79±0.003[a] [b] (-3.65)
S. arvensis	Raw	54.66±2.33[a]	1252.00±15.27[a]	454.66±4.33[a]	0.149±0.004[a]	20.02±0.009[a]	2.02±0.009[a]	6.61±0.09[a]	0.254±0.02[a]
	Boiled	51.36±1.11[c] (-6.03)	1198.00±10.82[c] (-4.31)	401.28±0.99[c] (-11.69)	0.138±0.003[b] (-7.38)	19.51±0.08[c] (-2.54)	1.88±0.18[b] (-6.93)	5.62±0.08[c](-14.97)	0.219±0.001[a] (-13.77)
	Microwave cooking	53.45±1.08[b] (-2.21)	1230.24±4.35 [b](-1.73)	446.36±1.65 [b] (-1.82)	0.143±0.006[b] (-4.02)	19.86±0.35[b] (-0.79)	1.96±0.45[a] (-2.97)	6.44±0.36[b] (-2.57)	0.24±0.006[a] (-5.51)
O. linearis	Raw	34.00±1.52[a]	840.66±3.33[a]	234.33±2.66[a]	0.146±0.002[a]	14.24±0.02[a]	4.25±0.017[a]	29.73±0.26[a]	3.54±0.026[a]
	Boiled	31.35±1.19[c] (-7.79)	828.24±2.01[c] (-1.47)	219.30±1.24[c] (-6.41)	0.121±0.003[c](-17.12)	12.49±0.06[c] (-12.28)	3.98±0.03[b] (-6.35)	27.62±0.81[c] (-7.09)	3.11±0.04 [c](-12.14)
	Microwave cooking	33.12±1.44[b] (-2.58)	835.56±1.33[b] (-0.61)	228.22±1.08 [b] (-2.60)	0.138±0.004[b] (-5.47)	13.21±0.08 [b](-7.23)	4.02±0.03[b] (-5.41)	28.78±0.65[b] (-3.19)	3.43±0.08[b] (-3.10)
P. ocymoides	Raw	24.66±1.85[a]	162.33±1.66[a]	44.66±1.66[a]	0.11±0.004[a]	12.52±0.002[a]	2.52±0.02[a]	0.55±0.0005[a]	0.27±0.02[a]
	Boiled	23.54±1.17[c] (-4.54)	156.36±1.21[b] (-3.67)	41.59±0.39[c] (-6.87)	0.10±0.002[a] (-9.09)	11.63±0.06 [c](-7.11)	2.19±0.09[c](-13.09)	0.49±0.0001[b] (-10.90)	0.24±0.04[a] (-11.11)
	Microwave cooking	24.08±1.54[b] (-2.35)	160.24±1.09[c](-1.28)	43.58±1.44[b] (-2.41)	0.105±0.007[a] (4.54)	12.20±0.44[b] (-2.55)	2.40±0.03[b](-4.76)	0.51±0.0003 [ab](-7.27)	0.25±0.03[a](-7.40)
C. colebrookeanum	Raw	24.00±2.08[a]	500.00±2.00[a]	383.66±2.66[a]	0.17±0.004[a]	11.87±0.017[a]	1.87±0.017[a]	16.01±0.01[a]	3.98±1.01[a]
	Boiled	21.85±1.22[c] (-8.95)	491.25±1.24[c](-17.50)	371.08±1.04[c] (-3.28)	0.15±0.002[a] (-11.76)	10.51±0.09[c] (-11.45)	1.65±0.22[c] (-11.76)	15.42±0.03[b] (-3.68)	3.67±0.09[c] (-7.78)
	Microwave cooking	23.55±1.55[b] (-1.87)	495.34±1.55 [b](-0.932)	379.22±1.28 [b] (-1.15)	0.16±0.001[a] (-5.88)	11.55±0.12[b] (-2.69)	1.73±0.44[b](-7.48)	15.89±0.17[a] (-0.75)	3.78±0.12[b] (-5.02)
S. gilo	Raw	25.33±1.45[a]	1078.66±1.33[a]	160.00±1.00[a]	0.158±0.004[a]	12.46±0.008[a]	2.46±0.008[a]	68.55±0.03[a]	1.24±0.02[a]
	Boiled	21.02±1.35[c] (-17.01)	1049.11±1.18 [c] (-2.73)	152.12±1.66[c] (-4.92)	0.134±0.001[b] (-15.18)	11.34±0.03[c] (-8.98)	2.21±0.08 [c](-10.16)	61.28±0.19[c] (-10.60)	1.11±0.07[b] (-10.48)
	Microwave cooking	24.35±1.78[b] (-3.86)	1065.33±1.56 [b](-1.23)	158.45±1.80 [b](-0.97)	0.145±0.006 [b](-8.22)	12.28±0.08[b] (-1.28)	2.34±0.09[b](-4.87)	67.65±0.22[b] (-1.31)	1.19±0.08[ab] (-4.03)
S. kurzii	Raw	38.33±1.45[a]	737.66±2.33[a]	134.66±1.66[a]	0.084±0.003[a]	10.72±0.02[a]	0.72±0.002[a]	0.234±0.015[a]	0.20±0.007[a]
	Boiled	33.52±0.18[c] (-12.54)	721.44±0.55[c] (-2.19)	126.22±1.38[c] (-6.26)	0.077±0.002[b] (-8.33)	10.45±0.03[c] (-2.51)	0.66±0.001[b] (-8.33)	0.219±0.001[b] (-6.41)	0.18±0.003[a] (-10.0)
	Microwave cooking	37.22±0.55[b] (-2.89)	730.67±0.38[b] (-0.95)	131.44±1.52 [b] (-1.64)	0.082±0.003[a] (-2.38)	10.58±0.12[b] (-1.30)	0.69±0.004[a] (-4.16)	0.228±0.004[ab] (-2.56)	0.19±0.005[a] (-4.55)
P. lineata	Raw	22.33±1.85[a]	326.66±4.66[a]	217.00±1.00[a]	0.079±0.003[a]	11.63±0.016[a]	0.64±0.02[a]	6.54±0.014[a]	0.86±0.02[a]
	Boiled	20.88±1.02[c] (-6.49)	314.45±2.24[c] (-3.73)	209.15±1.11[c] (-3.61)	0.068±0.0003 [b] (-13.92)	10.51±0.01[c] (-9.63)	0.59±0.03[b] (-7.81)	5.81±0.002[c] (-11.16)	0.82±0.001[b] (-4.65)
	Microwave cooking	21.04±1.18 [b](-5.77)	324.34±0.98[b] (-0.71)	214.56±1.09 [b] (-1.12)	0.078±0.0001 [a](-1.26)	11.34±0.08[b] (-2.49)	0.61±0.07[b] (-4.68)	6.18±0.004[b] (-5.50)	0.83±0.009[b] (-3.48)
Range of Loss in mg/100 gm	Boiled	4.54-17.01	1.36-17.50	3.28-11.69	7.56-17.12	2.51-12.28	2.94-13.09	1.80-14.97	4.65-17.88
Range of Loss in mg/100 gm	Microwave cooking	1.87-6.19	0.49-1.73	0.97-3.99	1.26-8.22	0.79-7.77	1.96-7.48	0.75-7.27	3.12-7.40

