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ADDRESSING THE PROBLEM OF MICRONUTRIENT MALNUTRITION IN NEH REGION – UNDERUTILIZED VEGETABLES AS A SOURCE OF FOOD

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ABSTRACT

The country's population is increasing at the rate of 1.548 percent and it is projected that it will be around 1256 million up to 2015 and 1331 million in 2020. According to the Recommended Dietary Allowances (RDA) of the Indian Council of Medical Research (ICMR), per caput consumption of vegetable must be 280 g, whereas availability of vegetable per caput per day is hardly 241 g. In our country, where problem of malnutrition is prevailing in general and micronutrient malnutrition in particular, addressing the household nutritional security is *sine qua non.* A recent study indicates that intake of micronutrients in daily diet is far from satisfactory and largely less than 50% RDA is consumed by over 70% of Indian population. The loss due to micronutrient deficiency costs 1 percent GDP of India. This amounts to a loss of Rs.27,720 crore per annum in terms of productivity, illness, increased health care costs and death. Every day, more than 6,000 children below the age of five year die in India. More than half of these deaths are caused by malnutrition-mainly the lack of Vitamin A, iron, iodine, zinc and folic acid. About 57% of preschoolers and their mothers have subclinical vitamin A deficiency. Anemia prevalence among children under five years is 69% and among women it is over 55% in a recently concluded national study. With the scientific reality of anemia being a late result of iron deficiency, these data reflect an almost universal iron deficiency in Indian population. The consequences of micronutrient malnutrition are unacceptably high morbidity and mortality. Vitamin A, iron and zinc deficiency when combined constitute the second largest risk factor in the global burden of diseases; 3,30,000 child deaths are precipitated every year in India due to vitamin A deficiency; 22,000 people, mainly pregnant women, die every year in India from severe anemia; 6.6 million children are born mentally impaired every year in India due to iodine deficiency; intellectual capacity is reduced by 15 per cent across India due to iodine deficiency; and 200,000 babies are born every year with neural tube defects in India due to folic acid deficiency. North East States comprising of 8 states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura has a total population of 75,587,982 (source –Census of India, 2011). In North East India 40.1% population is suffering from anaemia whereas in Arunachal Pradesh approximately 29.3% (stunting, wasting, under –nutrition) under age 3 in are suffering from Protein Energy Malnutrition.

Underutilized vegetables like drumstick (*Moringa oleifera*), *Momordica cochinchinensis* , *Momordica dioica*, *Mucuna* spp. *etc.* embedded with vitamins, minerals, fiber and phyto-chemicals are one of the most suitable options to address the problem of nutritional security. The intake of 350-400 g vegetables per caput per day is associated with reduced incidence of many common forms of cancer, and diets rich in plant foods are also associated with a reduced risk of heart disease and many chronic diseases of ageing. Vegetables contain phytochemicals that have anti-cancer and anti-inflammatory properties which confer many health benefits. Many phytochemicals are colourful, and recommending a wide array of colourful fruits and vegetables is an easy way to communicate increased diversity of intake to the consumer. For example, tomato contains lycopene which is localized in the prostate gland and may be involved in maintaining prostate health, and which has also been linked with a decreased risk of cardiovascular disease. Broccoli, Brussels sprouts and kale, contain glucosinolates which have also been associated with a decreased risk of cancer. Garlic and other alliums contain allyl sulphides which may inhibit cancerous cell growth. Several studies have suggested a strong link between dietary phytochemical intake and a reduced risk for cardiovascular disease. Dietary flavonoids have been inversely correlated with mortality from coronary artery disease, plasma total cholesterol and low-density lipoprotein (LDL). Further, leafy vegetables embedded with numerous micronutrients, principally b-carotene, vitamins B6, B9, E and K, plus iron, calcium and magnesium are one of the cheapest sources to recover quickly from nutritional anemia.

Keywords: Underutilized vegetables, lesser known vegetables, NEH region, genetic diversity and micronutrients.

