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Comparative Nutrient Assessment of Raw Vegetable Crops with Microgreens: A Nutritionally Potential, Self Growing Fresh Food Supplement for Soldiers Deployed at High Altitude

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Abstract

Various studies have been done on the nutritional aspects of microgreens that is trending now days as fresh green salad in urban population. We have worked on the idea to make these microgreens more popular among soldiers posted at high altitude as self growing potential fresh food supplement. In this study we have explored. The nutrition capabilities of fast and easily growing microgreens of five crops at high altitude i.e. Fenugreek, cabbage, garden orche (atriplex), buckwheat, broccoli and their microgreens were selected for the comparative nutrient analysis with their mature part. Nutrient analysis results have shown that protein content and dietary fibre is significantly higher in mature part of these five crops except cabbage (high in cabbage microgreens). Mature cabbage, broccoli and fenugreek possessed significantly higher minerals contents except, Mg, total P, Na, Zn and Fe (significantly higher in fenugreek microgreens). The mean K content (4481.3±1.86 mg/kg) in mature broccoli was highest. The vitamin C and vitamin B3 are found higher in all the three microgreens than counterpart while beta carotene is found higher in cabbage and broccoli microgreens but comparatively less in fenugreek. Vitamin B9 was found significantly higher in cabbage microgreen, almost equal amount in microgreen broccoli and in mature fenugreek. In harsh climatic condition where fresh food availability throughout the year is a major challenge. Microgreens rich with mineral and vitamins can be good option as dietary supplement to the troops and for local residents especially when mature fresh vegetables are not available.

Keywords: Microgreens; High altitude; Vitamins; Counterpart; Harsh climate.

Introduction

According to the global nutrition report-2018, UNICEF, undernourishment is a world-wide issue and difficult to manage individually. According to a report one-third of reproductive-age women are anaemic, while 39% of the world's adults are overweight or obese and each year around 20 million babies are born underweight. Thus the need of fresh

food and nutrition is one of the basic needs for adequate health to overcome all forms of malnutrition. It requires focus on not only ensuring an adequate supply of food but also equally on quality of diets. (Patrick W. et al, 2018). According to the FAO report 2019, to speed up the improvement towards ending hunger and achieving good nutrition and food security, it is important to understand the connections between food insecurity and malnutrition. The countries that have greater levels of social inequality, economic slowdowns and downturns have a disproportionately negative effect on food and nutrition security. Though nutrition security and health are major concern of all population distributed geographically at different part of earth but scarcity of good quality fresh food availability and limited access to more healthy foods (e.g., fruits and vegetables, whole grains, meat) is a major concern for remote areas of world. The relationship between limited healthy food access and chronic disease has been well documented among urban populations and evidence among rural populations is more recently emerging (Bardenhagen et al, 2017). Geographical isolation of the habitat also includes high altitude regions, which beginsat 2,400 meters (8,000 ft) above sea level.

In India, high altitude cold arid regions like Ladakh (cold desert) and some areas in Himachal Pradesh, Uttrakhand, Sikkim and Arunachal Pradesh comprise of uneven land, barren mountains and have extremely harsh climatic conditions. These are the most difficult terrains in the world due to tough life with lack of resources. The local people at high altitudes are still heavily dependent on agriculture and livestock for their food security and livelihoods, The livelihoods and food security of mountain communities are limited due to cold arid agro-climatic conditions, less availability of fertile land, practical difficulties in farming system and low population density. Although specific agro-ecological and livelihood potentials vary considerably according to the region but the people depend largely on local available resources at all elevations, (Merrey, D.J. et. al., 2018)

Nutritious diet is a basic need in the region where it is a challenge to maintain the physical and mental efficacy especially for soldiers from low lands posted in these regions. A paucity of efforts has been expended to determine the effects of cold and altitude on vitamin and mineral requirements even though these elements are absolutely essential in converting the food consumed into the energy that is required for various body functions in these extreme conditions. In context to nutrition, not many efforts have been made to determine energy intake and to determine the preferred mix of energy derived from carbohydrate, fat, and protein. Unfortunately, these micronutrients are no less important than oxygen. It just takes longer to become a nutrient deficient than oxygen.