Each value in the table was obtained by calculating the average of three experiments and data are presented as Mean ± Standard error of the mean (SEM).

Statistical analysis were carried out by Tukeys test at 95% confidence level and statistical significance were accepted at the $p < 0.05$ level. The superscript letter a,b and c denotes the significant differences within raw and different cooking method of individual plant. The negative value within bracket indicates percentage decrease and positive value within bracket indicates the percentage increase of the test parameters.

Antinutritional composition

The consequences of the antinutrient organization of both crude and cooked consumable plants were introduced in table 3. The outcome indicated a critical decrease in the counter supplement substance in the wild eatable plants subsequent to boiling and microwave treatment. Oxalate is an enemy of supplement and found in nature in certain plants as a solvent and insoluble salts

and as oxalic acid. It ties with supplements in the gastrointestinal tract, rendering them disconnected to the body [443]. The utilization of consumable plants with higher measures of oxalic acid may prompt the healthful inadequacies. The convergences of oxalate in the crude palatable plants go from 0.086% in *S. kurzii* to 0.559% in *V. foetidum*. The boiling treatment caused the decrease of 0.12-3.37% oxalate content in the palatable plants and critical decline (0.37-5.09%, P<0.05) was accomplished when the crude plants were microwave cooked. The most noteworthy misfortune (5.09%) of oxalate was seen in microwaved *V. foetidum* pursued by *C. colebrookeanum* (3.54%). The boiling and microwave cooking of eatable plants with water influenced their oxalate substance principally because of loss of dissolvable oxalate in cooking water and subsequently improving the nourishing nature of edible plants. Phytic acid (myoinositol, 1, 2, 3, 4, 5, 6 hexakis-dihydrogen phosphate) and phytates are chiefly found in vegetables and furthermore present in vegetables in low focus. It ties with minerals, for example, iron, zinc, calcium and magnesium and structure insoluble complex. It additionally structures edifices with proteins and starch [44].

Table 3: The antinutritional properties of wild edible plants and effect of cooking

