Research Article

Nutritional Analysis of Few Edible Microgreens in Variable Growth Medium using XRF Technique

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ABSTRACT

The aim of this study is to quantify different elements present in three different Microgreen species using XRF technique. Seeds of three species namely *Vigna radiata* L., *Brassica nigra* L., *Trigonella foenum graecum* L. were taken to grow as microgreens. Three species were grown in different growth conditions like soil and water. The leaves were collected and analyzed by X-Ray Fluorescence (XRF) analysis to find out the presence of different elements. The result revealed that different varieties of microgreens constitute the rich source of mineral elements which is variable depending upon the species. The elemental composition at various stages of microgreens in different growth medium was estimated. Microgreens could be an excellent way to provide the families staying in cities with seasonal fresh organic leafy green vegetable. Microgreens of *T. foenum graecum* L. Provides maximum potassium and calcium and can be taken for nutritional deficiencies. The microgreen grown in soil contains molecules instead of elements and therefore, microgreens grown in water medium are better for providing nutritional supplement. These microgreens can be grown in home with little space and effort to meet the nutritional requirement from these organic grown little greens to meet the demand of every household staying in cities.

Key words: Microgreens, Mineral elements, Nutritional deficiencies, Quantify, XRF technique.

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INTRODUCTION

In recent time, there is an increase in interest for consumption of organic fruits and vegetables for their high bioactive constituents. Among these organic products, microgreens are known to have beneficial effect as they provide nutrients in human diet and important effects on health.[1] Microgreens are edible very small leafy green vegetables which include the cotyledonary and first pair of leaf. The size generally varies from five to ten centimetres long. For last few years, microgreens have been used in garnishing salads or used as a new salad ingredient and used in other dishes for its high nutritional value.[2,3] Microgreens are considered as "functional foods" for promoting health and preventing diseases. Recently there is demand for microgreens because of their particular characteristics like unique colour, flavour and presence of bioactive compounds and are good source of minerals in human diet.[4-7] Cultivation time of two to three weeks is needed only for the production of microgreens. Major role of current research is to reduce the production cost and increase of shelf life of microgreens.[8,9] Microgreens contain vitamins, minerals and antioxidants and are grown mainly from cabbage, beet, mustard, radish, fenugreek, coriander and amaranth. Even carrots and beets can be sown and harvested as microgreens. Microgreens include seedlings of edible vegetables, herbs or other plants with size ranging from 5 to 10 cm.[10] It consists of stem, cotyledon leaves and first pair of emerged true leaves. Based on growth stages of plant, microgreens fall in the stage older than "Sprouts" and younger than "Baby greens. In this study, mustard, green gram and fenugreek seeds were taken for raising microgreens in water and soil medium and separately evaluated for their elemental evaluation using XRF method.

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MATERIALS AND METHODS

Initial Preparation of Plant Materials

Seeds of green garm (*Vigna radiata* L.), mustard (*Brassica nigra* L.) and fenugreek (*Trigonella foenicum-graecum* L.) were soaked in water for eight to 12 hr and then drained. Sprouting process occurs in dark or low light. In the present study two methods were employed to grow the microgreens (Figures 1-6). In first method the microgreens were grown in water medium. The presoaked seeds were spread over the tissue sheets kept in the containers. In second method, one to three inch moistened soil was kept and leveled uniformly with mild pressure to grow the soil based microgreens. The presoaked seeds were scattered on the top of the soil and pressed gently in to the soil manually by hands. Water was sprinkled one to two times a day to keep the tissue sheet and soil moist. The containers were covered till the seeds were germinated. After sprouting of the seeds, the cover was removed and water was sprinkled every day. Sunlight of three to four hours is required to

Figure 1: *Vigna radiata* L. Grown in Water.

Figure 3: *Brassica nigra* L. Grown in Water.

Figure 2: *Vigna radiata* L. Grown in Soil.

Figure 4: *Brassica nigra* L. Grown in Soil.

Figure 5: *T. foenicum-graecum* L. Grown in Water.

Figure 6: *T. foenicum-graecum* L. Grown in Soil.

grow. The leaves were collected, washed with tap water to remove dust particles. About two gm. of this plants leaves are grinded with motor pestle by adding water in proper ratio.

