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Analysis of nutritive value of leafy vegetables of underutilized plants in certain villages of Tumkur, Karnataka

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Abstract: Current survey was carried out in the 2019 to explore the nutritive values and elemental compositions of leafy vegetables of underutilized plants in the selected regions of Tumkur. The two leafy vegetable plants such as, *Celosia argentea* and *Achyranthes aspera* is considered as weed, but used as cattle feed by some people and unkown to the rest of the world is subjected to nutritive value and elemental composition experiments. The results revealed that, *Celosia argentea* and *Achyranthus aspera* were nutritionally rich when compared to the commercial leafy vegetable *Amaranthus viridis* and can be used by the horticulture and plant industries as nutritionally rich leafy vegetables for commercialising in a large scale.

Keywords: *Celosia argentea*, *Achyranthus aspera*, Nutritive value, elemental analysis, Tumkur.

INTRODUCTION

Earth is a unique planet in the solar system. It is the home for billions of organisms. On the earth plants are the gift of nature. The plants not only provide food, shelter and fresh air but also are the rich source of medicine which cures many diseases. Humans by observation and practice identified many plants and their products to cure disease. The plants or its products which are directly or indirectly used as medicine to cure diseases are termed as medicinal plants. Plants have been extensively used as treasured source of natural products for food, shelter as well as medicine. In developing countries major portion of people relied on the plant as primary food resources. In many tropical and subtropical countries, native people traditionally use different plant parts leaf, roots, tubers, fruits and entire plant collected from forests and cultivated lands for their daily food routine (Nascimento *et al*., 2000).

India is major country where most of the people relied on the plant practicing veganism. Major portion of tribal communities in India use over 4000 wild edible species which are serving as a source of food alternative during food scarcity in respective areas. Different wild leafy vegetables used by Indian local people as an excellent source of fibre, proteins and minerals. But still there is huge quantity of wild edible species which are consumed by tribal communities whose nutritional potential is unexplored (Pradeepkumar *et al*., 2015)

In the changing context of modern food consumption practices and fast-food world wild edible plants were forgotten. In many developing countries different nutrient deficiencies were reported due to lack of nutrition in their daily food routine. Scientific exploration on the nutritional value of unexplored vegetable plants is important in terms of providing sustainable nutrition in cheaper way to as well for global food security. It is in

these contexts an attempt was made to analyse the nutritive values and other potentials of the three unexplored wild edible leaves consumed by local villagers around Tumkur district, Karnataka.

MATERIAL AND METHODS

Plant collection and authentication: The plant materials were collected in the villages around Tumkur city, Karnataka in January 2019. (13.367190° N, 77.101176° E) The plants were identified by Dr. Y. N. Seetharam DSRO Botany, Tumkur University, Tumakuru and voucher specimen was conserved under the reference number GFGC/DB/FTZJ/001-003.

Plant preparation and extraction: The plant samples were dried in shade for 20 to 25 days, mechanically powdered and were collected in air-tight plastic containers and stored in dry condition.

Elemental analysis: The macro-elements *viz*., sodium and potassium were analysed by Flame photometer-Jenway-PFP-7 FPM Compressor unit- 122. The phosphorus was analysed by Jenway 6300 spectrophotometer. The microelements *viz*., calcium, magnesium, zinc, copper, manganese, lead, and cadmium were analysed by using atomic absorption spectra GBC 932 AA/AAS.

Atomic absorption spectra analysis the plant samples were pre-digested with nitric acid (HNO_3) and HCl in the ratio of 1:3 for 1-4 hour depending upon the plant sample. Then, the sample is kept over hot water bath (95º C) for 4-5 hours till the sample completely dissolved (Uddin *et al*., 2016).

Physico-chemical parameters: Physico-chemical parameters such as foreign matter, pH, water soluble extractive, alcohol soluble extractive, water soluble ash, total ash and acid insoluble ash using standard protocol (Ashwathanarayana *et al*., 2019).

Determination of foreign matter- One gram of sample was weighed and foreign matter was carefully separated. The matter differing in colour and texture were considered as foreign. The separated matter was weighed and subtracted from one gram and percentage was calculated.

Determination of pH - The 5% (w/v) (5 g in 100 ml of water) powder was kept on shaker for 5 h with 140 rpm and filtered. The filtrate was analysed for the pH using pH meter.

Determination of water-soluble extractive- Five grams of powder was weighed and added into a 100 ml conical flask. 25 ml of distilled water was added into it and kept on a rotator shaker (140 rpm) for 24 h. After 24 h it was filtered and dried in hot air oven set at 80˚C for 24 h and weighed again. The difference in the weight was determined and percent of water-soluble extractive was calculated.

***Determination of alcohol soluble extractive*:** Five grams of powder was weighed and added into a 100 ml conical flask. 25 ml of absolute alcohol was added into it and kept on a rotator shaker (140 rpm) for 24 h. After 24 h it was filtered and dried in hot air oven set at 80˚C for 24 h and weighed again. The difference in the weight was determined and percent of water-soluble extractive was calculated.