In such harsh conditions preventing hypothermia is crucial especially to those soldiers who work or spend recreation time in severe cold environments. Thus adequate energy from the correct proportion of carbohydrates, fats and proteins can help. Vitamins and minerals are also necessary to prevent nutrition deficiencies and impaired function, but there is no evidence to suggest an increased requirement for them is attributable to cold exposure alone. High protein diets appear to be the worst choice for cold weather work; compared with diets high in carbohydrates or fats, high protein diets increase metabolic water requirements and reduce cold tolerance. (Askew EW, Hecker AL, 1989)

However, a newly emerging form of fresh food, loaded with extra nutrition without any bio-fortification and genomic changes and has the potential to be produced independently of the climatic conditions is microgreens. Microgreens have been a staple of the culinary world for the last decade, showing up to add dazzling colour and a punch of bright flavour to salads. Microgreens are harvested just before the seedlings begin to grow their first set of true leaves, which follow the original cotyledon (seed) leaves. A single serving of these greens will provide significantly more vitamins and plenty of minerals than an equivalent serving of same vegetable in the mature edible form.The potential nutritional benefits of microgreens combined with their ease of cultivation, has increased consumer interest in cultivating microgreens, especially on remote locations where these are not widely available for retail sale.

Without any disbelief, microgreens are now proven nutrition rich 21st century instant growing food for all group of people throughout the globe. We have worked on the idea to make these microgreens more popular among soldiers deployed at forwarded post of difficult terrains of India as self growing potential fresh food supplement. Such harsh winters of high altitude region makes nothing possible to grow in open field throughout the year. Therefore growing microgreens is a boon for monotonous minds of troops 'deployed at boonies due to its simplicity of growing in a maintained temperature inside their bunkers.

During the study, it was realized that comparison of exact nutrient concentration of successful grown crops as microgreens with their mature edible part as less scientific data for comparing the nutrient content of microgreens and mature plants are

available.Thus, in this study the nutrient contents of cabbage broccoli and fenugreek and mature crops grown at high altitude have been assessed to understand and establish the idea as a fact that microgreens version of plant based food are also appropriate for human health and can act as alternative food for fulfilling daily nutrition when mature fresh vegetables are not consistently available due to harsh climatic conditions.

Here, the major concern to note that microgreens are obtained within 10-15 days without hard core farming practices. It can be grown easily in any season while whole appropriate season and skilled hands are required for cultivation of mature vegetables. Surly, microgreens cannot replace for a feeling of full stomach (as in case of mature vegetables) but in nutrition content per gram quantity, they are either rich or equal to mature. It becomes very special food for the troops who are mostly dependent on tinned/processed food at high altitude and other remote areas of country.

Materials and Methods

2.1 Plant material, growing microgreens and mature crops

The low cost, good quality (non-hybrid and non-pelleted) and well performed variety seeds of cabbage (*Brassica oleraceavar*. Golden Acre) and fenugreek (*Trigonellafoenum-graecum* var. Multi-cut) were procured from Durga Seed Farm (Chandigarh, India) and broccoli (Brassica oleracea var. italica -PUSA KTS-1) and were purchased from regional station of Indian Agriculture Research Institute, (Katrain H.P. India). Garden orche and buckwheat seeds were obtained from the Seed Production Division of the Institutes as these crops are indigenous crops of Ladakh. All crop seeds were sown in well prepared open field at Defence Institute of High Altitude Research, Leh, India campus in May 2018 for obtaining the mature parts of vegetables. All the seeds for microgreens were grown in plastic trays (30 cm Lx, 24 cm W and 7.0 cm D) filled with media mixture (500 g) in ratio of 5:2:1 as cocopeat, vermiculite and perlite respectively. After sowing, trays were kept in microgreens farming unit of size 1.0 meter length, 0.5 meter width and about 1.50 meter height made of stainless steel/aluminium framing and 5 shelves were used to keep the trays in tier system with semi-controlled environment at DIHAR, Leh (Ladakh). Garden orche does not perform well in tray thus it was grown in greenhouse soil for 10 days.

