WELCOME


eat
right.

MICROGREENS




UNIVERSITY OF HORTICULTURAL SCIENCES, BAGALKOT

COLLEGE OF HORTICULTURE, BENGALURU

Seminar-2

Microgreens - A Novel Approach For Food and Nutritional Security

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Seminar outline

- Introduction
- Microgreens: What are they? and History
- Commercially grown microgreens and Nutritional Importance
- Important vegetable crops as Microgreens
- Microgreens: The Growing Process
- Homestead utility
- Review of Literature
- Conclusion

Introduction

- ✓ The spectrum of life in terms of income, life style and spending is changing rapidly with economic development leading to major challenge of numerous diseases related to nutritional deficiencies.

- ✓ Non-availability of fresh and pesticide residue free vegetables for consumption.

- ✓ Diet-related diseases - Imbalanced food consumption patterns.

(Ebert *et al.*, 2014)

Option???????????

MICROGREENS

It can easily be grown in **urban or peri urban areas.**

* Short growth cycle.
* Grown with and without-soil.
* Successfully grown using organic manures.

Rich in -

Vitamins,

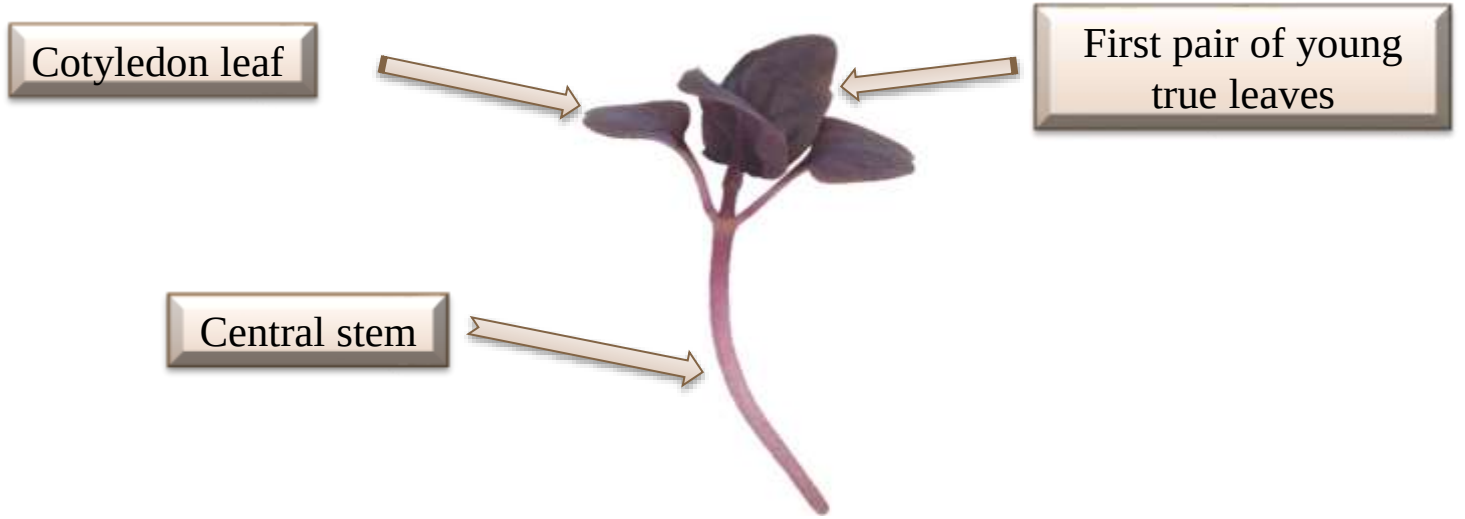
Minerals,

Antioxidants.

(Ebert *et al.*, 2014)

Microgreens: What are they?

Microgreens are a new class of edible vegetables (Pinto *et al.*, 2015), a very specific type which includes seedlings of edible vegetables, herbs or other plants, ranging in size from 8 to 10 cm (Xiao *et al.*, 2012).



Older than "Sprouts" and younger than "Babygreens"

(Danielle *et al.*, 2010)

Different Stages of Plant

Sprouts

Microgreens

Babygreens

Sprouts

- Germinated seeds with emerging root

Micro greens

- 2-3 inches in height; 7-21 days
- (harvest stem, cotyledons, and emerging true leaves)

Baby greens

- 4-6 inches in height; 21-40 days

Mature greens

- >6 inches in height; 40-60 days

(Morgan, 2014)

Difference between sprouts and microgreens

Micro greens

- ✓ Grown in soil or without soil
- ✓ Leaves and stem are eaten
- ✓ Takes 1-3 weeks to grow
- ✓ Filled with flavour and are used for garnishing

Sprouts

- ✓ Grown in water
- ✓ Seeds are eaten as such
- ✓ Takes 2-3 days
- ✓ Great for crunch

(Morgan, 2014)

History

1930s - North America - Wheatgrass as a medicine

1960s - Sunflower, buckwheat and radish - winter “Greens”

1970s - home grown “Grasses” for health benefits

1980s, - “Cresses” and “Seedlings” for garnishing

1990s - California - popularized as “Vegetable Confetti.”