Determination of total ash content: The clean and dry crucible (silica) was weighed and its weight was noted. 10 g of powder was weighed in crucible and powder was kept in a muffle furnace and heated up to 300˚C for 3-4 h until the whole powder turns into ash. The crucible was cooled and weighed again. The difference in the weight was noted and percent of total ash was calculated.

***Determination of water-soluble ash*:** One g of ash was weighed and 10 ml of distilled water was added into it. The mixture was kept on a shaker with 140 rpm for 8 h and filtered through ash less filter paper. The ash remained in the paper was kept in a crucible (Silica) and burnt to ash again in a muffle furnace for 3-4 h. The weight of ash obtained was noted and percent of water-soluble ash was determined.

***Determination of acid insoluble ash*:** One gram of ash was weighed and 10 ml of concentrated H was added into it. The mixture was kept on a shaker with 140 rpm for 8 h and filtered through ash less filter paper. The ash remained in the paper was kept in a crucible (Silica) and burnt to ash again in a muffle furnace for 3-4 h. The weight of ash obtained was noted and percent of acid insoluble ash was determined.

Elemental composition and Nutritive value: The microelements sodium and potassium were analysed by Flame Photometer- Jenway-PFP-7 FPM Compressor Unit- 122. The phosphorus was analysed by Jenway 6300 Spectrophotometer. The microelements calcium, magnesium, zinc, copper, manganese, lead and cadmium were analysed by atomic absorption spectra GBC 932 AA/AAS (Iqbal *et al*., 2010).

DETERMINATION OF MACRONUTRIENTS

***Determination of Potassium/sodium*:** The concentration of potassium was determined using flame photometer with separate standards of potassium / sodium. The sample was subjected to flame photometer to detect the concentration of potassium/sodium. Finally, the percentage of potassium was calculated with the formula.

$$\%\ of\ Na/K = \frac{ppm}{10^6} \times dilution\ factor \times \frac{volume\ of\ sample\ digistion\ made}{weight\ of\ the\ sample} \times 100$$

***Determination of Phosphorous*:** The 5 ml of digestive sample was diluted to 40 ml in volumetric flask and mixed with 10 ml vanado molybdate reagent, final volume was adjusted to 50 ml by double distilled water. After 30 min the yellow colour was measured with the help of spectrophotometer at 470 nm. By the standard graph concentration of phosphorous was calculated. The percentage of phosphorous is calculated with the following formula.

$$\%\ of\ P = \frac{ppm}{10^6} \times \frac{volume\ digestion\ made}{aliquot} \times \frac{volume\ of\ sample\ digestionmade}{weight\ of\ the\ sample} \times 100$$

***Determination of Calcium and Magnesium*:** One ml of digested material was taken in 40 ml in volumetric flask, final volume makes up to 50 ml by adding double distilled water. In AAS the presence of calcium and magnesium were determined at the wavelength 422.7 and 228.2 nm respectively. The percentage of calcium and magnesium were calculated with the following formula.

$$\%\ of\ Ca/Mg = \frac{ppm}{10^6} \times dilution\ factor \times \frac{volume\ of\ sample\ digistion\ made}{weight\ of\ the\ sample} \times 100$$

DETERMINATION OF MICRONUTRIENTS

***Analysis of Zinc, Copper and Manganese*:** The 2 ml of digested samples diluted to 40 ml in volumetric flask, final volume makes up to 50 ml by double distilled water, to detect concentration of Zn, Cu and Mn in AAS the

wavelengths should be of 213.9, 324.75, and 279.5 respectively. Finally, the values of micronutrients are expressed in ppm by the following formula.

$$ppm\ Zn, Cu, Mn = \frac{ppm}{1000} \times dilution\ factor \times \frac{volume\ of\ sample\ digistion\ made}{weight\ of\ the\ sample} \times 100$$

***Analysis of Iron, Lead and Cadmium*:** The 2 ml of digested samples were taken and diluted to 100 ml. The presence of lead and cadmium were detected by AAS by in the wavelength of 217 nm and 228 nm. The ppm of lead and cadmium were calculated by the following formula.

$$ppm\ of\ Fe/Pb/Cd = \frac{ppm}{1000} \times dilution\ factor \times \frac{volume\ of\ sample\ digistion\ made}{weight\ of\ the\ sample} \times 100$$

***Determination of nutritive value*:** For the calculation of nutritive value, the various parameters were estimated using the grinded plant material.

***Determination of ash content* :** Each sample was weighed in a silica crucible. The crucible was heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 3-5 h at 600°C. It was cooled in a desiccator and weighed to ensure completion of ashing. It was heated again in the furnace for half an hour, cooled and weighed. This was repeated consequently till the weight became constant (ash became white or greyish white). Weight of ash gave the ash content.

***Determination of crude Carbohydrates*:** 1g of the powdered sample was extracted with 30 cm of 80% ethyl alcohol by using Soxhlet extractor for 6 h. The crude extract was diluted to 100 cm with 80% ethyl alcohol. The quantity of ethanol soluble sugar in the extract was determined using phenol sulphuric acid method.