The medium was prepared by hydrating well with drinking water before the sowing. The seeds were sown at proper depth of 0.50 cm in 11-12 rows depending upon the weight and size of seeds. Just after sowing, seeds were covered by a thin layer of wet medium. For growing of tinny plants, 18-25°C temperature; more than 1000 Lux light intensity for 6 hours in a day and 55- 65% humidity was recorded in the growing unit. During the growing period, trays were shifted to different positions within the light field to ensure that seedlings are getting sufficient light and heat. Misting of drinking water was done by sprayer on time intervals when growth media showed dryness.

After 10 days of sowing, microgreens of cabbage, broccoli and fenugreek (may take 12 days) were harvested with ethanol cleaned scissors without roots. harvested microgreens from each of the replicate of all crops were placed into a tared aluminium foil cup and weighed up to 10 gram each on Aicosetfx- 4000 electronic balance, this 10 gram biomass of each replication was dried in hot air oven at 45°C temperature for4-5 hours or untila observe the constant dry mass weight. Crop names, scientific names, mean test weight, dry weight and moisture contents of the three microgreens crops are listed in Table 1.

Table 1: Comparative of Mean fresh weight, dry weight and moisture percentage in five microgreens and their mature crops.

Crop Name	Family	Genes & Species	Seed Test weight (g)	Microgreens			Mature Counterpart		
				Fresh Weight (g)	Dry Weight (g)	Moisture %	Fresh Weight (g)	Dry Weight (g)	Moisture %
Cabbage	Brassicaceae	*Brassica L. Brassica oleracea L.*	3.78± 0.13	10	0.94 ±0.02	90.60 ±0.23	10	1.07±0.06	89.3±0.62
Broccoli	Brassicaceae	*Brassica oleracea var. italica*	4.44± 0.08	10	1.11 ±0.07	88.93±0.66	10	1.21±0.06	87.9±0.56
Fenugreek	Fabaceae	*Trigonella foenum-graecum*	13.14±0.04	10	1.14±0.04	88.6±0.40	10	1.23±0.04	87.67±0.35
Garden orche	Amaranthaceae	*Atriplex hortensis*	4.30 ±0.05	10	1.70 ± 0.15	82.90 ±1.48	10	1.90 ±0.06	80.9± 0.56
Buckwheat	Polygonaceae	*Fagopurum tarticum*	18.83±0.15	10	1.23 ± 0.16	87.73 ±1.60	10	1.44±0.12	85.63±1.17

Values are expressed in Mean ± SD (n=3)

From the each replication 50 g sample was wrapped in aluminium foil and get frozen in liquid nitrogen immediately than kept in separate polybag with proper tagging. These samples were stored in -80°C refrigerator for nutrients' determinations. On next day, these 3nine replications samples were immediately placed in a non-insulated box filled with frozen-ice packs and sealed it properly. These samples were brought from Leh-Ladakh to Chandigarh by one hour air journey and sent immediately toPunjab Biotechnology Incubator, Mohali, India, an authenticated parameters testing laboratory.

Later on, in August, after harvesting the mature crops from the DIHAR, Leh, fenugreek mature, cabbage and broccoli curd was weighed up to 10 gram each and dried in hot air oven until obtaining a constant moisture content.100 g from the edible part of all three replication of cabbage, broccoli and mature leaves of fenugreek were immediately wrapped in aluminium foil and get frozen in liquid nitrogen and packed in polybag with taggingand kept in -80°C for overnight. These samples were also brought to Chandigarh from Leh by air in a non-insulated box full with frozen-ice packets and were immediately sent it to analytical laboratory, Punjab Biotechnology Incubator, Mohali, India for analysis.

2.2 Nutrient analysis

Nutrient analysis of selected parameters was carried out at Punjab Biotechnology Incubator (Mohali, Punjab, India) by using standard methods for different analytical instruments. Mineral content (Zn, Mg, Mn, Fe, Na, K, Ca and Total P) was estimated by standardized method (Lars Jorhem and Joakm Engman, 2000) in which an amount of 0.5 g of fresh samples (microgreens and mature) were accurately weighted into a Teflon digestion vessel on a micro analytical balance and then treated with a mixture of 60 ml of nitric acid and 1 ml of hydrogen peroxide in the microwave digestion system. The extracts thus obtained were re-dissolved in 50 ml of purified water and subsequently analysed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). For the measurements of beta carotene, vitamin B_1, vitamin B_2, Vitamin B_3 vitamin B_5, vitamin B_9, vitamin A, and vitamin C has been estimated by HPLC and vitamin B_6 concentration is evaluated by using LCMS-MS. Other parameters were also estimated as per standard method mentioned in Table1.