INTRODUCTION

About 600 species constitute the global diversity in vegetable crops. However, presently only one fourth is utilized as a major vegetable crops and rest are named as minor, underutilized, rare vegetables, wild edible vegetables or so on. The distinction between underutilized and life support species is by no means strict. The life support species help to sustain life in stress prone habitats under abiotic stresses like temperature, soil and water and in emergency situations (Paroda *et al.*, 1988). Underutilized crops, like life support species mostly tropical and sub-tropical are not limited to specific environments. Their distinguishing feature is a potential for expansion of what is currently a limited area of cultivation. Some had been more widely used in the past but have given away to more remunerative alternatives. The main impetus for revivals or promotions of underutilized crops is to diversify and stabilize agricultural production. For this there are several agronomic and economic reasons. Alternative and additional crops should make system more sustainable through modifying and diversifying crop rotations, improving the soil structures and the nutrient status (e.g. by the inclusion of nitrogen assimilating crops) and through reducing the buildup of pests and parasites which occur in mono crop or short rotation agricultural systems. The economic advantage of diversifications is the stabilization of farm incomes that depend on major commodities subject to price fluctuations.

NUTRITIONAL POTENTIAL OF UNDERUTILIZED VEGETABLES

Underutilized vegetable have immense potential for contribution to a particular pocket's of food production because they are well adapted to existing as well as adverse environmental conditions and are generally resistant to pests and pathogens. *Euryale ferox* grown in ponds and other water bodies of Madhubani, Bihar is considered one of the most viable sources of income of the local people. Underutilized legumes may be a cheap, alternate source of protein and can alleviate protein malnutrition among preschool children in rural areas. Nutritious pods of *Parkia roxburghii* are consumed as staple legume vegetable in the NEH region of the country. Similarly, *Mucuna pruriens* is considered one of the most preferred legume vegetables in tribal people of Uttar Pradesh, Bihar and Jharkhand. A vast reservoir of leafy vegetables belongs to group of underutilized vegetables, which are rich source of vitamins, minerals, fiber and diversity in the diet. Furthermore, they have been a traditional part of cropping systems, especially in home gardens. Their cultivation, utilization and acceptability should not be a problem (Ghosh and Kalloo, 2001). Underutilized flower and fruit vegetables have longer shelf life than leafy vegetables. Underutilized vegetables as a whole can, therefore, make an impact on the nutritional status of population, yet among food crops, they are neglected. They are generally low in energy and dry matter content, but immensely important as source of protective nutrients, especially vitamins, mineral and phyto-chemicals. Vegetables are the most important source of vitamin A, which is deficient in most part of the world; where rice based diets predominate, blinding thousands of children, annually.

FOLIC ACID CONTENT OF UNDERUTILIZED VEGETABLES

Underutilized vegetables are rich source of folic acid, which is commonly referred to as folate. Folic acid is involved in the multiplication and maturation of cells, and its deficiency results in certain types of anemia especially in infants and in pregnant women. Recent researchers have associated it with the reduced risk of cardiovascular disease. Earlier studies revealed that diets with higher folic acid reduced the risk of colon cancer. Folic acid is crucial in foetal development in the early weeks of pregnancy, hence, nutritionists recommend that woman of child bearing age should consume the recommended amount (400 µg/day) of folic acid by taking a healthy balanced diet that includes vegetables. Folic acid content of underutilized vegetables is given in table (1).

Table1. Folic acid content in some of underutilized vegetables (µg per 100 g edible portion)

Underutilized vegetables	Folic acid	
	Free	Total
Amaranth	41.0	149.0
Cluster bean	50.0	144.0
Coccinia	18.0	55.0
Colocasia	16.0	94.0
Curry leaf	23.5	93.0
Mint	9.7	114.0
Plantain green	1.6	16.4
Snake gourd	7.5	15.5
Sorrel	40.0	125.0
Spinach	51.0	123.0
Yam	0.9	17.5