1998 - The first documented use of the word "MICROGREENS" in USA.

2000s -North America - distributing fresh “Microgreens” to local market

2010 - Microgreens started to appear at grocery stores

(Pinto *et al.*, 2015)

Commercially Grown Microgreens

Commercial name	Botanical Name	Family	Microgreen colour
Arugula	*Eruca sativa Mill.*	Brassicaceae	Green
Bull's blood beet	*Beta vulgaris* L.	Chenopodiaceae	Reddish green
Celery	*Apium graveolens* L.	Apiaceae	Green
Cilantro	*Coriandrum sativum* L.	Apiaceae	Green
Garnet amaranth	*Amaranthus hypochondriacus* L.	Amaranthaceae	Red
Golden pea tendrils	*Pisum sativum* L.	Fabaceae	Yellow
Green basil	*Ocimum basilicum* L.	Lamiaceae	Green
Green daikon radish	*Raphanus sativus* L.	Brassicaceae	Green
Magenta spinach	*Spinacia oleracea* L.	Chenopodiaceae	Red
Mizuna	*Brassica rapa* L.	Brassicaceae	Green
Opal basil	*Ocimum basilicum* L.	Lamiaceae	Greenish purple
Opal radish	*Raphanus sativus* L.	Brassicaceae	Greenish purple
Pea tendrils	*Pisum sativum* L.	Fabaceae	Green
Pepper cress	*Lepidium bonariense* L.	Brassicaceae	Green
Popcorn shoots	*Zea mays* L.	Poaceae	Yellow
Purple kohlrabi	*Brassica oleracea* L.	Brassicaceae	Purplish green
Purple mustard	*Brassica juncea* L.	Brassicaceae	Purplish green
Red beet	*Beta vulgaris* L.	Chenopodiaceae	Reddish green
Red cabbage	*Brassica oleracea* L.	Brassicaceae	Purplish green
Red mustard	*Brassica juncea* L.	Brassicaceae	Purplish green
Red orach	*Atriplex hortensis* L.	Chenopodiaceae	Red
Red sorrel	*Rumex acetosa* L.	Polygonaceae	Reddish green
Tartary buckwheat	*Fagopyrum tataricum* L.	Poaceae	Green

(Xiao *et al.*, 2012)

Nutritional Status

- Phytonutrient levels differ according to the growth stage and colour of the plant and often decrease from the seedling to the fully developed stage.

(Barillari *et al.*, 2005)

- Seven days after germination, lettuce microgreens had the highest total phenolic concentration and antioxidant capacity in comparison to the mature plants.

(Oh *et al.*, 2011)

- Spinach microgreens generally had higher levels of phytonutrients and the carotenoids than mature leaves.

(Lester *et al.*, 2015)

Cont..

- Microgreens from ***Brassica*** species are good sources of phenols.
- Microgreens = 'Functional Foods'
- Nutritional miracle-food

(Sun *et al.*, 2013)

Health benefits of microgreens

- Cure anaemia.
- Anti-cancer properties (rich in antioxidants).
- Anti-septic and anti-inflammatory properties.
- Reduce the constipation.
- Protects the body from harmful effects of free radicals.
- Reduce the risk of eye diseases
- Maintains the strong and healthy bones.
- Promotes blood clotting.

(Sharma *et al.*, 2018)

Important Vegetable Crops as Microgreens

Red Amaranth

- Flavour is sweet and tangy.
- Gorgeous magenta leaves
- Vit- A, C, K, and minerals like Ca, Fe.

Beetroot

- Attractive, deep reddish metallic purple leaves
- Delicious, mild spinach like flavour.
- Rich in vit-A, B, K.

(Xiao *et al.*, 2016)

Broccoli

- Highly nutritious.
- Rich in vit-A, C, minerals-Ca, Fe, protein and chlorophyll.
- Stimulate the immune system.
- Broccoli is a cruciferous (sulfur-containing) powerhouse.

Cress

- Traditional microgreen
- finely curled leaves and a peppery flavour.
- Good source of vitamin A, C and sulphur. Rich in fibre.

Dill

- Fine, feathery foliage and a great flavour.
- Goes well with eggs, cucumbers, cheese, and cabbage.

(Xiao *et al.*, 2016)

Fenugreek

- High in protein, vit- A, E, B and minerals.
- Stimulate appetite
- Effective against anaemia and fatigue.

Kale

- Mild cabbage like flavour
- known to be a vitamin C powerhouse.
- Rich in anti-oxidants - prevent macula degeneration

Linseed

- Mildly spicy and very tender.
- Highly nutritious, rich in Omega-3 fatty acids.