		Oxalate (%)	Phytate (%)	Saponin (%)	Tannin (%)	Cyanogenic glycoside %)
Z. acanthopodium	Raw	0.274±0.05^{a}	0.31±0.07^{a}	0.018±0.003^{a}	0.411±0.04^{a}	0.0047±0.0001^{a}
	Boiled	0.11±0.01^{b}(-59.87)	0.13±0.09^{b}(-58.06)	0.0054±0.0006^{b} (-70.00)	0.140±0.09^{b}(-65.85)	0.0034±0.0006^{b} (-27.65)
	Microwave cooking	0.087±0.04^{c} (-68.38)	0.11±0.09^{b} (-64.51)	0.0041±0.0003^{c} (-77.22)	0.080±0.004^{c} (80.48)	0.0012±0.0005^{c} (-74.46)
V. foetidum	Raw	0.559±0.08^{a}	0.43±0.02^{a}	0.062±0.008^{a}	0.300±0.01^{a}	0.0059±0.0007^{a}
	Boiled	0.278±0.06^{b} (-50.22)	0.38±0.07^{b}(-11.62)	0.043±0.0012^{b} (-30.80)	0.140±0.03^{b} (-53.33)	0.0041±0.0005^{b} (-30.50)
	Microwave cooking	0.135±0.07^{c}(-75.86)	0.21±0.06 ^{c}(-51.16)	0.0124±0.0016^{c} (-80.00)	0.085±0.007^{c} (-71.66)	0.0023±0.0003^{c} (-61.01)
H. cordata	Raw	0.145±0.09^{a}	0.41±0.05^{a}	0.055±0.0022^{a}	0.440±0.03^{a}	0.0091±0.0001^{a}
	Boiled	0.091±0.02^{b} (-37.35)	0.34±0.02^{b} (-17.07)	0.0325±0.008^{b} (-40.90)	0.275±0.07^{b} (-37.5)	0.0043±0.0009^{b}(-52.74)
	Microwave cooking	0.061±0.01^{c} (-58.04)	0.26±0.01^{c}(-36.58)	0.0124±0.006^{c} (-77.45)	0.180±0.04^{c} (-59.09)	0.0037±0.0001^{c} (-59.34)
S. arvensis	Raw	0.173±0.05^{a}	0.35±0.04^{a}	0.035±0.0068^{a}	0.389±0.06^{a}	0.0057±0.0002^{a}
	Boiled	0.155±0.08^{b} (-10.14)	0.28±0.03^{b} (-20.00)	0.0281±0.005^{b}(-19.71)	0.271±0.04^{b} (-30.14)	0.0044±0.0005^{b} (-22.80)
	Microwave cooking	0.062±0.01^{c} (-63.76)	0.11±0.07^{c}(-68.57)	0.0196±0.003^{c}(-44.00)	0.172±0.05^{c} (-55.88)	0.0019±0.0002^{c} (-66.66)
O. linearis	Raw	0.239±0.04^{a}	0.48±0.06^{a}	0.077±0.009^{a}	0.221±0.03^{a}	0.0062±0.0005^{a}
	Boiled	0.148±0.09^{b} (-37.97)	0.40±0.05^{b} (-16.66)	0.0548±0.006^{b} (-28.83)	0.164±0.09^{b} (-25.77)	0.0048±0.0003^{b} (-22.58)
	Microwave cooking	0.067±0.02^{c} (-71.77)	0.29±0.03^{c} (-39.58)	0.0344±0.008^{c} (-55.32)	0.099±0.007^{c}(-55.15)	0.0021±0.0002^{c} (-66.12)
P. ocymoides	Raw	0.10±0.04^{a}	0.26±0.08^{a}	0.042±0.007^{a}	0.043±0.02^{a}	0.0072±0.0002^{a}
	Boiled	0.09±0.004^{ab}(-10.00)	0.19±0.03^{b} (-26.92)	0.0292±0.008^{b} (-30.47)	0.031±0.002^{b} (-27.27)	0.0057±0.0007^{b} (-20.83)
	Microwave cooking	0.046±0.06^{b} (-53.33)	0.11±0.07^{c}(-57.69)	0.0125±0.007^{c} (-70.23)	0.018±0.004^{c} (-59.09)	0.0039±0.0003^{c}(45.83)
C. colebrookeanum	Raw	0.399±0.08^{a}	0.37±0.09^{a}	0.025±0.003^{a}	0.215±0.007^{a}	0.0076±0.0005^{a}
	Boiled	0.194±0.06^{b} (-51.35)	0.26±0.03^{b} (-29.72)	0.0178±0.008^{b} (-28.80)	0.108±0.02^{b}(-50.00)	0.0058±0.0003^{b} (-23.68)
	Microwave cooking	0.104±0.05^{c} (-73.90)	0.12±0.06^{c} (-67.56)	0.0095±0.0004^{c} (-62.00)	0.086±0.006^{c}(-60.00)	0.0027±0.0005^{c} (-64.47)
S. gilo	Raw	0.103±0.02^{a}	0.24±0.02^{a}	0.056±0.003^{a}	0.357±0.02^{a}	0.0086±0.0005^{a}
	Boiled	0.085±0.009^{b} (-17.07)	0.18±0.003^{b} (-25.00)	0.0335±0.007^{b} (-40.17)	0.308±0.04^{a}(-13.63)	0.0071±0.0002^{b} (-17.44)
	Microwave cooking	0.072±0.014^{c}(-30.08)	0.08±0.002^{c} (-66.66)	0.0155±0.002^{c} (-72.32)	0.162±0.06^{b} (-54.54)	0.0034±0.0001^{c} (-60.46)
S. kurzii	Raw	0.086±0.002^{a}	0.31±0.05^{a}	0.097±0.004^{a}	1.61±0.016^{a}	0.0054±0.0003^{a}
	Boiled	0.070±0.009^{b} (-18.26)	0.22±0.03^{b} (-29.03)	0.0681±0.001^{b} (-29.79)	1.02±0.07^{b} (-37.14)	0.0048±0.0004^{b}(-11.11)
	Microwave cooking	0.053±0.004^{c} (-37.50)	0.11±0.07^{c} (-64.51)	0.0262±0.002^{c} (-72.98)	0.736±0.09^{c}(-54.28)	0.0023±0.0001^{a} (-57.40)
P. lineata	Raw	0.258±0.04^{a}	0.31±0.09^{a}	0.046±0.005^{a}	0.172±0.016^{a}	0.0081±0.0007^{a}
	Boiled	0.204±0.02^{b} (-20.71)	0.19±0.08^{b} (-38.70)	0.0205±0.006^{b} (-55.43)	0.115±0.03^{b} (-33.12)	0.0044±0.0002^{b} (-45.67)
	Microwave cooking	0.145±0.07^{c} (-43.68)	0.11±0.07^{c} (-64.51)	0.0111±0.008^{c} (-75.86)	0.061±0.04^{c} (-64.37)	0.0017±0.0001^{c}(-79.01)
Range of loss (%)	Boiling	10.00-59.87	11.62-58.06	19.71-70.00	13.63-65.85	11.11-52.74
Range of loss (%)	Microwave cooking	30.08-75.86	36.58-68.57	44.00-80.00	54.28-80.48	45.83-79.01