MINERAL CONTENTS OF UNDERUTILIZED VEGETABLES

On an average a man excretes daily about 20 to 30 g of mineral salts, consisting mostly of chlorides, sulphate and phosphates of sodium, potassium, magnesium and calcium and this output must be recuperated by the intake of food stuffs. In case of the growing body, provision must be made for additional amounts of many of the elements to ensure adequate growth of the tissues. Underutilized vegetables are considered to be a reservoir of various mineral nutrients. Looking into the prevalence of high level of micronutrient malnutrition among the vulnerable sections in the developing countries and the increasing prevalence of chronic degenerative diseases globally, the need for exploration of underutilized foods is significant to overcome the nutritional disorders. The diet and food based approach in combating micronutrient malnutrition is

essential for its role in increasing the availability and consumption of micronutrient rich foods (F.A.O., 1997). Increasing the utilization of green leafy vegetables (GLV) in our diet, known to be rich sources of micronutrients as well as dietary fiber can be a food-based approach for ensuring the intake of these nutrients. It is essential that the locally available GLV, which are inexpensive and easy to cook, be used in the diets to eradicate micronutrient malnutrition and also to prevent the degenerative diseases.

Table 2- Mineral contents of underutilized leafy greens (per 100 g of edible portion)

Green leafy vegetables	Ash (g)	Ca (mg)	P (mg)	K (mg)	Na (mg)	Mg (mg)
Trianthema portulacastrum	2.29	52	22	317	16.0	153
Celosia argentea	2.65	188	35	476	240.6	233
Polygala erioptera	0.77	41	43	125	9.8	57
Boerhaavia diffusa	2.91	330	27	381	—	167
Centella asiatica	2.06	174	17	345	107.8	87
Coleus aromaticus	1.06	158	16	138	4.7	88
Digera arvensis	3.54	506	63	604	—	232
Cocculus hirsutus	1.44	126	18	343	9.4	35
Commelina benghalensis	1.85	113	19	473	20.7	77
Amaranthus tricolor	2.51	239	33	433	84.0	253
Gynandropsis pentaphylla	1.80	151	38	360	15.7	77
Cucurbita maxima	3.04	302	34	368	12.0	150
Delonix elata	1.36	112	29	365	10.8	59

Source: Gupta *et al*. (2005)

Table 3 - Trace element content of underutilized leafy greens (mg per 100 g of edible portion)

Green leafy vegetables	Iron	Zinc	Copper	Chromium	Manganese
Trianthema portulacastrum	4.16	0.46	0.12	0.200	0.43
Celosia argentea	13.15	0.49	0.15	0.153	0.27
Polygala erioptera	4.76	0.68	0.15	0.029	0.18
Boerhaavia diffusa	7.83	0.44	0.22	0.040	—
Centella asiatica	14.86	0.97	0.24	0.046	—
Coleus aromaticus	2.62	0.33	0.12	0.022	—
Digera arvensis	17.72	0.57	0.16	0.243	0.23
Cocculus hirsutus	9.86	0.55	0.22	0.059	—
Commelina benghalensis	7.11	0.63	0.09	0.115	0.08
Amaranthus tricolor	15.01	0.60	0.09	0.140	—
Gynandropsis pentaphylla	4.84	0.57	0.13	0.078	—
Cucurbita maxima	4.38	0.62	0.19	0.049	—
Delonix elata	6.20	0.76	0.27	0.068	—

Source: Gupta *et al*. (2005)

MEDICINAL PROPERTIES OF UNDERUTILIZED VEGETABLES

A number of underutilized vegetables possess several desired medicinal properties. Drumstick (*Moringa oleifera*) is known for its medicinal properties since time immemorial and its leaves are used by physicians of traditional medicine for the treatment of hypertension. Bhalla *et al*. (1983) have reported the hypotensive action of alcoholic extract obtained from the dried drumstick leaves in patients with moderate to severe hypertension. Coleonol, a diterpenoid isolated at Central Drug Research Institute (C.D.R.I.), Lucknow from *Coleus forskohlii* may become a good antihypertensive agent (Rastogi and Dhavan, 1982). The anti-perkinsonian and prolactin reducing effects of an underutilized legume vegetable, *Mucuna pruriens* have been reported by Vaidya *et al.* (1978 a, b). Eating leaves of *Polygonum plebeium* as vegetable improves lactation. Sinha *et al.* (1984) have carried out a detailed macro and micro-scopical studies on the underutilized leafy vegetable *Alternanthera sessilis* and have given the inflorescence analysis, ash and extractive values of the leaf. Lal (1980) has investigated in detail the macro and microscopical features of the underutilized leafy vegetable *Portulaca quandrifida* and the inflorescence analysis of its powder, quantitative microscopy and micro chemical tests. The study is helpful to identify the drug when it is adulterated or substituted. Lal and Khan (1982) have studied the pharmacognosy of the stem of *Portulaca quandrifida* and *P. oleracea* and reported their distinguishable features. Trivedi *et al.* (1980) have studied the pharmacognosy of the