(Xiao *et al.*, 2016)

Radish

- Spicy microgreen.
- Ca, Fe, K, Zn, anti-oxidants, vit-A, B, C, K and folic acid
- Stimulate immune system.

Red Cabbage

- Red purple microgreen, mild sweet cabbage flavour.
- Rich in vitamins A, B, C, E, K and minerals-Ca, Mg and chlorophyll.
- Stimulate immune system.

Fennel

- Light leaves and Liquorish flavour.
- Higher in K, vitamin C, B.
- Decrease risk of heart disease.

(Xiao *et al.*, 2016)

Mustard

- Stimulate blood circulation
- Effective against fever and colds.

Pea

- Sweet and tender.
- Pea shoots promising seven times the vitamin C of blueberries and eight times the folic acid of bean sprouts.

Carrot

- Fine textured leaves.
- Rich in β-carotene and other phytonutrients like lutein and zeaxanthin.
- Cancer prevention and anti-aging.

(Xiao *et al.*, 2016)

Red Veined Sorrel

Golden Corn

Onion

Basil

Arugula

Clover

Rapini

wasabi

How to grow microgreens …….?

Material and Media

- ✓ Flat tray with good drainage.
- ✓ Media: Coco peat, Vermiculite, perlite, coconut coir.
- ✓ Fill the tray with moist media about 2-3 cm deep.
- ✓ Seed.

(Kyriacou *et al*., 2016)

Sowing

- ✓ Soaking .
- ✓ Seeding - Broadcast or sprinkle the seeds on top of the media and press lightly.
- ✓ Covered with paper towel/ Vermiculite/ Cocopeat.

(Kyriacou *et al*., 2016)

Practices

- ✓ Watering by fine spray .
- ✓ High light conditions with low humidity and good air circulation.
- ✓ Requires 12 and 16 hours of light and 18–24 C° temperature.

(Kyriacou *et al.*, 2016)

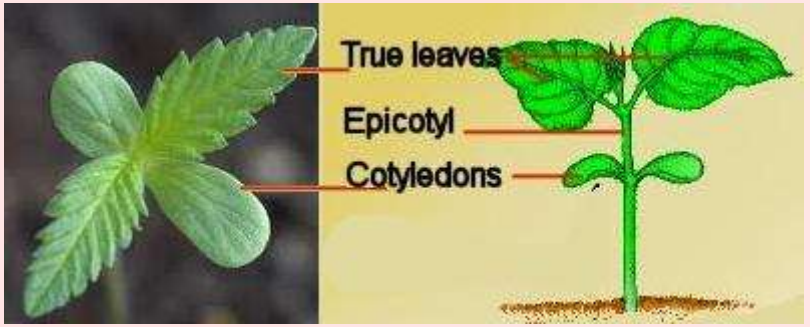
Nutritional requirement

- ✓ Not need much fertilizer.
- ✓ Diluted organic nutrients. *e.g.* Seaweed spraying will improve the nutrient levels in the microgreens
- ✓ Germination paper dipping into fertilizer if grown without media.

(Kyriacou *et al.*, 2016)

Harvesting

- ✓ Appearance of 1st set of true leaves.
- ✓ Cutting above from media surface.
- ✓ Packing without roots.



- ✓ Some types will regrow and can be cut several times.
- ✓ Invert the media, top it up with a bit of fresh media and replant.

(Kyriacou *et al.*, 2016)

How to Sow Microgreens

Step 1

Fill a seed tray or other shallow, wide container with fine seed compost. Compress lightly.

Step 2

Sprinkle seed thickly all over. Do not bury. Water using a fine nozzle or by lowering the tray into shallow water to hydrate from the bottom up.

Step 3

Cover the tray with a board to keep the seeds in the dark until they germinate.

Step 4

Remove the board as soon as the seeds germinate.

Step 5

Water and grow on for another 1 to 2 weeks.

Step 6

Harvest by pulling gently out of the compost, roots and all, or by snipping off with scissors. Eat immediately.

Table:1 Some Requirements for Growing Microgreens

Micro-greens	Seed (g)/Tray (30 x 30 cm)	Soaking Time (h)	Depth of media Mix (cm)	Temperature (°C)	Maturity (Days)
Amaranth	2.5	NA	2	>22	16-20
Purple Basil	2.5	NA	1	>24	16-20
Beet root	12.5	8 - 10	2	16-25	16-20
Buckwheat	12.5	8 -12	2	20-25	5-6
Cress	8	NA	1	16-25	5-14
Dill	5	NA	1	15-23	16-20
Kale	5	4-8	2	16-28	16-20
Linseed	36	NA	2	16-25	6-8
Mustard	2.5	8	2	16-25	15-20
Pea shoots	100-150	8-12	2	15-25	10-14
Radish	5	6-12	3	16-28	12
Cabbage	5	4-8	2	16-25	3-6
Arugula	3	NA	2	16-25	16-20
Sunflower	50	8-12	2	20-25	8-12

(Kyriacou *et al.*, 2016)

Post Harvest Management

Microgreens have a short shelf life. Hence, require better methods of storing and transporting.