***Determination of moisture content*:** One gram of powdered sample was taken in a flat bottom dish and kept overnight in a hot air oven at100-110°C for 24 hrs. and weighed. The loss in weight was regarded as a measure of moisture content.

***Determination of crude fat*:** Crude fat was determined by extracting 2gm moisture free samples with petroleum ether in a soxhlet extractor, heating the flask on sand bath for about 6 h till a drop taken from the drippings left no greasy stain on the filter paper. After boiling with petroleum ether, the residual petroleum ether was filtered using Whatman No. 40 filter paper and the filtrate was evaporated in a pre-weighed beaker. Increase in weight of beaker gave the crude fat.

***Determination of crude protein*:** Crude protein was determined by using Kjeldhal method. One gram of powdered dried plant material was taken in Kjeldhal flask; 25 ml of di-acid mixture was added. The digestion was carried out on low flame initial for 10 to 15 minutes until frothing stops. Then digestion at 1 to 1½ h or till the content in Kjeldhal flask become clear the flask was cooled and the contents was transferred quantitatively to the 100 ml volumetric flask and final volume was adjusted to 100 ml by adding distilled water, 10 ml of diluted acid digested samples was taken in a micro Kjeldhal distillation assembly. The boric acid mixed indicator solution was kept ready at the receiving end to trap ammonia, 30ml of 40% NaOH was added and distillation was carried out till the color of the mixture changes and was further continued for some time to trap the all ammonia released. No

changes in color of the red litmus paper indicate the completion of distillation. The quantity of ammonia distilled was estimated by titrating against 0.01N H_2SO_4 or HCl till the color changes to purple.

The percentage (%) of N was calculated with the help of following formula

$$Percentage\ of\ nitrogen = \frac{titrate\ value \times N.H2SO4 \times 0.014 \times dilution\ factor \times 100}{weight\ of\ the\ plant\ sample}$$

The percent of crude protein was estimated by multiplying the percent of Kjeldhal nitrogen into 6.25 (standard factor) it was calculated by using the following formula.

$$Percetage\ of\ crude\ protein = \ Percentage\ of\ Kjeldhal\ nitrogen \times 6.25$$

***Determination of crude fibre*:** The estimation crud fiber was based on treating the moisture and fat free material with 1.25% dilute. HCl, then with 1.25% alkali, then 2gm of moisture and fat free material was treated with 200 ml of 1.25%H_2SO_4. After filtration and washing, the residue was treated with 1.25% NaOH. It was filtered, washed with hot water and then 1% HNO_3 and again with hot water. The residue was ignited and the ash was weighed. Loss in weight gave the weight of crude fiber. Percentage of crude fiber was calculated by using the formula.

$$\%\ of\ crude\ fiber = 100 - (\%\ of\ ash + \%\ of\ moisture + \%\ of\ fat + \%\ of\ protein)$$

NUTRITIVE VALUE

Nutritive value was finally determined by using the following formula

$$Nutritive\ value = 4 \times \%\ of\ Protein + 9 \times \%\ of\ Fat + 4 \times \%\ of\ Carbohydrates$$

Data analysis: The experiment is triplicated and the result was presented as Mean ± SE, the data was analyzed in the statistical software Prism.

RESULT AND DISCUSSION

Acute Toxicity Test: The plant extracts of different plant parts were at the dose at the range from 2500-3000 mg/kg which shows that the extract was well tolerated. These plants were traditionally utilized as leafy vegetable by locals so it is experimentally proved.

Physico-chemical parameters: To evaluate the purity of the sample or plant materials, physicochemical parameters like total ash content, acid insoluble ash, water-soluble ash, pH, foreign matter, alcohol soluble extractive and dry matter were calculated (Table-1 and Fig.-1).

Table-1: Physico-chemical parameters of plant samples (Mean ± SE)

Parameters	Plant samples		
	Celosia argentea	*Achyranthus aspera*	*Amaranthus retroflexus*
Total ash content	4.12 ± 0.32	3.33 ± 0.34	6.22 ± 1.31

Acid insoluble ash	2.26 ± 0.15	3.23 ± 1.27	4.13 ± 1.49
Water soluble ash	2.19 ± 1.34	4.41 ± 1.34	7.33 ± 1.22
pH of 5% w/v solution of aqueous extract	6.24 ± 1.34	7.02 ± 0.76	7.74 ± 0.11
Foreign matter	1.31 ± 0.34	1.65 ± 0.76	1.89 ± 0.23
Alcohol soluble extractive	61.35 ± 0.76	65.43 ± 0.57	72.23 ± 0.49
Dry matter percentage	6.46 ± 0.43	5.54 ± 1.55	5.33 ± 1.25

The total percentage of ash was maximum found in *Amaranthus retroflexus* (6.22 ± 1.31) followed by *Celosia argentea* (4.12 ± 0.32) and least is in *Achyranthus aspera* (3.33 ± 0.34) these three plants are herbaceous of about few centimetres' height has meagre percentage of ash. Acid soluble and water-soluble ash determines the different types of nutrients dissolved in it and also its solubility, *Amaranthus retroflexus* has more acid soluble and more water-soluble percentage.