Elemental (X-Ray Fluorescence) Analysis

Presence of different mineral elements in these three microgreens raised in different medium was investigated quantitatively by using X-ray Fluorescence (XRF) technique. XRF is a very useful analytical technique to investigate the chemical composition of different materials. This XRF method is being used to determine the quantitative composition of different elements present in all types of materials. XRF technique was carried out at Advanced Testing and Calibration laboratory in Centurion University. Elemental range of the instrument is from oxygen to uranium and software used by the instrument is the Super Q software.

RESULTS

Three microgreens were analyzed separately to detect the presence of different elements. The results of XRF analysis clearly revealed that the different microgreens constitute the rich source of mineral elements (Table 1-3). Three species *Vigna radiata* L., *Brassica nigra* L., *Trigonella. foenum graecum* L. was tested for detection of 20 mineral elements. It was observed that maximum of 19 mineral elements were detected by X-Ray Fluorescence (XRF) analysis except Cobalt (Co) which was not found in any of the tested species. These identified elements were silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe), cobalt (Co), copper (Cu), zinc (Zn), tin (Sn), samarium (Sm), europium (Eu), rhenium (Re), rubidium (Rb), strontium (Sr) and bromine (Br).

Data in Table 1 revealed the presence of 12 elements in *Vigna radiata* L. microgreens grown in water medium in variable proportion. These are silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), rubidium (Rb) and rhenium (Re). Among these

Table 1: Elements Present in Green Gram Microgreens.

Green gram Microgreens (*Vigna radiata* L.)			
Grown on Water		Grown on soil	
Elements	Quantity (%)	Molecules	Quantity (%)
Si	0.856	SiO_2	10.0
p	0.496	P_2O_5	12.39
S	0.248	SO_3	7.14
Cl	0.220	Cl	3.97
K	0.871	K_2O	27.49
Ca	0.589	CaO	29.93
Mn	0.0056	TiO_2	0.38
Fe	0.0356	MnO	1.28
Cu	0.00125	Fe_2O_3	3.83
Zn	0.0017	CuO	0.0868
Rb	0.0014	ZnO	0.115
Re	0.0002	Eu_2O_3	1.21
H_2O	96.67	CO_2	1.70
-	-	Re	0.0226

elements, maximum potassium (0.871%) was detected followed by silicon (0.856%) in *Vigna radiata* L. in the microgreens grown in water medium.

Data in Table 2 revealed the presence of 12 elements in *Brassica nigra* L. microgreens grown in water medium in variable proportion. These are silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), manganese (Mn), iron (Fe), zinc (Zn), erbium (Er) and rhenium (Re). Among these elements, maximum phosphorus (0.88%) was detected followed by sulphur (0.77%) in *Brassica nigra* L.

Table 2: Elements Present in Mustard Microgreens.

Mustard Microgreens (*Brassica nigra* L.)			
Grown on Water		Grown on soil	
Elements	Quantity (%)	Molecules	Quantity (%)
Si	0.57	SiO_2	18.587
p	0.88	P_2O_5	12.77
S	0.77	SO_3	26.32
Cl	0.47	Cl	5.27
K	0.36	K_2O	7.37
Ca	0.55	CaO	24.37
Mn	0	TiO_2	0.45
Fe	0.04963	MnO	0.56
Co	0	Fe_2O_3	3.47
Zn	0.0017	ZnO	0.0567
Er	0.05445	Rb_2O	0.029
Re	0.00025	Eu_2O_3	0.73
H_2O	96.29	CO_2	0
-	-	Re	0.0088

Table 3: Elements Present in Fenugreek Microgreens.