Commercial microgreens are most often stored in plastic clamshell containers and refrigeration @ 2.5-3.5^0 C up to 7 days.

Biodegradable Clamshell containers also available.

(Danielle *et al.*, 2010)


RADISH MICROGREENS
Sustainable Roots


LOCAL & ORGANIC
GREENBELT MICROGREENS
LOCAL & BIOLOGIQUE
WHEATGRASS • HERBE DE BLÉ


FRESH CUT ORGANIC HERBS
FRESH CUT ORGANIC HERBS
FRESH CUT ORGANIC HERBS
FRESH CUT ORGANIC HERBS
Fresh Herbs
Super Salad

Microgreen Troubleshooting

Weak, skinny microgreens

Over crowding

Over soaking

Wrong sowing time

(Danielle *et al.*, 2010)

Microgreens under Vertical garden

Orientation

- ✓ It determines the amount of light each plant receives.
- ✓ Need full sun, or at least 5-6 hours of bright light .
- ✓ An A-frame vertical garden gives maximum food in minimum space.

(Patterson, 2016)

✓Choose south or southwestern exposure to grow high-light plants.

✓ Eastern exposure is good for root vegetables, herbs and greens.

✓Artificial lighting - Using overhead lighting

✓Arrange high-light veggies on the top shelves and the others at lower levels.

(Patterson, 2016)

Vertical planting of microgreens against wall

Crops suitable for vertical gardening

- Red amaranth
- Cabbage
- Broccoli
- Sunflower
- Beet
- Daikon radish
- Basil
- Mustard
- Khol rabi
- Chives
- Parsley
- Sage
- Mint
- Cilantro

(Patterson , 2016)

Hydroponic Production of Microgreens

❖ Media : Paper towel, hessian/burlap sheets, rockwool cubes or sheets, thin kitchen cloth and hydroponic microgreen pads can all be used.

❖ Microgreens best produced on thin mat/ capillary pad.

(Morgan, 2014)

Step 0: Balance the pH of water – 5.5 to 6.5

Step 1: Preparation of Trays

Step 2: Spread of Seeds

For smaller seeds (arugula, broccoli) - 2-3 table spoon.

larger seeds like (radish) quarter cup.

Step 3: Mist & Cover – use the spray mister to spray the seeds.

.

Step 4: Mist Every 12 Hours.

Do not add additional water other than the misting.

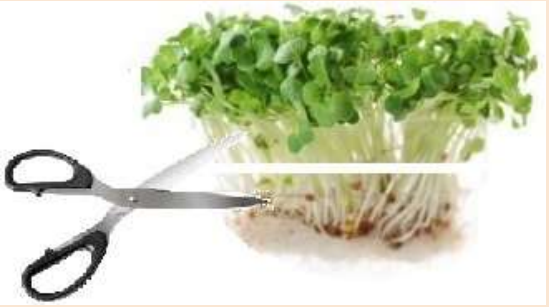
(Morgan, 2014)

Step 5: Uncover The Tray – after 4 or 5 days.
Direct sunlight, fluorescent, or incandescent lights, propagation lamps.

Step 6: Check Daily – Right balance of water from seeding to till harvest.

Step 7: Time to Harvest – Most microgreens will be ready to harvest in 10 days.

Step 8: Harvest – Move the trays to a cool, shady place.
Harvest greens during late evening or early morning
Uproot the entire clump from the grow pad.
Use scissors to trim the roots from the greens.



(Morgan, 2104)

Step 9 : Washing- Use cold water.

Step 10: Packing – In clamshell boxes.

Problems:

- Seedling rot
- Fungal pathogens

(Morgan, 2014)

Homestead Utility

- Plate's presentation (add vivid colours)
- Introduce hidden tangy flavour
- Microgreen Salads: All the flavour of a Big Salad in a Tiny Pile on Plate.

***Idada* with mustard microgreens**

Mix vegetable soup with microgreens

***Khaman* with microgreens**

CASE STUDIES

Case study-1

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

2012 Article

pubs.acs.org/JAFC

Assessment of Vitamin and Carotenoid Concentrations of Emerging Food Products: Edible Microgreens

Zhenlei Xiao,[†] Gene E. Lester,*[,‡] Yaguang Luo,[‡] and Qin Wang*[,†]

[†]Department of Nutrition and Food Science, University of Maryland, College Park, Maryland 20742, United States

[‡]Food Quality Laboratory, Beltsville Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture, 10300 Baltimore Avenue, Beltsville, Maryland 20705, United States

Objective:

To determine the concentrations of ascorbic acid, tocopherols, phylloquinone and carotenoids in 25 commercially available microgreens.