The pH is directly proportional to hydrogen ion concentration, in our experiment all the plants shows almost neutral pH value in that *Amaranthus retroflexus* has slightly alkaline pH while *Achyranthus aspera* is nearer to neutral and *Celosia argentea* is acidic pH. Plants pH was nearer to neutral is due to the translocation of water from root to flower (Naylor, 1926).

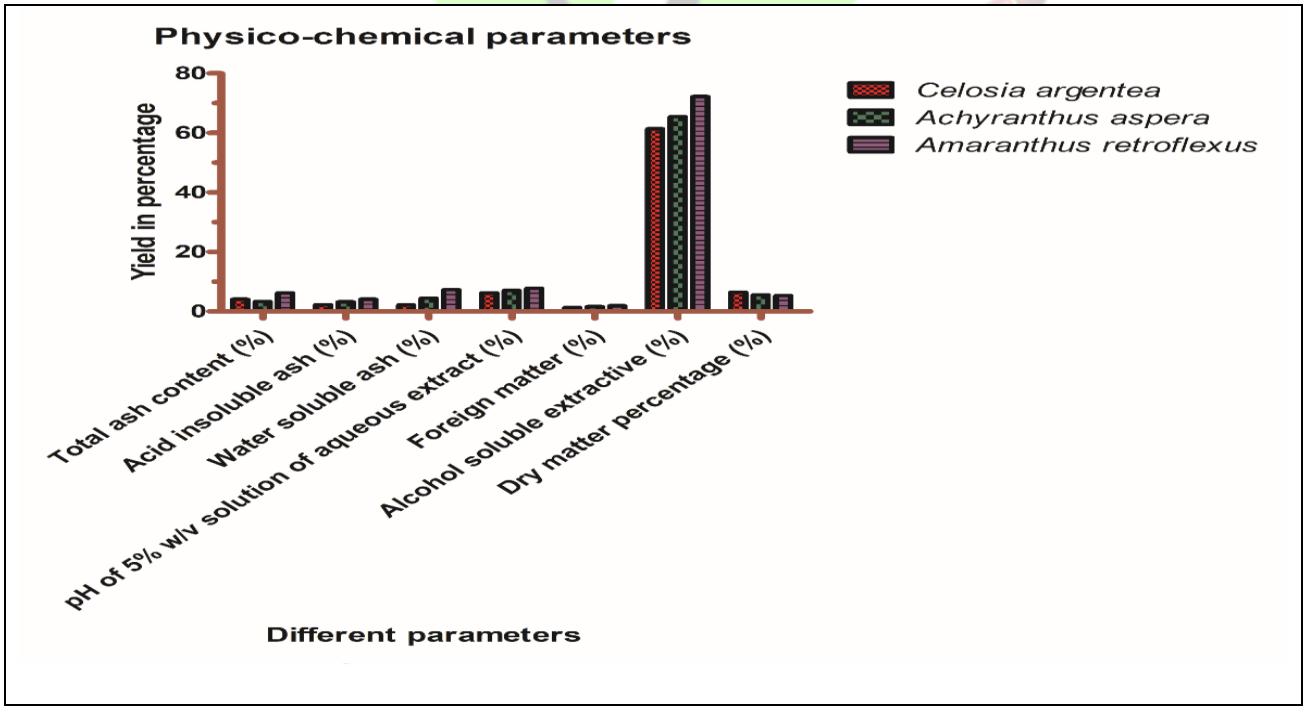

Figure 1: Physico-chemical parameters of the experimented plants

The foreign matter is the main drawback in the quality and purity of a sample. The plant *Amaranthus retroflexus* (1.89 ± 0.23) has higher percentage of foreign matter compared to the rest of the experimental plants. All the plant samples were found to have appreciable percentage of alcohol-soluble extractive in that, *Amaranthus retroflexus* (72.23 ± 0.49) had the highest alcohol-soluble extractive. The leaf contains mainly chlorophylls, xanthophyll, carotenoids etc. readily dissolves in alcohol and stem mainly contains lignin, pectin, suberin,

terpenoids which were easily dissolved in alcohol than water. so, these chemical easily dissolves in alcohol than water (Padmashree *et al*., 2018).

MACRONUTRIENTS

Macronutrient analysis of three experimented edible plants confirms appreciable quantity of macroelements such as Calcium, potassium, magnesium, nitrogen, sodium and phosphorous (Table-2 and Figure-2).

The plant *Achyranthus aspera* (1.5 ± 5.44) has maximum calcium percentage followed by *Celosia argentea* (1.3 ± 0.37) and least is in *Amaranthus retroflexus* (0.9 ± 0.11). In animal system calcium has a vital role in metabolism, mainly has a role in ion gated channels in cell signalling function (Matschi *et al*., 2013).