2.4 Statistical analysis

All the comparative nutrient analysis results data have been expressed as mean (n=3) ± standard deviation. The descriptive statistics mean, standard deviation and median is obtained for all the parameters. Due to small samples size the nonparametric test Mann Whitney U test is carried out to see the significant difference between two types of crops (matured and microgreens) for all parameters. The effect size was computed for significance results. The statistical significance values (p values) are compared with 0.05 or 0.01 level of significance. The whole statistical analysis is carried out by using SPSS 21 software. The principle component analysis was done for the nutrients which are significantly higher in microgreens.

Result and Discussion

Results have shown that microgreens possess a good content of dietary fibres, vitamins and minerals than their mature counterpart.

3.1 Relative nutrient value of microgreens cabbage, broccoli, fenugreek, garden orche, buckwheat to their mature counterpart

The average test weight of seeds, fresh weight, dry weight and moisture content of microgreens and mature crop are listed in Table 1. The average fresh weight of microgreens and mature crops shows the mean nutrient content in both microgreens and mature counterpart.

3.2 Energy, macromolecules and dietary fibres

An analysis was done to compare the contents of energy, carbohydrate, protein, sugar, fat, cholesterol and dietary fibres in the microgreens of five crops and mature edible version. The values of these parameters are expressed in mean ± standard deviation (n=3) in Table 2-6 for cabbage, broccoli, fenugreek, garden orche and buckwheat, respectively.

Table 2: Comparative of major nutrients in fresh weight of mature cabbage and its microgreens.

Principle		Cabbage	
Nutrients		**Mature**	**Microgreens**
Energy	Kcal/100 g	41.60±0.39	31±1.73
Carbohydrate	%	8.50±0.58	5.67±0.58
Sugar	%	6.17±0.20	0.0
Fat	%	BDL*	BDL*
Protein	g/100g	1.12±0.11	1.33±0.58
Dietary Fibre	%	2.68±0.28	3.00±0.00
Cholesterol	mg/Kg	BDL*	BDL*
Minerals			
Calcium (Ca)	mg/Kg	458.67±0.58	47.67±2.52
Potassium (K)	mg/Kg	2972±1.00	159.33±3.79
Manganese (Mn)	mg/Kg	2.18±0.15	1.00±0.0

Magnesium (Mg)	mg/Kg	168± 1.00	34±0.0
Phosphorous (TP)	mg/Kg	405.67± 0.58	86.00±3
Sodium (Na)	mg/Kg	401.67± 0.58	41.67±0.58
Zinc (Zn)	mg/Kg	1.90±0.09	1.00±0.0
Iron	mg/Kg	6.23±0.20	2.67±0.58
Vitamins			
Beta Carotene	ug/100g	BDL*	523±0.0
Vitamin C	mg/100g	BDL*	5.00±0.0
Vitamin A	ug/100g	BDL*	BDL*
Vitamin B9	ug/100g	28.73±0.46	31.33± 0.58
Vitamin B3	mg/100g	BDL*	4.00 ±0.0
Vitamin B5	mg/100g	BDL*	BDL*
Vitamin B6	mg/100g	0.14±0.12	BDL*
Vitamin B2	mg/100g	BDL*	BDL*
Vitamin B1	mg/100g	BDL*	BDL*

Values are expressed in Means ± SD, n=3.

*Fat, cholesterol vitamin A, B_5 B_2 and B_1 found Below Detection Level (BDL) in both form of cabbage.

Table 3: Comparative of major nutrients in fresh weight of microgreens and mature broccoli.