(Xiao *et al.*, 2012)

Material and Methods

Material:

- Twenty-five vareities of microgreens

Methods:

- Phylloquinone - HPLC analysis(270nm)
- TAA - Spectrophotometric method(525nm)
- Tocopherol & Carotenoids – HPLC(290 &450nm)

(Xiao *et al.*, 2012)

Table :2 Twenty-five Commercially Grown Microgreens Assayed in the Nutrient Study

Common Name	Scientific Name	Family	Plant color
Arugula	*Eruca sativa* Mill.	Brassicaceae	Green
Bull's blood beet	*Beta vulgaris* L.	Chenopodiaceae	Reddish green
Celery	*Apium graveolens* L.	Apiaceae	Green
China rose radish	*Raphanus sativus* L.	Brassicaceae	Purplish green
Cilantro	*Coriandrum sativum* L.	Apiaceae	Green
Garnet amaranth	*Amaranthus hypochondriacus* L.	Amaranthaceae	Red
Golden pea tendrils	*Pisum sativum* L.	Fabaceae	Yellow
Green basil	*Ocimum basilicum* L.	Lamiaceae	Green
Green daikon radish	*Raphanus sativus* L.var. *longipinnatus*	Brassicaceae	Green
Magenta spinach	Spinacia oleracea L.	Chenopodiaceae	Red
Mizuna	*Brassica rapa* L.ssp.*Nipposinica*	Brassicaceae	Green

(Xiao *et al.*, 2012)

Cont……

Pea tendrils	*Pisum sativum* L.	Fabaceae	Preen
Pepper cress	*Lepidium bonariense* L.	Brassicaceae	Preen
Opal basil	*Ocimum basilicum* L.	Lamiaceae	Greenish purple
Opal radish	*Raphanus sativus* L.	Brassicaceae	Greenish purple
Popcorn shoots	*Zea mays* L.	Poaceae	Pellow
Purple kohlrabi	*Brassica oleracea* L. var. *gongylodes*	Brassicaceae	Purplish green
Purple mustard	*Brassica juncea* (L.) Czern.	Brassicaceae	Purplish green
Red beet	*Beta vulgaris* L.	Chenopodiaceae	Peddish green
Red cabbage	*Brassica oleracea* L. var. *capitata*	Brassicaceae	Purplish green
Red mustard	*Brassica juncea* (L.) Czern.	Brassicaceae	Purplish green
Red orach	*Atriplex hortensis* L.	Chenopodiaceae	Red
Red sorrel	*Rumex acetosa* L.	Polygonaceae	Reddish green
Sorrel	*Rumex acetosa* L.	Polygonaceae	Green
Wasabi	*Wasabia japonica* Matsum.	Brassicaceae	Green

(Xiao *et al.*, 2012)

Table:3 - Mean Phylloquinone, Total ascorbic acid, Tocopherol Concentrations in 25 Commercially Grown Microgreens

Table:4 - Mean β-Carotene, Violaxanthin, and Lutein/Zeaxanthin Concentrations in 25 Commercially Grown Microgreens

(Xiao *et al.*, 2012)

Case study-2

FOOD SCIENCES 2015

LIGHT - EMITTING DIODES (LEDs) FOR HIGHER NUTRITIONAL QUALITY OF *BRASSICACEAE* MICROGREENS

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RESEARCH FOR RURAL DEVELOPMEN T 2015, V OLUME 1

Objective:
To investigate the effect of industrially designed LED lamp lighting on nutritional quality of *Brassica* microgreens.

(Viktorija and Akvile, 2015)

Material and Methods

Material – Red pak choi (*Brassica rapa*)

- Musturd (*Brassica juncea* L. red lion)

Three light treatment: 1) High pressure sodium lamps

2) LED_{150}

3) LED_{250}

- ❖ Leaf area (cm^2) - Automatic leaf area meter
- ❖ Ascorbic acid – Spectrophotometric method (600nm)
- ❖ Total phenol – Folin – ciocalteu method (765nm)
- ❖ Total anthocyanin – Spectrophotometric method (420, 520, 700nm)

(Viktorija and Akvile, 2015)

Table:5 - Growth parameters of microgreens cultivated under different light treatments

Light treatment	Hypocotyl length (cm)	Plant height (cm)	Leaf area (cm2)
Red pak choi 'Rubi F$_1$'			
HPS	3.66±0.33	4.86±0.51	0.89±0.03
LED 150	2.79±0.25^b	3.98±0.30^b	0.90±0.10
LED 250	2.59±0.35^b	3.96±0.30^b	1.00±0.10
LSD_{05}	0.30	0.46	0.37
Mustard 'Red Lion'			
HPS	3.39±0.22	4.71±0.24	0.91±0.10
LED 150	2.56±0.11^b	3.84±0.15^b	0.81±0.07
LED 250	2.05±0.06^b	3.47±0.10^b	0.85±0.13
LSD_{05}	0.22	0.24	0.27

Values are expressed as mean ± SD (n=10). LSD_{05} - Fisher's protected least significant difference ($P \leq 0.05$); b - the value is significantly lower than control (HPS). FW - fresh weight.