In experimental plants *Achyranthus aspera* (1.5 ± 3.78) has maximum potassium percentage followed by *Celosia argentea* (1.1 ± 1.11), and least is in *Amaranthus retroflexus* (0.9 ± 0.18). The plant collected from medium rain fed region, has some biotic stresses like pathogens and pests, so that disease-prone parts like leaf, stem, and root has most potassium accumulation. In human's potassium is a vital macronutrient which helps in the maintenance of body fluid, muscular movements, nerve stability, enzyme activation, proper blood pressure maintenance (Aaron and Sanders, 2013).

Table-2: Macronutrients (Mean ± SE)

Macronutrients	*Celosia argentea*	*Achyranthus aspera*	*Amaranthus retroflexus*
Ca (%)	1.3 ± 0.37	1.5 ± 5.44	0.9 ± 0.11
K (%)	1.1 ± 1.11	1.5 ± 3.78	0.9 ± 0.18
Mg (%)	0.7 ± 2.45	0.6 ± 2.66	0.5 ± 0.54
N (%)	0.8 ± 2.25	0.8 ± 5.6	2.1 ± 0.17
Na (%)	2.23 ± 0.33	2.1 ± 6.91	1.76 ± 0.24
P (%)	0.8 ± 0.04	0.9 ± 0.99	0.4 ± 0.03

Magnesium was found maximum percentage in *Celosia argentea* (0.7 ± 2.45) followed by *Achyranthus aspera* (0.6 ± 2.66), and least is in *Amaranthus retroflexus* (0.5 ± 0.54). In animal system, magnesium plays an important role in maintaining steady heartbeat, in proper functioning of enzymes and activation, in normal functioning of muscle, nerve function, in maintenance of normal sugar level in blood, in maintaining normal body fluid, in protein and ATP synthesis. Magnesium is an essential nutrient which mainly situated in leaf and fruit. In leaf, magnesium is required for photosynthesis and in fruit, magnesium mainly triggers an enzyme that synthesis sugars (Bose *et al*., 2011).

Nitrogen was found maximum percentage in *Amaranthus retroflexus* (2.1 ± 0.17) followed by *Achyranthus aspera* (0.8 ± 5.6), and least is in *Celosia argentea* (0.8 ± 2.25). Nitrogen is a major constituent of DNA, RNA, amino acids. Nitrogen is required in the proper maintains normal growth of cell and proper functioning of muscles. Nitrogen has a vital role in protein synthesis, enzyme synthesis. In the cell cycle, nitrogen has an important role (Hirel *et al*., 2007).

Sodium was found maximum percentage in *Celosia argentea* (2.23 ± 0.33), followed by *Achyranthus aspera* (2.1 ± 6.91), and least is in *Amaranthus retroflexus* (1.76 ± 0.24). In the human body sodium has a crucial role in maintaining the blood pressure, body fluid, normal functioning of nerve and muscles. Sodium is a key nutrient in the proper functioning of photosynthesis (Farquhar *et al*., 2015).

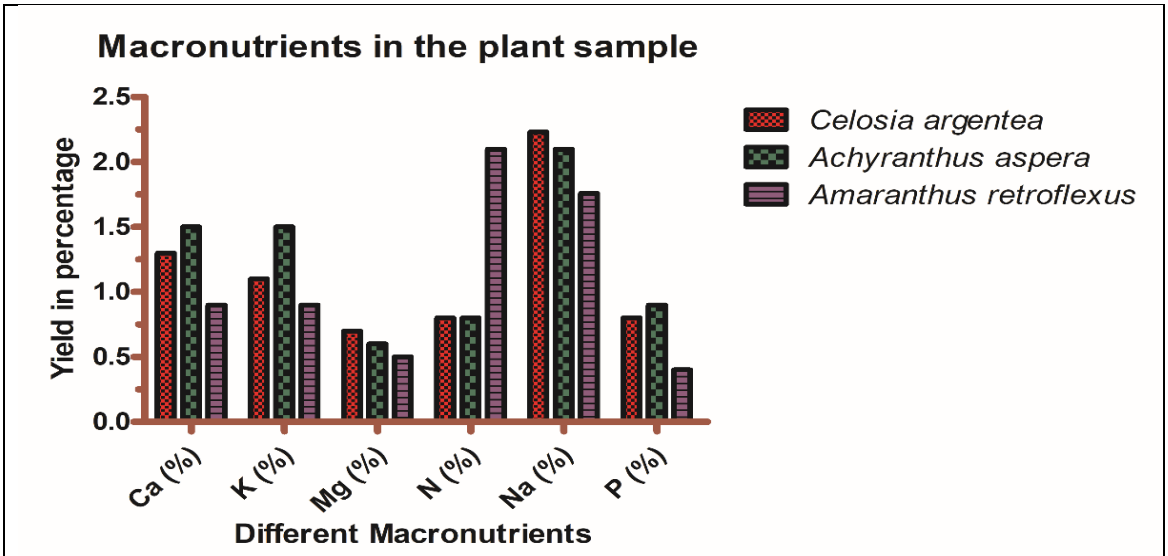

Figure 2: Macronutrients present in the experimented plants

Phosphorus was found maximum percentage in *Achyranthus aspera* (0.9 ± 0.99) has maximum potassium percentage followed by *Celosia argentea* (0.8 ± 0.04) and least is in *Amaranthus retroflexus* (0.4 ± 0.03). Phosphorus (P) an essential element participates in photosynthesis, respiration and other metabolic processes[33]. In animals phosphorous play an important role in energy metabolism and bone mineralization, phosphorus take part in the structural component of DNA and RNA. The role of phosphorus in the plant is to promote normal growth and maturity of roots, photorespiration, proper photosynthesis of leaf and proper growth of stem (Takeda., 2004). From our study it is proved that the experimental plants have sufficient quantity of macronutrients which is enough to full fill the daily macronutrient dose of an adult human being.