Principle		Broccoli	
Nutrients		**Mature**	**Microgreens**
Energy	Kcal/100 g	54±0.0	37±2.0
Carbohydrate	%	8.0±0.0	5.67±0.58
Sugar	%	BDL*	BDL*
Fat	%	BDL*	BDL*
Protein	g/100g	5.0±0.0	3.0±0.0
Dietary Fibre	%	5.0±0.0	4.00±0.00
Cholesterol	mg/Kg	BDL*	BDL*
Minerals			
Calcium (Ca)	mg/Kg	805.33±3.06	47±2.65
Potassium (K)	mg/Kg	4481.33±3.21	231±2.0
Manganese (Mn)	mg/Kg	1.0±0.0	3.00±0.0
Magnesium (Mg)	mg/Kg	300.67± 4.16	41.33±0.58
Phosphorous (TP)	mg/Kg	104.33± 2.08	779.67±5.51
Sodium (Na)	mg/Kg	190±3.0	69.33±0.58
Zinc (Zn)	mg/Kg	4.0±0.09	1.00±0.0
Iron	mg/Kg	8.0±1.0	2.0±0.0
Vitamins			
Beta Carotene	ug/100g	58.67±0.58	1763.33±3.51
Vitamin C	mg/100g	BDL*	5.00±0.0
Vitamin A	ug/100g	BDL*	BDL*
Vitamin B9	ug/100g	82.0±0.46	78.33± 0.58
Vitamin B3	mg/100g	BDL*	3.00 ±0.0
Vitamin B5	mg/100g	BDL*	BDL*
Vitamin B6	mg/100g	BDL*	BDL*
Vitamin B2	mg/100g	BDL*	BDL*
Vitamin B1	mg/100g	BDL*	BDL*

Values are expressed in Means ± SD, n=3.
Sugar, fat, cholesterol, vitamin A and B_5, B_6, B_2 and B1 found Below Detection Level (BDL) in broccoli.

Table 4: Comparative of major nutrients in fresh weight of mature fenugreek and its microgreens.

Principle		Fenugreek	
Nutrients		**Mature**	**Microgreens**
Energy	Kcal/100 g	57.67±0.58	5.0±0.0
Carbohydrate	%	10.0±0.0	BDL*
Sugar	%	BDL*	BDL*
Fat	%	BDL*	BDL*
Protein	g/100g	4.0±0.0	2.0±0.0
Dietary Fibre	%	5.0±0.0	3.00±0.00
Cholesterol	mg/Kg	BDL*	BDL*
Minerals			
Calcium (Ca)	mg/Kg	67.67±1.53	35.67±3.51
Potassium (K)	mg/Kg	207.67±2.52	188.33±2.08
Manganese (Mn)	mg/Kg	BDL*	BDL*
Magnesium (Mg)	mg/Kg	22± 0.0	32.33±2.08
Phosphorous (TP)	mg/Kg	60±2.0	70.33± 1.52
Sodium (Na)	mg/Kg	14.67± 0.58	58.33±2.08
Zinc (Zn)	mg/Kg	BDL*	1.00±0.0
Iron	mg/Kg	6.0±0.0	6.0±0.0
Vitamins			
Beta Carotene	ug/100g	2962±1.0	1410.67±0.57
Vitamin C	mg/100g	3.0±0.0	5.00±0.0
Vitamin A	ug/100g	BDL*	BDL*
Vitamin B9	ug/100g	83.67±0.58	43± 1.0
Vitamin B3	mg/100g	BDL*	1.0±0.0
Vitamin B5	mg/100g	BDL*	BDL*
Vitamin B6	mg/100g	BDL*	BDL*
Vitamin B2	mg/100g	BDL*	BDL*
Vitamin B1	mg/100g	BDL*	BDL*

Values are expressed in Means ± SD, n=3.

*Sugar, fat, cholesterol, vitamin A and, B_3 B_5, B_6, B_2 and B_1 found Below Detection Level (BDL) in fenugreek.

Table 5: Comparative of major vitamin contents in fresh weight of Garden orche (Ladakh indigenous) and its microgreens.