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±Standard error of the mean (SEM).

Statistical analysis were carried out by Tukeys test at 95% confidence level and statistical significance were accepted at the p<0.05 level. The superscript letter a,b and c denotes the significant differences within raw and different cooking methods of individual plant. The negative value within the bracket indicates percentage decrease and the positive value within bracket indicates the percentage increase of the test parameters.

[4Phytic acid substance in wild consumable plants ran from 0.24±0.02% in *S. gilo* to 0.48±0.06% in *O. linearis*. The impacts of various cooking medications on phytic acid substance of consumable plants are appeared in table 3. The boiling treatments demonstrated the decline in phytate content (0.05 to 0.18%) though increasingly huge misfortune (0.15 to 0.25%, P<0.05) was seen in the microwave plants. The obvious reduction in the substance of phytic acid of palatable plants during boiling might be incompletely because of filtering of phytic acid into the cooking water. Phytic acid is moderately heat-labile subsequently, more decrease might be because of microwave cooking [45]. 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 likewise in charge of harming red platelets, repressing compounds and meddling with thyroid capacity [45]. The amount of saponin in the plants vary in extent with the species. The most astounding measure of saponin was seen in *S. kurzii* (0.097±0.004%) while the leaves of *Z. acanthopodium* had the most reduced fixation (0.018±0.003%). The boiling treatment demonstrated the consumption of 0.65-2.89% saponin content in the eatable plants and the microwaved cooking displayed more lessening (1.39-7.08%). Tannin is a significant antinutritional calculate that exists the vast majority of the vegetables. It is portrayed because of their harsh polyphenolic exacerbates that dilemma or structure hasten with proteins and different other natural mixes, for example, alkaloids and amino acids. These tannins generally present in sustenance items which repress the enzymatic movement of amylase, lipase, trypsin and chymotrypsin. Consequently, decline the nature of protein and meddle with iron retention [43]. The most elevated centralization of tannin was identified in the fruits of *S. kurjii* (1.61±0.016%) and most reduced sum was seen in *P. ocymoides* (0.043±0.02%). Cooking treatment caused the most noteworthy decrease of tannin content (1.57%) in microwaved *O. linearis* though least exhaustion was found in boiled *C. colebrookeanum* (0.02%). Since the phenolic mixes are water solvent in nature, the misfortune might be because of filtering out in the cooking medium [42]. Cyanogenic glycosides are auxiliary metabolites that are found in different plant tissues and produce HCN upon hydrolysis. They are generally appropriated 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, expulsion of cyanogenic glycosides is important to improve the dietary benefit and wellbeing of cyanogen-containing foods [46]. This investigation uncovered that the cyanide substance of the crude vegetables go-between 0.0091±0.0001% in *H. cordata* and 0.0047±0.0001% in *Z. acanthopodium*. Boiling method affected the decrease of cyanide content in the range 11.11-52.74% and the microwave cooking demonstrated the critical abatement of cyanide levels from 45.83% to 79.01% in the wild vegetables.