MICRONUTRIENTS

Micronutrients like copper, manganese, iron and zinc were analyzed using standard protocols (Table-3 and Figure-3).

Table-3: Micronutrients

Micronutrients	*Celosia argentea*	*Achyranthus aspera*	*Amaranthus retroflexus*
Cu	**4.6 ± 0.09**	1.7 ± 0.04	1.8 ± 3.99
Fe	53 ± 0.04	**56 ± 0.02**	54 ± 1.12
Mn	**110 ± 0.1**	70 ± 0.03	60 ± 0.99
Zn	**67** ± 0.14	39 ± 0.01	39 ± 2.97

Note- Data Mean ± SE

Copper was found maximum percentage in *Celosia argentea* (4.6 ± 0.09) followed by *Amaranthus retroflexus* (1.8 ± 3.99) and least is in *Achyranthus aspera* (1.7 ± 0.04). Copper is an essential micronutrient, has vital role in the human body, as a main envoy in neuron signalling and maintaining of proper brain health and activates antioxidant defence, copper is very much essential in maintenance of skin and connective tissue health, proper functioning of heart and blood vessels and circulation of blood, formation of

white blood cells in triggering immune response and normal function of cell organelles like mitochondria and chloroplasts. In animals, copper has an important role in the activation of proteins and metalloenzymes, proper development of nerves, brain, heart and bone along with the

suppression of different cancer (Angelova *et al*., 2011).

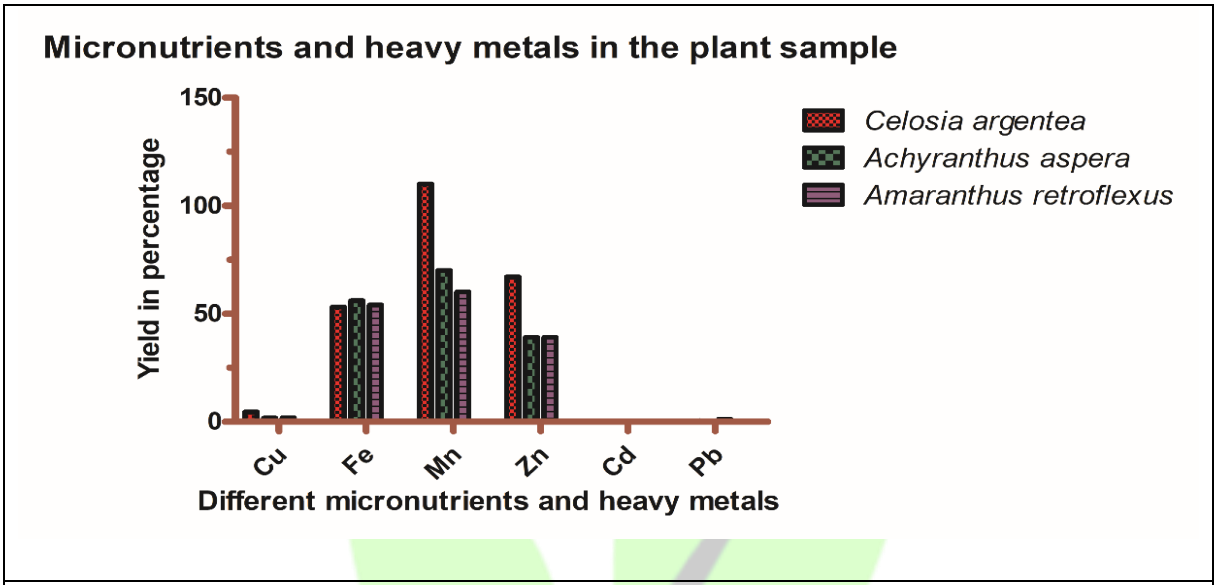

Figure-3: Micronutrients and heavy metals present in the experimented plants

Iron was found maximum percentage in *Achyranthus aspera* (56 ± 0.02), followed by *Amaranthus retroflexus* (54 ± 1.12) and least is in *Celosia argentea* (53 ± 0.04). The leaves have the highest iron content mainly involved in photosynthesis, mitochondrial respiration, nitrogen assimilation and hormone biosynthesis (ethylene, gibberellic acid, jasmonic acid). Up to 80% of the cellular iron is found in the chloroplasts that is consistent with its major function in photosynthesis. In a plant, iron has many key roles, especially, in mitochondrial respiration, hormone biosynthesis and in pathogenic defense. In the human body, iron is a vital component of red blood cells (RBC), constituent for many proteins, enzymes and hormones, the function of hemoglobin and myoglobin, a cofactor for enzyme and in electron transport (Clara *et al*., 1998).