Principle		Farden Arche	
Nutrients		**Mature**	**Microgreens**
Energy	Kcal/100 g	44.33±1.15	24.33±0.58
Carbohydrate	%	7.0±0.0	3.0±0.0
Sugar	%	BDL*	BDL*
Fat	%	BDL*	BDL*
Protein	g/100g	4.0±0.0	2.0±0.0
Dietary Fibre	%	6.0±0.0	3.0±0.00
Cholesterol	mg/Kg	BDL*	BDL*
Minerals			
Calcium (Ca)	mg/Kg	1612.67±2.52	131.33±3.06
Potassium (K)	mg/Kg	8747±3.61	8748±2.0
Manganese (Mn)	mg/Kg	2.33±0.58	BDL*
Magnesium (Mg)	mg/Kg	2018.33±2.08	107±2.65
Phosphorous (TP)	mg/Kg	544± 2.65	92.67±2.52
Sodium (Na)	mg/Kg	1405.67±2.08	9.00±1.0

Zinc (Zn)	mg/Kg	3.0±0.0	1.67±0.58
Iron	mg/Kg	28.67. ±1.15	8.0±0.0
Vitamins			
Beta Carotene	ug/100g	4618.33±0.58	1535.33±7.51
Vitamin C	mg/100g	7.0±0.0	2.00±0.0
Vitamin A	ug/100g	307.33±4.04	BDL*
Vitamin B9	ug/100g	25.33±0.58	90.33± 0.58
Vitamin B3	mg/100g	1.0 ±0.0	2.0 ±0.0
Vitamin B5	mg/100g	1.0 ±0.0	BDL*
Vitamin B6	mg/100g	BDL*	BDL*
Vitamin B2	mg/100g	BDL*	BDL*
Vitamin B1	mg/100g	BDL*	BDL*

Values are expressed in Means ± SD, n=3.

Sugar, fat, cholesterol, vitamin, B_6, B_2 and B_1 found Below Detection Level (BDL) in garden orche.

Table 6: Comparative of major nutrients in fresh weight of Buckwheat and its microgreens.

Principle		**Buckwheat**	
Nutrients		**Mature**	**Microgreens**
Energy	Kcal/100 g	50.67±0.58	924.33±1554.23
Carbohydrate	%	9.0±0.0	4.0±0.0
Sugar	%	BDL*	BDL*
Fat	%	BDL*	BDL*
Protein	g/100g	3.0±0.0	2.0±0.0
Dietary Fibre	%	5.67±0.58	3.67±0.58
Cholesterol	mg/Kg	BDL*	BDL*
Minerals			
Calcium (Ca)	mg/Kg	125±3.61	70.0±2.0
Potassium (K)	mg/Kg	143.33±2.52	311.33±2.52
Manganese (Mn)	mg/Kg	1.0±0.0	1.0±0.0
Magnesium (Mg)	mg/Kg	83.33±0.58	65.67±0.58
Phosphorous (TP)	mg/Kg	187± 2.65	112.67±2.52
Sodium (Na)	mg/Kg	1.00±0.0	23.67±0.58
Zinc (Zn)	mg/Kg	1.0±0.0	2.0±0.0
Iron	mg/Kg	8.33. ±0.58	2.67±0.58
Vitamins			
Beta Carotene	ug/100g	3125.67±0.58	2032.67±0.58
Vitamin C	mg/100g	2.0±0.0	3.0±0.0
Vitamin A	ug/100g	208±2.0	BDL*
Vitamin B9	ug/100g	82.0±0.0	29± 0.0
Vitamin B3	mg/100g	8.0 ±0.0	1.0 ±0.0
Vitamin B5	mg/100g	BDL*	BDL*
Vitamin B6	mg/100g	BDL*	BDL*
Vitamin B2	mg/100g	BDL*	BDL*
Vitamin B1	mg/100g	BDL*	BDL*

Values are expressed in Means ± SD, n=3.

Sugar, fat, cholesterol, vitamin B_5, B_6, B_2 and B_1 found Below Detection Level (BDL) in buckwheat.

As applied nonparametric Mann Whitney U test indicated, energy and carbohydrate found significantly higher in per 100 g of mature than microgreens except energy in buckwheat. Fat, cholesterol and sugar content is observed below detection level (BDL) of instrumental (ICP-MS) capability in all forms except sugar in mature cabbage. Protein content and dietary fibre is significantly higher in mature part of these five crops except cabbage microgreens. These data support the vegetables microgreens as a perfect food for some dietary approaches e.g. low carbohydrate diets in daily diet which recommends restricting the intake of fruits, whole grains, and legumes because of their high sugar or starch content, especially in diabetes (Forouhi N. et. al. 2018). As per the analysis, vegetables microgreens can be sanctified as healthy food for old age people and diabetic patients due to their negligible cholesterol, fat, and carbohydrate but rich in micronutrient, phytochemical and fibre content.