Table 4: Toxicity studies of wild edible plants and effect of cooking

Name of the plant	Concentration of the extract (µg/ml)	RBC cell viability (%)			Hepatocytes cell viability (%)			Genotoxicity % tail DNA		
		Raw	Boiled	Microwave cooking	Raw	Boiled	Microwave cooking	Raw	Boiled	Microwave cooking
Z. acanthopodium	100	98.47±2.01	99.78±1.52	99.94±1.68	91.38±3.01	92.87±2.11	96.25±1.88	3.28±0.74	2.79±0.38	2.08±0.56
	300	95.03±1.82	98.07±1.88	99.08±2.01	90.45±1.56	92.29±3.26	96.18±1.06	3.61±0.48	3.11±0.32	2.98±0.76
	500	90.11±1.25	96.34±1.24	98.21±1.99	90.56±1.78	92.02±3.28	95.28±2.15	3.92±0.81	3.25±0.56	3.06±0.49
V. foetidum	100	98.47±1.08	93.25±1.19	97.32±2.55	93.83±1.86	94.28±1.98	96.19±2.78	3.36±0.98	2.99±0.76	2.52±0.42
	300	95.85±1.11	88.49±1.82	93.55±2.02	92.60±1.08	93.55±2.54	95.38±1.95	3.82±0.15	3.11±0.61	2.68±0.34
	500	90.42±1.87	93.56±1.34	97.34±3.11	91.22±1.12	93.28±1.05	94.19±0.94	4.01±0.55	3.76±0.69	3.02±0.49
H. cordata	100	96.70±2.11	98.25±2.78	99.15±1.87	95.19±1.55	96.14±1.29	97.65±1.55	3.65±0.28	3.09±0.33	2.85±0.88
	300	92.36±2.56	95.41±1.67	97.43±1.92	94.23±2.11	95.55±1.88	96.28±1.92	3.92±0.35	3.56±0.38	3.11±0.10
	500	90.30±1.04	92.24±1.88	95.31±1.05	93.02±1.07	94.10±1.34	95.48±1.67	4.28±0.77	4.02±0.61	3.78±0.19
S. arvensis	100	98.19±1.77	99.10±1.89	99.78±1.28	96.0±1.77	98.29±1.28	99.06±1.02	4.01±0.52	3.76±0.68	3.18±0.44
	300	97.68±2.05	98.09±1.62	99.12±1.37	94.34±1.09	95.27±1.34	96.38±1.19	4.55±0.11	4.11±0.46	3.98±0.17
	500	92.68±1.28	93.68±1.41	95.33±1.08	94.06±1.11	95.31±1.67	96.09±1.65	4.96±0.28	4.38±0.39	4.02±0.26
O. linearis	100	96.90±2.34	97.12±1.55	98.33±2.76	95.12±2.33	96.05±2.11	97.19±1.90	4.16±0.66	3.85±0.18	3.48±0.88
	300	94.19±1.68	95.66±2.01	98.42±1.64	94.19±1.06	95.28±1.33	96.34±2.11	4.98±0.41	4.59±0.55	4.08±0.16
	500	92.27±1.89	94.34±2.18	97.22±2.11	93.76±1.68	94.88±1.88	95.10±2.08	6.18±0.35	5.96±0.68	5.48±0.35
P. ocymoides	100	93.20±2.08	94.11±1.88	97.34±1.29	94.33±1.96	95.01±2.18	96.11±1.35	4.38±0.77	3.96±0.59	3.37±0.66
	300	92.13±2.11	95.44±1.02	98.68±1.89	93.25±1.55	94.28±1.76	95.44±1.48	5.14±0.18	4.98±0.88	4.76±0.28
	500	89.36±1.95	91.23±1.57	97.36±1.76	92.44±1.09	93.08±1.59	95.66±1.69	6.27±0.55	5.95±0.31	5.78±0.19
C. colebrookeanum	100	95.10±2.10	96.12±1.55	98.34±1.76	94.48±1.55	95.28±2.11	96.11±2.88	3.97±0.56	3.63±0.17	3.11±0.24
	300	95.42±1.98	97.33±1.12	98.11±1.23	93.14±1.08	94.36±2.09	95.29±1.25	4.29±0.48	4.07±0.08	3.77±0.16
	500	91.63±1.04	93.78±1.68	95.12±1.11	92.46±1.01	93.65±2.03	95.01±1.92	5.18±0.33	5.01±0.26	3.98±0.32
S. gilo	100	92.88±1.28	93.12±1.78	96.56±1.77	92.95±1.99	93.55±1.28	94.68±1.88	4.34±0.33	3.93±0.56	3.55±0.33
	300	95.19±2.09	96.25±0.89	98.21±1.13	91.25±1.02	92.19±1.01	93.27±1.65	5.26±0.47	5.01±0.24	4.78±0.18
	500	92.08±1.58	94.48±1.36	98.34±1.08	90.68±1.15	91.59±1.72	92.68±1.02	6.54±0.38	6.02±0.19	5.79±0.25
S. kurzii	100	95.32±3.01	96.36±2.16	97.23±1.48	95.66±1.55	96.38±1.08	97.55±1.11	4.92±0.11	4.77±0.28	4.38±0.99
	300	92.10±1.44	94.75±2.09	97.68±1.97	94.21±1.64	95.11±0.98	96.28±1.73	5.65±0.78	5.19±0.34	4.96±0.53
	500	90.85±1.87	92.65±2.78	96.21±1.02	94.05±1.83	95.18±1.46	96.22±1.52	7.01±0.16	6.79±0.28	6.18±0.18
P. lineata	100	98.97±2.88	99.89±1.83	99.90±1.64	95.24±1.68	96.38±1.08	97.55±2.01	6.78±0.62	6.26±0.99	5.98±0.78
	300	97.11±1.49	98.14±1.14	99.25±1.88	94.21±1.36	95.19±1.72	96.28±1.84	6.94±0.44	6.38±0.18	6.02±0.26
	500	91.14±1.11	92.65±1.98	97.54±1.95	93.38±1.78	94.21±1.81	95.55±1.37	7.45±0.36	7.11±0.22	6.98±0.37
Negative control	0	100.18±2.08			99.72±1.56			1.79±1.81		
Positive control (H_2O_2)	50 µM	79.18±1.54			76.58±1.88			25.18±1.06		
	100 µM	66.35±1.06			63.20±1.28			55.46±1.44		
	200 µM	48.25±1.55			39.25±1.11			76.35±1.48		

Each value in the table was obtained by calculating the average of three experiments and data are presented as mean±Standard error of the mean (SEM).