(Viktorija and Akvile, 2015)

Table :6 - Antioxidant properties of brassicaceae microgreens cultivated under different light treatments

Light treatment	Ascorbic acid (mg $^{g-1}$ FW)	Total phenols (mg $^{g-1}$ FW)	Total anthocyanins (mg $^{g-1}$ FW)
			Red pak choi 'Rubi F_1'
HPS	0.92±0.07	1.32±0.01	0.52±0.02
LED 150	1.08±0.05^{a}	1.61±0.05^{a}	0.63±0.03^{a}
LED 250	1.12±0.05^{a}	1.69±0.03^{a}	0.53±0.01
LSD_{05}	0.11	0.07	0.03
			Mustard 'Red Lion'
HPS	1.47±0.02	1.41±0.06	0.38±0.02
LED 150	1.58±0.03^{a}	1.65±0.02^{a}	0.44±0.03^{a}
LED 250	2.26±0.06^{a}	2.10±0.05^{a}	0.43±0.02
LSD_{05}	0.10	0.12	0.05

(Viktorija and Akvile, 2015)

Case study-3

Journal of Food Composition and Analysis 49 (2016) 87–93

Contents lists available at ScienceDirect

Journal of Food Composition and Analysis

journal homepage: www.elsevier.com/locate/jfca

Original research article

Microgreens of Brassicaceae: Mineral composition and content of 30 varieties

Zhenlei Xiao[a,b], Eton E. Codling[c], Yaguang Luo[a,*], Xiangwu Nou[d], Gene E. Lester[a], Qin Wang[b]

Objective:

Assesment of concentrations of Macro and Micro elements and toxic heavy metals of 30 varieties of Brassicaceae microgreens.

(Xiao *et al.*, 2016)

Material and methods

Material:

- 30 varieties of Brassicaceae microgreens

Methods:

- Spectrophotometric method.

(Xiao *et al.*, 2016)

Table:7 - 30 commercially grown microgreens of Brassicaceae family.

sl.no	Commercial name	Scientific name
1	Arugula	*Eruca sativa Mill.*
2	Broccoli	*Brassica oleracea L. var. italica*
3	Brussel sprouts	*Brassica oleracea L. var. Gemmifera*
4	Cabbage Chinese	*Brassica rapa L. var. pekinensis*
5	Cabbage green	*Brassica oleracea L. var. capitata f. alba*
6	Cabbage red	*Brassica oleracea L. var. capitata f. rubra*
7	Cabbage savoy	*Brassica oleracea L. var. capitata f.sabauda*
8	Cauliflower	*Brassica oleracea L. var. botrytis*
9	Collard	*Brassica oleracea L. var. viridis*
10	Kale Chinese	*Brassica oleracea L. var. alboglabra*
11	Kale red	*Brassica oleracea L. var. acephala*
12	Kale Tucsan	*Brassica oleracea L. var. acephala*
13	Kohlrabi purple	*Brassica oleracea L. var. gongylodes*
14	Komatsuna red	*Brassica rapa L. var. perviridis*

(Xiao *et al.*, 2016)

Cont….

15	Mizuna	*Brassica rapa L. var. nipposinica*
16	Mustard Dijon	*Brassica juncea (L.) Czern*
17	Mustard red	*Brassica juncea (L.) Czern.*
18	Pak choy	*Brassica rapa L. var. chinensis*
19	Pepper cress	*Lepidium bonariense L.*
20	Radish China rose	*Raphanus sativus L.*
21	Radish daikon	*Raphanus sativus L. var. longipinnatus*
22	Radish red	*Raphanus sativus L.*
23	Radish ruby	*Raphanus sativus L*
24	Rapini	*Brassica rapa L. var. ruvo*
25	Rutabaga	*Brassica napus L. var. napobrassica*
26	Tatsoi	*Brassica narinosa L. var. rosularis*
27	Turnip	*Brassica rapa L. var. rapa*
28	Upland cress	*Barbarea verna (P. Mill.) Aschers*
29	Wasabi	*Wasabia japonica Matsum.*
30	Watercress	*Nasturtium officinale L*

(Xiao *et al.*, 2016)

Tabel :8 - Mean Macro element concentrations of Ca, Mg, P, K, and Na in 30 commercially grown microgreens in Brassicaceae family.