3.3 Mineral contents

The comparative values of minerals between the mature and microgreens of five crops are depicted in Table 2-6. Statistical analysis showed that mature cabbage, broccoli, garden orche, and fenugreek possessed significantly higher minerals contents except buckwheat and fenugreek microgreens. In fenugreek microgreens magnesium (Mg), total phosphorous (P), sodium (Na), and zinc (Zn) are found significantly higher. The mean potassium (K) content (4481.3±1.86 mg/kg) in mature broccoli was highest. In buckwheat microgreens, potassium (K), phosphorous (P), sodium (Na), and zinc (Zn) are found significantly higher than mature buckwheat plant.

3.4 Essential Vitamins contents

The essential vitamins *i.e.* beta carotene, vitamin C, vitamin A, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_5, vitamin B_6 and vitamin B_9 concentrations of cabbage, broccoli, buckwheat, garden orche, fenugreek microgreens and their mature part grown at high altitude have been determined. In research literature, it has been reported earlier that microgreens contain considerably higher content of vitamins than their mature plant counterparts, (Xio *et. al*. 2012) although crop varieties wise variations are found among the different vegetables microgreens. All the estimated vitamins for cabbage, broccoli and fenugreek mature vs microgreens are depicted in Table 2-6. The vitamin C and vitamin B_3 are found significantly higher, (based on effect size) in the microgreens form of stated crops (except buckwheat) than their counterpart while beta

carotene is found higher in cabbage and broccoli microgreens. Vitamin B_9 was found significantly higher in garden orche microgreens, Vitamin B_2, B_5 B_6 and B_1 was found below detection level (BDL) in both form of five crops except B_5 in Garden orche mature and B_6 in cabbage mature.

Here overall significance is microgreens being rapid growing plants could provide a sufficient daily intake of most minerals compared with mature crop which is hard to grow in snow falling winter season of high altitude conditions specifically at forwarded post of soldiers. These microgreens if consumed 100 g as one or two meals daily can provide appropriate nutrition to the people or troops that are living or deployed in unfavourable climate of remote location and are mostly dependent on tinned food.

This nutritional information is a breakthrough in the field of human nutrition. The consumption of microgreens can ensure nutritional security economically to meet daily requirements in a very short span of time (10 days).

Conclusion

This is the first study that compared the detailed nutrient content of cabbage, broccoli, fenugreek, buckwheat, garden orche microgreens and their mature counterpart grown at high altitude. The data produced in the study likely provide a comparison basis scientific evaluation of the nutritional quality of microgreen cotyledon leaves. It can also be used as a possible reference in estimating the dietary intake and capabilities of microgreens. However, recent years research has stated that climatic conditions, growing methods, lighting system, harvesting, and postharvest handling conditions have a considerable impact on the synthesis and degradation of phytocompounds, including minerals and vitamins, further studies may be needed to evaluate the different agricultural practices on phytonutrient preservation for long.

The need of the microgreens and their nutrient study was realized from aspect that it can be obtained within ten to twelve days of sowing but vegetables crops take a quarter (75-90 days) of year to get mature edible parts. Fenugreek cabbage and broccoli garden orche and buckwheat are the most prominent microgreens produced as fresh food for troops in the conditions like high altitude where temperature goes more than -20o C in winter season and it is not possible to grow such vegetables under harsh climate in open field. The situations becomes more critical for obtaining the fresh food based diet at forward snowing posts of borders regions of the country where troops remain dependant mostly on tinned food.

Therefore indoor growing of microgreens at such conditions may fulfil the daily need of nutrition to stay healthy and maintaining operational efficiency. Most of the nutrients and their higher concentration in a particular microgreens reported in this study can be obtained only in 10-12 days of sowing while other additional nutrients (which are higher in mature) can also be obtained up to some level when it is unavailable to the troops and residents during winters of high altitude conditions with the help of fixed and less resources. The yield, texture and taste performance is also been recorded good in high altitude.Therefore this study indicates that microgreens can be considered a good source of nutrition especially for the harsh climatic remote locations.

Declarations of interest: None

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