Toxicity studies

The consequences of the poisonous quality investigations of both crude and cooked eatable plants including the feasibility of cells and level of DNA harm utilizing buffer (negative control) and hydrogen

peroxide (positive control) were exhibited in table 4. The outcome demonstrated the increments of RBC and hepatocytes cell suitability and lessening the level of tail DNA of at three different concentrations of the aq. concentrates of wild eatable plants subsequent to boiling and microwave treatment. Haemolytic examines were performed in light of the fact that plants demonstrated strong nutraceutical properties and these may not be devoured on the off chance that they have haemolytic impact. Likewise, these information additionally may uncover some data about the component of cytotoxicity.

Haemolytic toxicity studies

In vitro haemolytic exercises on rat erythrocyte of different focuses (100,300 and 500 µg/ml) extricates acquired from palatable pieces of wild plants under scrutiny were performed. The 51.75% haemolysis was gotten utilizing H_2O_2 (200µM) and 0% haemolysis was acquired with cushion. The haemolysis prompted by concentrates in red platelets was fixation subordinate however all concentrates demonstrated lower haemolytic impact on human red platelet on all focuses. The reasonability of the haemolytic cell was most extreme (92.68%) at a high portion of 500µg/ml if there should be an occurrence of crude *S. arvensis* and the base was seen in the aq. concentrate of crude *P. ocymoides* (89.36%) at same fixation. At a lower concentration (100µg/ml) the most elevated RBC cell feasibility was seen in uncooked *P. lineata* (98.97%) and least practicality was seen in uncooked *S. gilo* (92.08%). The examination demonstrated that both the cooking strategy builds the practicality of haemolytic cells and in this manner caused the decrease of poisonous quality of wild palatable plants everything being equal. The boiling technique demonstrated the most noteworthy suitability (96.34%) of RBC cells for *Z. acanthopodium* at most astounding portion and least suitability (91.23%) was seen in *P. ocymoides* in same concentration. The microwave cooking technique showed the reasonability of RBC cells in the range 95.12-98.21% at a most elevated focus (500µg/cc) of the wild palatable plants.

Cytotoxicity studies

Hepatocytes were confined from fresh goat liver and the impacts of different focuses (100,300 and 500 µg/ml) of aq. concentrates of consumable plants were seen on the practicality of hepatocytes cell. The feasibility of the hepatocytes cell was most extreme (94.06%) at a high portion of 500µg/ml if there should arise an occurrence of uncooked *S. arvensis* and the base was seen in the aq. concentrate of crude *Z. acanthopodium* (90.56%) at same fixation. At a lower concentration (100µg/ml) the crude *S. kurzii* demonstrated most astounding hepatocytes cell feasibility (95.66%) while the least reasonability (91.38%) was seen in uncooked *Z. acanthopodium*. The examination demonstrated that both the cooking strategy builds the reasonability of hepatocytes cells and consequently caused the consumption of lethality of wild palatable plants at all fixations. The boiling technique demonstrated the most astounding reasonability (95.31%) of hepatocytes for *S. arvensis* at most noteworthy portion and least suitability (91.59%) was seen in *S. gilo* at same focus. The microwave cooking strategy showed the practicality of hepatocytes cells in the range 92.68-96.22% at a most noteworthy fixation (500µg/ml) of the wild consumable plants.