Manganese was found maximum percentage in *Celosia argentea* (110 ± 0.1), followed by *Achyranthus aspera* (70±0.03) and least is in *Amaranthus retroflexus* (60 ± 0.99). In human body manganese work as metalloenzymes in the activation of enzyme-substrate reaction, also present in bone, cartilages, connective tissue synthesis, urea cycle, carbohydrate metabolism, amino acid metabolism and also has antioxidant, anti-cancer properties. In animals manganese has antioxidant properties in suppressing reactive oxygen species and also helps in the synthesis of bone, cartilages, connective tissue, cofactor for many enzymes in the carbohydrate, fat, amino acid metabolism, proper functioning of thyroid and sex hormone, maintenance of blood sugar level, proper functioning urea cycle, and key element in blood clotting mechanism (Aschner *et al*., 2002).

Zinc was found maximum percentage in *Celosia argentea* (67 ± 0.14), followed by *Achyranthus aspera* (39 ± 0.01) and least is in *Amaranthus retroflexus* (39 ± 2.97). In a plant, zinc plays also an important role in seed development, DNA-transcription, RNA-processing, translation, as a cofactor for many enzymes and proteins, zinc also helps in growth hormone synthesis. In the human body, zinc plays a vital role in activation T

lymphocytes, activation of essential enzymes in metabolic process and in the proper maintenance of neurophysiological function (Hafeez *et al*., 2013).

All the tested plants have appreciable microelements concentration sufficient enough to full fill the daily dose of an adult human being. By the data obtained from our study, it is proved that all the plant parts contain sufficient micronutrients, in that, iron, Manganese and zinc was found to be in higher quantity than the commercially available leafy vegetables.

Heavy metals: Two heavy metals were analyzed in the experimental plants, the results showed that in all the plants, Lead (Pb) content was present in meager quantity whereas Cadmium is completely absent. The percentage of Pb was found maximum in *Amaranthus retroflexus* (1.21 ± 0.65) followed by *Achyranthus aspera* (0.31 ± 1.02) and least percentage was in *Celosia argentea* (0.11 ± 0.42). Pb is a common contaminant from the automobiles which is the main reason of accumulation. Lead is essential to defense pathogens and also helpful in antioxidant defence (Ruley *et al*., 2004). (Table-4 and Figure-3).

Table- 4: Heavy metals (Mean ± SD)

Heavy metals	*Celosia argentea*	*Achyranthus aspera*	*Amaranthus retroflexus*
Cd	-	-	-
Pb	0.11 ± 0.42	0.31 ± 1.02	1.21 ± 0.65

Nutritive value: To evaluate the nutritive value of three experimented plants parameters such as moisture, carbohydrates, crude protein, crude fibre and crude fat is essential (Table-5 and Fig. 4).

Table-3: Nutritive value of whole

Samples	*Celosia argentea*	*Achyranthus aspera*	*Amaranthus retroflexus*
Moisture (%)	86.45 ± 1.56	64.39 ± 0.34	61.44 ± 0.76
Carbohydrates (%)	56.77 ± 0.34	46.61 ± 1.45	44.51 ± 1.65
Crude protein (%)	7.53 ± 0.82	4.51 ± 2.55	3.27 ± 0.76
Crude fiber (%)	4.12 ± 1.56	1.12 ± 1.87	4.23 ± 2.60
Crude fat (%)	1.32 ± 2.34	1.02 ± 0.73	1.1 ± 2.56
Nutritive value Cal/100 gm	267.24 ± 0.65	210.46 ± 1.58	199.11 ± 1.39

Moisture content in the plant directly proportional to the water uptake, as well as, the translocation of water in plant. In *Celosia argentea* (86.45 ± 1.56) moisture content was found to be highest compared to the rest of the plants. *Celosia argentea* is stored maximum water content due to its growing conditions.

Carbohydrate is one of the chief energy resources abundantly found in plants. In *Celosia argentea* (56.77 ± 0.34), maximum percentage of carbohydrate content was noticed compared to the rest. Leafy vegetable not only helps in digestion but also provides little energy. Generally, in local villages *Celosia argentea* was provided as good fodder for cattle and it is evident that there is increase in lactation in cattle which is provided with *Celosia argentea* as a fodder (Prabha, 1998).

Proteins in one of the energy resources and main component of chloroplast, mitochondria, ribosomes etc. were a different form of proteins mainly located in aerial parts like leaf, fruit and flower which is metabolically active compared to other parts. In experimental plant parts, crude protein content was found high in *Celosia argentea* (7.53 ± 0.82) compared to rest. Proteins are the building block of living things and also alternative energy resources. Leaf is mainly containing the maximum number of chloroplasts, mitochondria and ribosomes when compared to rest, which is metabolically active compared to other parts (Paul *et al*., 2013).