starches from the rhizome of *Canna indica* and *Nelumbo nucifera*. Antifibrionolytic activity of the roots of an under-utilized leafy vegetable *Boerhaavia diffusa* has been found to be due to a phenol glucoside, punarnvoside. It was found effective in controlling IUD induced bleeding in monkeys (Srivastava *et al.,* 1980). List of under-utilized vegetables reported to have significant pharmacological activity is given in table (4).

Table4- Vegetables possessing medicinal properties

Vegetables	Family	Activity
Boerhaavia diffusa L.	Nyctaginaceae	IUCD
Carica papaya L.	Caricaceae	Anti- androgenic
Cissus quandragularis L.	Vitaceae	Analgesic
Coleus forskohlii (Willd.) Briq.	Labiatae	CNS depressant, Hypotensive Spasmolytic
Costus speciosus (Koen. ex Retz.) Sm	Costaceae	Hypotensive
Cyamopsis tetragonoloba (L.) Taub	Papilionaceae	Hypoglycaemic, Hypolipidaemic
Gymnema sylvestre (Retz.) Schult	Asclepiadaceae	Hypoglycaemic
Mollugo cerviana (L.) Ser.	Molluginaceae	Cordiostimulant
Momordica charantia L.	Cucurbitacea	Hypoglycaemic, Hypolipidaemic
Trianthema portulacastrum L	Aizoaceae	Analgesic, Antipyretic, CNS depressant

ADAPTIVE ABILITY OF UNDERUTILIZED VEGETABLES UNDER ADVERSE A-BIOTIC CONDITIONS

Underutilized vegetables possess unprecedented ability to stand against several stress conditions like vulnerable soil, moisture stress, and unfavorable temperature. Cassavas are adaptable to soils of low fertility and are able to tolerate low Ca, N and K. The edaphic tolerances give cassava an advantage over many other crops in acidic infertile soils. Sweet potato is fairly tolerant to Al and Mn and less tolerant to soil acidity. Yams are also less tolerant to soil acidity. In general, commonly grown vegetables are very prone to excessive moisture conditions where as some of underutilized vegetables are fully adapted to excess moisture; water logged or flood prone conditions. The underutilized vegetables which are catering the needs of flood affected people are given in table (5).

Table 5- Underutilized vegetables for flood prone conditions

SN	Underutilized vegetables	Family	Parts used
1.	*Achyranthes aquatica*	Amaranthaceae	Leaves
2.	*Alternanthera philoxeroides*	Amaranthaceae	Leaves
3.	*Aponogeton echinatum*	Aponogetonaceae	Leaves
4.	*Aponogeton crispum*	Aponogetonaceae	Leaves
5.	*Aponogeton natans*	Aponogetonaceae	Leaves
6.	*Colocasia* sp.	Araceae	Corms
7.	*Enhydra fluctuans*	Asteroceae	Potherb
8.	*Euryale ferox*	Nymphaeaceae	Rhizome, young leaves
9.	*Ipomoea aquatica*	Convolvulaceae	Leaves
10.	*Nelumbo nucifera*	Nyphaeaceae	Rhizome
11.	*Nymphaea nouchali*	Nyphaeaceae	Petioles and pedicels
12.	*Nymphoides cristata*	Menyanthaceae	Stem, fruits and leaves
13.	*Ottelia alismoides*	Hydrocharitaceae	Stem, leaves
14.	*Sonneratia caseolaris*	Sonneratiaceae	Young edible fruits
15.	*Trapa bispinosa*	Trapaceae	Immature kernel
16.	*Typha angustata*	Typhaceae	Rhizome

Besides above mentioned leafy vegetables, leaves of other species like *Allium sphaeroceph-alum, Allium* spp., *Aconitum heterop-hyllum, Polygonum viviparum, Sedum rhodiola, S. tibeticum, Scorz-onera mollis* are eaten by the natives.