Genotoxicity studies

The genotoxicity investigations of plants included the incubation of rat lymphocytes in a low-melting-point agarose suspension alongside plant concentrate of various fixation (100-500µg/ml), lysis of the cells in alkaline (pH>13) conditions, and the electrophoresis of the suspended lysed cells. This was trailed by a quick visual examination of the slides with staining under Fluorescence Microscope and ascertaining fluorescence to decide the degree of DNA harm. Olive Tail Moment (OTM) of individual stained nuclei was determined utilizing comet examine programming. Negative (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 demonstrated a more elevated amount of DNA harm and larger amount of genotoxicity of plant extract. The single cell gel electrophoresis test (comet examine) is a cheap, straight forward and fast strategy for estimating DNA strand breaks and because of its affectability permits examination at the individual cell level and the utilization of little examples [47]. The aftereffect of comet measure demonstrated that the aq. concentrate of crude *P. lineata* at a fixation 500 µg/ml had the most noteworthy rate (7.45%) of tail DNA though the least rate (3.92%) of tail DNA was found in uncooked *Z. acanthopodium* at same focus. The 1.79% of tail DNA was acquired utilizing negative control and positive control (blend of entire blood, RPMI 1640 and 200µM H_2O_2) indicated 76.35% of tail DNA. The arrangement of free radicals during natural digestion causes mutagenicity and genotoxicity. Because of oxidative pressure hydrogen peroxide displayed portion subordinate DNA harm (25.18-76.35% of tail DNA) which was recognized by the comet test. The aftereffect of examination uncovered that the degree of DNA harm brought about by the uncooked plant extricate at various focuses was particularly like the negative control. Natural compounds, particularly got from dietary sources give countless cell reinforcements. Ongoing examinations in people have demonstrated that supplementation with cell reinforcement mixes, for example, vitamin E and C, lycopene and ß-carotene can help diminish levels of free-radical harm apply a defensive impact against degenerative issue, for example, disease, by a reduction in DNA harm [48]. The microwave cooking strategy showed the DNA harm in the range 3.02-6.98% when the eatable plants were presented in the lymphocytes at most noteworthy fixation (500µg/ml) and the boiling technique caused minimal more harm of DNA (3.25-7.11%) at a similar focus. Plants have wide scope of pharmacologically viable phytochemicals. A considerable lot of them have been accounted for accommodating for the treatment of a few infections of person, however, couple of phytochemicals like saponin, tannin, cyanogenic glycosides and so on produce hurtful impacts after presentation and can go about as professional oxidants, include most likely in charge of the mutagenicity and genotoxicity [49]. So the examination demonstrated that both the cooking strategy diminishes the level of tail DNA and in this way caused the depletion of poisonous quality of palatable wild plants at all focuses.

CONCLUSION

The aftereffect of the investigation uncovered that the various types of palatable wild plants contain apparent amount of protein, starch, fat, minerals and antinutrients. Cooking and microwaving have inescapable outcomes on the dietary benefits of the edible plants. The boiling treatment caused the misfortunes of proteins yet microwaving improved the protein fixation. The microwave cooking caused slight misfortunes in minerals, while boiling caused noteworthy misfortunes. These vegetable species likewise contain abnormal state of hostile to wholesome components, as phytate, oxalate, tannin, cyanide and saponin, yet anyway boiling and microwaving decreased the counter supplement levels in plant sustenance source to safe level that can be devoured by person. Both cooking techniques additionally decreases the lethality of the plants and noteworthy consumptions were seen on microwaving. So it is very evident that cooking edible plants by microwave spares time as well as holds the most nutritive worth and guarantees higher quality nourishment for the upkeep of human wellbeing.

ACKNOWLEDGEMENT

The authors of this study are highly grateful to Dr. A. A. Mao, Director, Botanical Survey of India, Kolkata, for his encouragement and providing all facilities. We are also thankful to Mr. R. Shanpru, ex-Scientist, Botanical Survey of India, Eastern Regional Circle, Shillong, Meghalaya for identifying the plant specimens.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

We declare that we have no conflict of interest.