Commercial name	(mg/100 g FW)				
	Ca	Mg	P	K	Na
Arugula	67 ± 2[a]	41 ± 1	63 ± 1	343 ± 13	35 ± 1
Broccoli	88 ± 2	51 ± 1	69 ± 0	326 ± 9	52 ± 2
Brussel sprouts	81 ±4	49 ± 1	57 ± 1	293 ± 5	54 ± 3
Cabbage Chinese	68 ± 1	31 ± 0	69 ± 1	240 ± 35	25 ± 1
Cabbage green	92 ± 1	55 ± 1	57 ± 1	192 ± 2	57 ± 1
Cabbage red	75 ± 1	39 ± 0	65 ± 0	240 ± 2	32 ± 1
Cabbage savoy	98 ± 3	62 ± 2	59 ± 2	238 ± 9	65 ± 3
Cauliflower	94 ± 2	66 ± 1	62 ± 0	224 ± 13	61 ± 1
Collard	71 ± 3	53 ± 1	75 ± 2	266 ± 5	44 ± 1
Kale Chinese	66 ± 1	45 ± 1	68 ± 0	246 ± 23	38 ± 3
Kale red	59 ± 3	36 ± 1	60 ± 1	332 ± 18	43 ± 3
Kale Tucsan	80 ± 1	52 ± 2	69 ± 2	283 ± 8	51 ± 2
Kohlrabi purple	92 ± 5	55 ± 2	77 ± 3	342 ± 7	50 ± 3
Komatsuna red	55 ± 1	40 ± 2	70 ± 4	357 ± 3	32 ± 2
Mizuna	48 ± 5	29 ± 0	57 ± 1	354 ± 7	35 ± 4
Mustard Dijon	51 ± 4	35 ± 2	62 ± 2	365 ± 32	35 ± 1
Mustard red	47 ± 2	28 ± 1	52 ± 2	289 ± 5	27 ± 1
Pak choy	58 ± 1	31 ± 2	59 ± 4	284 ± 12	42 ± 5
Peppercress	39 ± 1	33 ± 2	58 ± 4	320 ± 26	29 ± 1
Radish China rose	54 ± 2	48 ± 2	71 ± 3	270 ± 7	38 ± 2
Radish daikon	66 ± 2	60 ± 3	86 ± 4	176 ± 10	57 ± 4
Radish red	56 ± 3	49 ± 2	81 ± 2	283 ± 10	42 ± 1
Radish ruby	41 ± 3	39 ± 2	82 ± 3	215 ± 6	19 ± 0
Rapini	92 ± 2	55 ± 1	85 ± 2	359 ± 1	56 ± 2
Rutabaga	59 ± 2	44 ± 1	64 ± 1	270 ± 14	39 ± 4
Tatsoi	62 ± 2	33 ± 1	66 ± 1	329 ± 13	36 ± 1
Turnip	57 ± 3	32 ± 1	61 ± 1	341 ± 12	26 ± 1
Upland cress	79 ± 5	47 ± 2	56 ± 0	376 ± 9	35 ± 1
Wasabi	56 ± 3	41 ± 1	69 ± 3	387 ± 9	33 ± 5
Watercress	51 ± 2	32 ± 2	62 ± 2	360 ± 3	68 ± 4

[a] Values are expressed as mean ± standard error (n = 3).

(Xiao *et al.*, 2016)

Tabel :9 - Mean concentrations of micro elementary minerals in 30 commercially grown microgreens in Brassicaceae family