TAPPING THE VAST POTENTIAL OF UNDERUTILIZED VEGETABLES IN CROP IMPROVEMENT

Many of the limitations of conventional breeding faced by the breeders can be overcomed with the help of various modern genetic and molecular technologies already developed for major crops. The application of these in underutilized crops should address the challenge of sustaining their diversity and improving their performance according to breeders' and consumers' needs. Now a days, molecular approaches available for many plant species offer tremendous possibilities for genetic diversity assessment, improving our understanding of complex characters as well as providing the basis for effective breeding strategies when coupled with more

traditional methods. Molecular markers are among the most promising, reliable and effective tools for basic and applied research. Their use can range from population genetic and evolutionary studies to construction of genetic maps and tagging genes responsible for economically important characters including loci associated with quantitative traits (Quantitative Trait Loci – QTLs). A diverse array of molecular approaches including isoenzyme and DNA markers is available for genetic improvement of many crops. The advantage of all DNA methods is that they provide direct access to the genomes of many organisms, and permit making all possible intra- and interspecific comparisons using the same type of data and can be developed easily for any underutilized, neglected or wild species. The genome scanning molecular markers (Random Amplified Polymorphic DNA - RAPD, Amplified Fragment Length Polymorphism - AFLP), markers partially complementary to intron splice junctions (ISJ), markers based on repetitive sequences (Simple Sequence Repeats – SSR) or transposons (Sequence Specific Amplification Polymorphism – SSAP) have a wide variety of applications along the phylogenetic hierarchy, especially in estimating genetic diversity and pairwise similarity (distance) between individuals from the enormous number of loci. Furthermore, routes of species migrations can be studies by analyzing chloroplast (cpDNA) or mitochondrial DNA (mtDNA).

USE OF UNDERUTILIZED/NEGLECTED VEGETABLES FOR ROOTSTOCKS

Grafting is a simple method of propagation in which desired rootstocks are obtained to induce vigour, precocity, enhanced yield and quality, better survival under biotic and abiotic stress conditions (Pandey and Rai, 2003). Technique of grafting is in vogue in fruit crops since time immemorial, however, the raising of grafted plants of vegetables first started in Japan and Korea in the late 1920s with watermelon [*Citrullus lanatus* (Thunb.) Matsum. and Nakai] onto gourd rootstock (Lee, 1994). Eggplant was grafted onto scarlet eggplant (*Solanum integrifolium* Poir.) in the 1950s. Since, then the area of grafted vegetables has increased multifold. The proportion of the area in Japan producing grafted watermelon, cucumber, melon, tomato and eggplants reached 57 per cent of the total production area in 1960 and 90 per cent in 1990 (Oda, 1993). Presently more than 95 per cent of the watermelon and oriental melon in Japan, Korea and Taiwan are grafted on squash and gourd rootstocks before transplanting. The number of vegetables being grafted is estimated to 540 million seedlings per year in Korea and 750 million in Japan (Lee *et al*., 1998). A number of underutilized cucurbits and solanaceous vegetable possess immense potential towards the resistance for biotic and abiotic stresses and can be utilized as rootstocks. A list of the promising rootstocks is given in table (6).

Table 6- Rootstocks for grafting of vegetables

Scion	Rootstocks
Cucumber	*Cucurbita moschata*
	Cucurbita ficifolia
	Cucurbita maxima
	Sicyos angulata
Melons (for open field)	*Cucurbita* spp.
	C. moschata × *C. Maxima*
	Cucumis melo
Melons (for greenhouse)	*Cucumis melo*
	Benincasa hispida
	Cucurbita spp.
	C. moshata × *C. maxima*
Watermelon	*Citrulus lanatus*
	Cucurbita maxima
	C. moschata
	C. moschata × *C. maxima*
	Lagenaria siceraria
Bitter gourd	*Cucurbita moschata*
	Lagenaria siceraria
	Luffa aegyptica
Tomato	*Solanum pimpinellifolium*
	Solanum esculentum
	Solanum nigrum
Eggplant	*Solanum torvum*
	Solanum melongena
	Solanum nigrum

Source: Pandey and Pandita (2002)