REFERENCES

1. Brahma J, Singh B, Rethy P, Gajurel P. Nutritional analysis of some selected wild edible species consumed by the Bodostribes of Kokrajhar district, BTC, Assam. Asian J Pharm Clin Res 2014;7:34-7.
2. Aberoumand A. Screening of less known two food plants for comparison of nutrient contents: Iranian and Indian vegetables. Funct Food Health Dis 2011;10:416-23.
3. Basu S, Das M, SEN A, Choudhury UR, Datta G. Analysis of the complete nutritional profile of *Amorphophallus campanulatus* tuber cultivated in Howrah district of West Bengal, India. Asian J Pharm Clin Res 2014;7:25-9.
4. Liener IE, Kkade ML. Protease inhibitor. In: Liener IE. (ed). Toxic constituents of plants foodstuffs. Academic Press. New York; 1980.
5. Larsgon M, Rossande Hulthen L, Sandstome B, Sandberg A. Improved iron and zinc absorption from breakfast meals containing malted oats with reduced phytate content. Br J Nutr 1996;76:677-88.
6. Reddy NR, Sathe SK, Pierson MD. Removal of phytate from great northern beans (*Phaseous vulgaris* L.) and its combined density fraction. J Food Sci 1988;53:107–10.
7. Hahn DH, Rooney LW, Earp CF. Tannins and phenols of sorghum. Cereal Food World 1984;29:776–9.
8. Plewa MJ, Wagner ED. Activation of promutagens by green plants. Annu Rev Genet 1993;27:93–113.
9. Kshirsagar PP, Bhogaonkar PY. *Nicandra physaloides* (L.) gaertn–a less known wild edible fruit. Int J Curr Pharm Res 2015;7:60-3.
10. Hefnawy TH. Effect of processing methods on nutritional composition and anti-nutritional factors in lentils (*Lens culinaris*). Ann Agric Sci 2011;2:57–61.
11. AOAC. Association of official analytical chemists, seventeenth. ed. Washington DC Arlington, Virginia, USA; 2000.
12. Hedge JE, Hofreiter BT. Determination of reducing sugars and carbohydrates. In: Whistler RL., Be Miller JN. Eds. Methods in Carbohydrate Chemistry. Academic Press, New York; 1962. p. 380-94.
13. Gawalko EJ, Nowicki TW, Babb J, Tkachuk R. 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.
14. Munro A, Bassir O. Oxalate in Nigerian vegetables. West Afr J Biol Appl Chem 1980;12:14-8.
15. Reddy MB, Love M. The impacts of food processing on the nutritional quality of vitamins and minerals. Adv Exp Med Biol 1999;459:99-106.
16. Hudson BJF, El-Difrawi EA. The sapogenins of the seeds of four lupin species. J Plant Foods 1979;3:181-6.
17. 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.
18. Gajjar DG, Patel RM, Patel VA, Patel PKM. Novel hydroxyl-terminated dendrimers as potential drug carriers: sustained release, hemolysis and cytotoxicity study. Int J Appl Pharm 2015;7:5-9.
19. Mosmann T. Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. J Immunol Methods 1983;65:55-63.
20. 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.
21. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian Foods. Printed by national institute of nutrition, Indian Council of Medical Research, Hyderabad-500 007, India; 2004. p. 2-58.
22. Satter MMA, Khan MMRL, 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.
23. Seal T, Chaudhuri K, Pillai B. Evaluation of proximate and mineral composition of wild edible leaves, traditionally used by the local people of Meghalaya state in India. Asian J Plant Sci 2013;12:171-5.
24. Seal T, Pillai B, Chaudhuri K. Evaluation of nutritional potential of five unexplored wild edible plants consumed by the tribal people of Arunachal Pradesh State in India. J Food Nutr Res 2017;5:1-5.
25. Narzary H, Swargiary A, Basumatary S. Proximate and vitamin C analysis of wild edible plants consumed by Bodos of Assam, India. J Mol Pathophysiol 2015;4:128-33.
26. Tsungai R, Munyanyi M, Mduluza T. Effect of cooking and preservation on the nutritional and phytochemical composition of the mushroom *Amanita zambiana*. Food Sci Nutr 2017;5:538-44.
27. Jenkin DJ, Jenkin AL, Wolever TMS, Rao AV, Thompson LU. Fibre and starchy foods: gut function and implication in disease. Am J Gastroenterol 1986;81:920-30.
28. Trumbo P, Schlicker S, Yates AA, Poos M. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids. J Am Diet Assoc 2002;102:1621-30.
29. Rehman NU, Hussain J, Ali L, Khan AL, Mabood F, Gillani SA, *et al*. Nutritional assessment and mineral composition of some selected edible vegetables. Euro J Med Plants 2014;4:444-57.
30. Vadivel V, Janardhanan K. Nutritional and anti-nutritional characteristics of seven South Indian wild legumes. Plant Food Hum Nutr 2005;60:69-75.
31. Gupta S, Lakshmi AJ, Manjunath MN, Prakash J. Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. LWT Food Sci Technol 2005;38:339-45.
32. Ali A. Proximate and mineral composition of the marchubeh (*Asparagus officinalis*). World J Dairy Food Sci 2009;4:142-9.
33. Saha J, Biswal AK, Deka SC. Chemical composition of some underutilized green leafy vegetables of Sonitpur district of Assam, India. Int Food Res J 2015;22:1466-73.
34. Bressani T. Grain quality of common beans. Food Rev Int 1993;9:237–97.
35. Bliss FA. Cowpeas in Nigeria: Nutritional improvement of food legumes Breeding, Milner M. ed. New York: John Wiley and Sons; 1975.
36. 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.
37. Sundriyal M, Sundriyal RC. Wild edible plants of the Sikkim Himalaya: nutritive values of selected species. Econ Bot 2004;58:286-99.
38. Mohammed MI, Sharif N. Mineral composition of some leafy vegetables consumed in Kano, Nigeria. Nig J Basic Appl Sci 2011;19:208-12.
39. Geissler CA, Powers HJ. Human nutrition, eleventh edition. Elsevier, Churchill Livingstone; 2005.
40. Chaturvedi VC, Shrivastava R, Upreti RK. Viral infections and trace elements: a complex trace element. Curr Sci 2004;87:1536-54.
41. 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.
42. Saikia P, Deka DC. Mineral content of some wild green leafy vegetables of North-East India. J Chem Pharm Res 2013;5:117-21.
43. Ilelaboye NOA, 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.
44. Yasir A, Ahmad A. Impact of processing on nutritional and antinutritional factors of legumes: a review. Ann Food Sci Technol 2018;19:199-215.
45. Sharma N, Goyal SK, Alam T, Fatma S, Chaoruangrit A, Niranjan K. Effect of high pressure soaking on water absorption, gelatinization, and biochemical properties of germinated and non-germinated foxtail milletgrains. J Cereal Sci 2018;83:162-70.
46. Fan Y, Guo DY, Song Q, Li T. Effect of total saponin of aralia taibaiensis on the proliferation of leukemia cells. Zhong Yao Cai 2013;36:604-7.

47. Fereidoon S, Wanasundara PKJPD. Cyanogenic glycosides of flaxseeds. Antinutrients and Phytochemicals in Food. Chapter 10; 1997. p. 171-85.
48. 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.
49. Kumari N, Deshwal RK. Antioxidants and their protective action against DNA Damage. Int J Pharm Pharm Sci 2011;3:28-32.
50. 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 Agric 2016;28:737-40.