Plant fibre is a made up of pectin and lignin. Fibre cell not only supports the aerial parts but also effectively defend the biological threats. In experimental plants, crude fibre was found high in *Amaranthus retroflexus* (4.23 ± 2.60) compared to the rest. Fibre is a made up of cellulose, pectin and lignin. In timber plants, fiber was heavily lignified and located in the cell walls. On maturation, fibre cells will die and be filled with mainly lignin and pectin compounds and function as support tissue in stems and roots. Fiber cell effectively defends the pathogen, physical damage and protect the plant from physical and biological stress (Wang *et al*., 2015).

In experimental plants, crude fat was mainly noticed in *Celosia argentea* (1.32 ± 2.34) compared to the rest. Fat is the highest energy-rich carbon resource gives more energy than carbohydrates. In leaf fat is in the form of a cuticle layer. Especially in flower, fats or lipid is present to synthesize sex-related hormones. Lipids also have a role in pollination and flower senescence (Sarkar *et al*., 2015).

Nutritive value of all the plant was calculated in that *Celosia argentea* (267.24 ± 0.65) was found to have high nutritive value followed by *Achyranthus aspera* (210.46 ± 1.58) and least nutritive value was found *Amaranthus retroflexus* (199.58 ± 1.39) (Table.8 and Fig. 4).

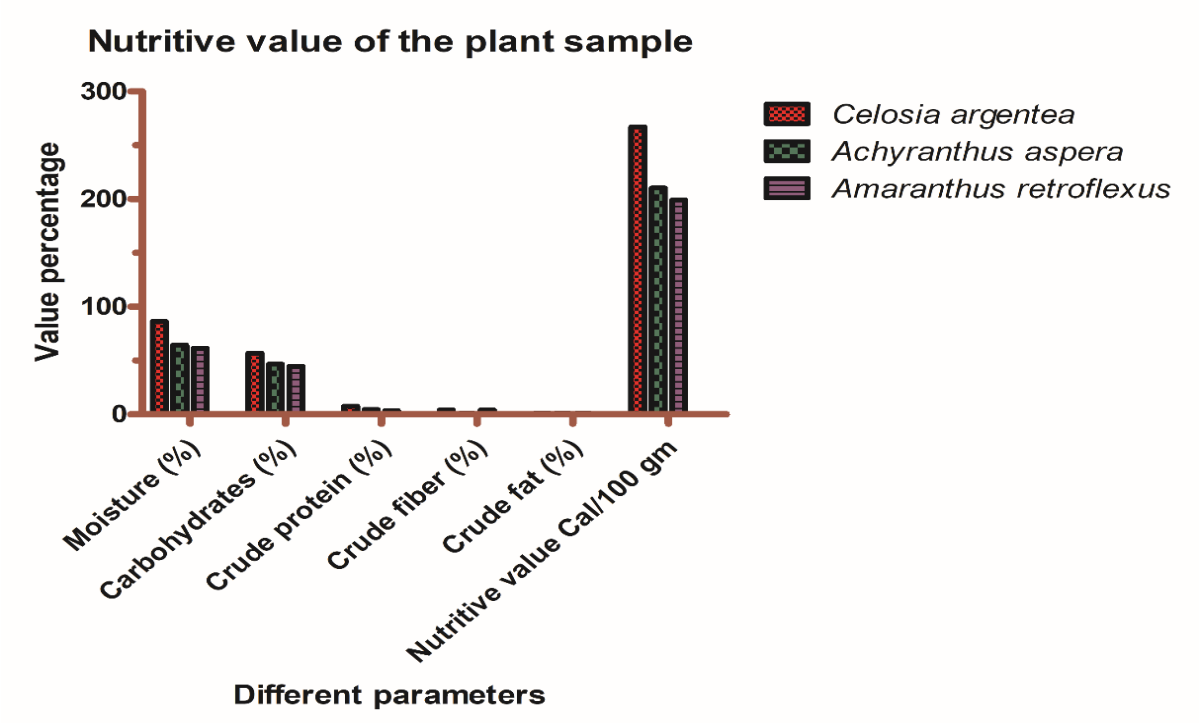

Figure-4: Nutritive value and other parameters present in the experimented plants

CONCLUSION

The nutritive value and elemental studies were conducted on three leafy vegetable plant parts using standard procedures. On the basis of the result obtained in the present investigation, we concluded that the experimental plants have appreciable micro and macro nutrient even though heavy metal elements were found in appreciable concentration, the nutritive values were found to be highest in *Celosia argentea* which is commercially unknown followed by *Achyranthus aspera* which is restricted as a cattle food and is not known as leafy vegetable in urban world. The commercial plant *Amaranthus retroflexus* proved to have less nutritive values than the tested two plants. There is no Cadmium in tested plants but has Lead (Pb) which is due to the pollution through anthropogenic activity and automobile exhaust. The plants tested in this experiment has can be explored by horticulture and agriculture sectors in mass production of these plants which is highly nutritious with appreciable amount of macro and micronutrients.

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