Fenugreek Microgreens (*T. foenum graecum* L.)			
Grown on Water		Grown on soil	
Elements	Quantity (%)	Molecules	Quantity (%)
Si	0.335	SiO_2	21.35
p	0.960	P_2O_5	17.15
S	0.684	SO_3	8.95
Cl	0.755	Cl	7.86
K	3.798	K_2O	19.44
Ca	1.407	CaO	19.96
Ti	0.004	TiO_2	0.42
Mn	0.011	MnO	0.16
Fe	0.069	Fe_2O_3	3.80
Cu	0.003	ZnO	0.094
Zn	0.009	Rb2O	0.049
Br	0.0006	Eu_2O_3	0.743
Rb	0.0016	CO_2	0
Sr	0.001	Re	0.017
Sm	0.009	0	0
Re	0.0003	0	0
H_2O	91.95	0	0

Data in Table 3 revealed the presence of 16 elements in *T. foenum graecum* L. microgreens) grown in water medium in variable proportion. These are silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), bromine (Br), rubidium (Rb), strontium (Sr), samarium (Sm) and rhenium (Re) (Table 1 to Table 3). Among these elements, maximum potassium (3.798%) was detected followed by calcium (1.407%) in *T. foenum graecum* L. Microgreens of *T. foenum graecum* L. Provides maximum potassium and calcium and can be taken for nutritional deficiencies. The microgreen grown in soil contains molecules instead of elements and therefore, microgreens grown in water medium are better for providing nutritional supplement.

DISCUSSION

Elemental analysis has shown that the presences of different types of elements having important role in treatment of various ailments are present in all the three studied microgreens grow in different growth conditions. Minerals like Ca, K, Mn are responsible to repair worn out cells, strong bones and teeth, red blood cell productions and other important mechanisms of cells and essential for disease prevention. Potassium is required to transmit the messages and regulation of contractions of muscles and contains highest potassium .The elements such as P, S, K, Ca, Mn, Cu and Zn are reported to be essential in the regulation of blood sugar level in human body and production of insulin. In the biosynthesis, storage and secretion of insulin zinc has a vital role in the maintaining of structural integrity of insulin. Calcium is an essential component and is required in low concentration for optimal insulin mediated functioning within insulin responsive tissues viz. skeletal muscle and adipose tissue. Pre harvest and postharvest treatments like application of calcium, modified packaging and temperature control are essential to enhance the nutritional value and can augment the shelf life of the microgreens because degradation of quality occurs immediately after harvest.[11] Data revealed the high nutritional value of microgreens based on the estimated value of macro and micro elements using the XRF technique[12] in comparison to sprouting seeds. Literature data revealed the pre sowing treatments

with nonchemical seed treatments is essential for surface sterilization that ensures shorter production cycle and enhance yield and quality. It was also found that modular fertilization may fortify the bioactive compounds of microgreens which are required for enhancing their sensorial attributes. Functional quality and shelf life can also be enhanced by light intensity and photoperiod combinations.[13]

CONCLUSION

The growth of microgreens in water medium was found to be relatively more in comparison to the growth in soil. The elemental composition at various stages of microgreens in different growth medium was also varied. Microgreens could be an excellent way to provide the families staying in the cities with seasonal fresh organic leafy green vegetables at a low cost. These are easy to grow at home in a confined space. A small space will provide a significant return in terms with variety, organic produce and nutrients. Iron content in fenugreek microgreens is more as compared to mustard and green gram microgreens and can be supplemented in iron deficiency disease. Variation in elements present in different microgreens can be a rich source and can be used according to the nutritional requirements. Research is needed to identify the methods to increase the quality and shelf life of microgreens and commercialization of packaged microgreens.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

Author Contributions

Dr. Sagarika Parida conceived the original idea, supervised the work and wrote the manuscript. Aischarya Mohanty and Dr. Gyanranjan Mahalik carried out the experiment and all authors contributed to the final manuscript.

ABBREVIATIONS

Br: Bromine; **Ca:** Calcium; **Cl:** Chlorine; **Co:** Cobalt; **Cu:** Copper; **Er:** Erbium; **Eu:** Europium; **Fe:** Iron; **Mn:** Manganese; **P:** Phosphorus; **K:** Potassium; **Re:** Rhenium; **Rb:** Rubidium: **Sm**: Samarium; **Si:** Silicon; **Sr:** Strontium; **S:** Sulphur; **Sn:** Tin; **Ti:** Titanium; **H_2O:** Water; **XRF:** X-ray Fluorescence; **Zn:** Zinc.

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