TRIBALS: THE CUSTODIAN OF UNDERUTILIZED VEGETABLES

Ninety per cent of the communities that live in and around India's forest areas of 63.3 million hectares, occupying 19.3 per cent of the landmass of the country are mostly tribal. They inhabit mostly forested village or lead a nomadic life, barring a few acculturated tribes. They speak over 116 different dialects and 227 subsidiary dialects. Each community with a distinct social and cultural identity of its own has economic pursuits ranging from hunting, gathering to settled agriculture and urban or industrial callings. Racially too, they belong to different ethnic stocks. Further, around 10,000 wild plant species are used by tribal communities for meeting their varied needs. Out of these about 8000 wild plants are used by the tribal communities for medicinal purposes. Of them, about 2000 are found to be new claims and worthy of further scientific scrutiny. Those wild plant species used for edible purposes account for over 4000, out of which at least 800 are new information and a minimum of 250 are worthy of attention to be developed as alternative source of food that the world would need in future. Category wise, more than three fourth (83%) of the plant species found in tribal environment are used by the tribal communities for either medicinal purposes or culinary use. Use of wild plants for various purposes is given in table (7).

Table 7- Plants used by the tribal's for various purposes

Purpose	Per cent use of wild plants
Medicinal	55
Edible use	28
Fibre or cord	4
Fodder	3
Pesticides	2
Piscicides	2
Incense and perfumes	1
Miscellaneous	5

Source: Kurup (2000).

Nutritional analysis of certain underutilized vegetables found in tribal areas showed that they are rich in essential amino acids and minerals. Leafy vegetables like *Laminum album* used by tribals of Gurez valley of Kashmir are very rich in minerals (20.4 per cent) and proteins (26%). Similarly high protein sources of some useful chemicals are discovered from some plants. For example seeds of *Cicer soongaricum*, a wild plant of Ladakh area, contain high protein and phospholipids. It also contains 1% lecithin, as is present in soybean, offering scope for its commercial exploitation for pharmaceuticals, cosmetics and food industries. Underutilized vegetables are directly in use of tribal people surrounding the area. In other words, it can be said that underutilized vegetables are product of 'Tribal's kitchen garden', who are in real sense maintaining and conserving the precious germplasm of wild vegetables. Tribal people have acquainted the use and medicinal properties of underutilized vegetables/life support plant species through trials and error from generation to generation.

THE DEPLETION OF BIO DIVERSITY OF UNDERUTILIZED VEGETABLES: A MAJOR CONCERN

According to a study of Food and Agricultural Organization (FAO) crop genetic resources are being wiped out at the rate of 1.2 per cent per annum. Tropical forests are falling at a rate of just under 1 per cent per annum, or 29 hectares per minute. From 1980-1990, this is equivalent to an area the size of Ecuador and Peru combined (Shand, 2000). Underutilized vegetables which are not in cultivation, confined in different types of ecosystems like forests, lagoons, ponds, rivers, ravage lands, mountain etc. Owing to various human activities, these systems are loosening their natural strength and bio-chain resulting in *de-novo* conditions, unsuitable for their existence. Further, the wide spread introduction of exotic species having viable economic potential is another major cause of biodiversity loss. Biodiversity is the lifeblood of commercial biotechnology. The genes from plants, animals and microorganisms of the developing world, in particular, are the strategic raw materials for the development of new food, pharmaceuticals and industrial products. We are losing the biological options; we need to strengthen food security and to survive global climate change.

CONCLUSION AND RECOMMENDATION

Underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions may prove boon to all concerns - growers, consumers and environmentalists, provided that they are tamed properly. The possible reasons for the low utilization of underutilized vegetables in spite of their recognized importance are the lack of seeds, lack of information about their performance and input requirements, lack of information on how they can fit into production systems and non-viability of indigenous vegetable production like the major cultivated species of vegetables such as tomato, pepper, eggplant, cauliflowers, cabbage, etc., whose improvement and seed production are taken care of by the private sector as well as government institutions, whereas the underutilized vegetables are a neglected lot. Most research on production covers only a few economically important vegetable crop species. Furthermore, the potential role of underutilized vegetables in sustainable agriculture through diversification of the agricultural environment has not been fully exploited (Ghosh and Kalloo, 2001).

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