Commercial name	(mg/100 g FW)					
	Fe	Zn	Cu	Mn	Cd	Pb
Arugula	0.71 ± 0.01[a]	0.35 ± 0.01	0.07 ± 0.00	0.29 ± 0.01	ND[b]	ND
Broccoli	0.67 ± 0.01	0.37 ± 0.00	0.09 ± 0.00	0.37 ± 0.00	ND	ND
Brussel sprouts	0.57 ± 0.01	0.29 ± 0.01	0.08 ± 0.00	0.37 ± 0.01	ND	ND
Cabbage Chinese	0.66 ± 0.01	0.36 ± 0.01	0.04 ± 0.00	0.30 ± 0.01	ND	ND
Cabbage green	0.59 ± 0.01	0.29 ± 0.01	0.05 ± 0.00	0.33 ± 0.00	ND	ND
Cabbage red	0.62 ± 0.01	0.36 ± 0.01	0.08 ± 0.00	0.31 ± 0.00	ND	ND
Cabbage savoy	0.57 ± 0.02	0.27 ± 0.01	0.05 ± 0.00	0.38 ± 0.01	ND	ND
Cauliflower	0.62 ± 0.01	0.29 ± 0.01	0.06 ± 0.00	0.31 ± 0.00	ND	ND
Collard	0.65 ± 0.01	0.40 ± 0.01	0.09 ± 0.00	0.36 ± 0.01	ND	ND
Kale Chinese	0.64 ± 0.04	0.37 ± 0.01	0.06 ± 0.00	0.28 ± 0.01	ND	ND
Kale red	0.47 ± 0.01	0.29 ± 0.01	0.06 ± 0.00	0.32 ± 0.01	ND	ND
Kale Tucsan	0.72 ± 0.02	0.37 ± 0.00	0.09 ± 0.00	0.44 ± 0.01	ND	ND
Kohlrabi purple	0.75 ± 0.03	0.43 ± 0.02	0.11 ± 0.01	0.39 ± 0.01	ND	ND
Komatsuna red	0.74 ± 0.05	0.38 ± 0.02	0.08 ± 0.01	0.34 ± 0.01	ND	ND
Mizuna	0.57 ± 0.02	0.28 ± 0.01	0.06 ± 0.00	0.36 ± 0.01	ND	ND
Mustard Dijon	0.56 ± 0.01	0.29 ± 0.01	0.06 ± 0.00	0.39 ± 0.01	ND	ND
Mustard red	0.62 ± 0.07	0.22 ± 0.01	0.06 ± 0.00	0.24 ± 0.00	ND	ND
Pak choy	0.49 ± 0.02	0.30 ± 0.01	0.05 ± 0.01	0.29 ± 0.02	ND	ND
Peppercress	0.48 ± 0.03	0.41 ± 0.03	0.06 ± 0.01	0.24 ± 0.02	ND	ND
Radish China rose	0.62 ± 0.03	0.35 ± 0.01	0.08 ± 0.00	0.27 ± 0.01	ND	ND
Radish daikon	0.57 ± 0.02	0.28 ± 0.01	0.05 ± 0.00	0.19 ± 0.00	ND	ND
Radish red	0.67 ± 0.02	0.43 ± 0.00	0.11 ± 0.01	0.30 ± 0.00	ND	ND
Radish ruby	0.55 ± 0.01	0.40 ± 0.01	0.06 ± 0.00	0.17 ± 0.00	ND	ND
Rapini	0.84 ± 0.05	0.51 ± 0.02	0.13 ± 0.01	0.40 ± 0.00	ND	ND
Rutabaga	0.52 ± 0.02	0.26 ± 0.01	0.07 ± 0.00	0.39 ± 0.00	ND	ND
Tatsoi	0.57 ± 0.01	0.35 ± 0.01	0.05 ± 0.00	0.29 ± 0.01	ND	ND
Turnip	0.58 ± 0.01	0.34 ± 0.01	0.07 ± 0.00	0.41 ± 0.00	ND	ND
Upland cress	0.63 ± 0.01	0.41 ± 0.01	0.12 ± 0.00	0.48 ± 0.01	ND	ND
Wasabi	0.65 ± 0.05	0.42 ± 0.01	0.08 ± 0.00	0.26 ± 0.01	ND	ND
Watercress	0.52 ± 0.01	0.41 ± 0.02	0.09 ± 0.01	0.39 ± 0.01	ND	ND

(Xiao *et al.*, 2016)

Case study-4

Journal of Food Composition and Analysis 37 (2015) 38–43

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Original Research Article

Comparison between the mineral profile and nitrate content of microgreens and mature lettuces

Edgar Pinto [a], Agostinho A. Almeida [b], Ana A. Aguiar [c], Isabel M.P.L.V.O. Ferreira [a,*]

Objective:

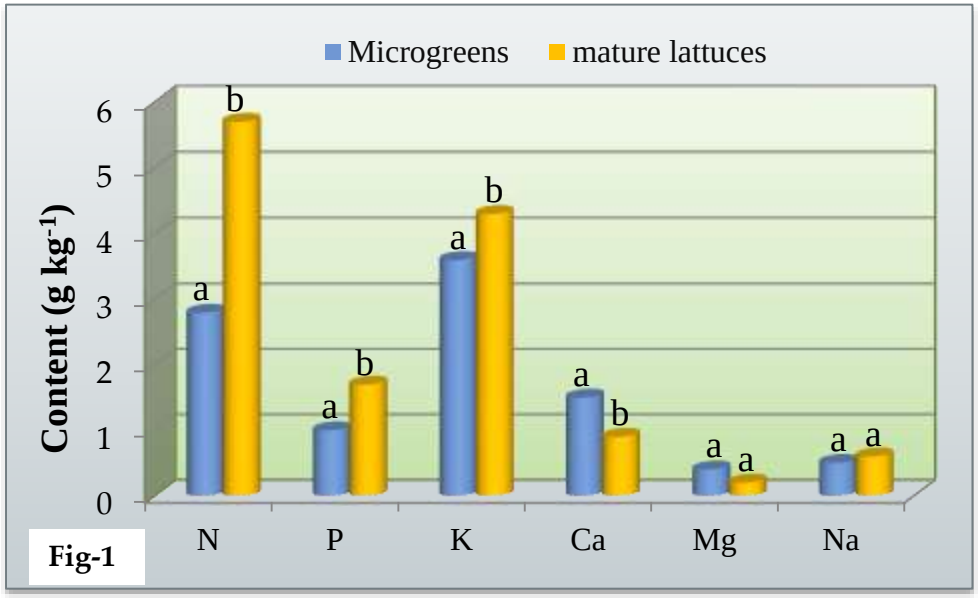
- To compare the mineral profile and nitrate level in the microgreens and mature lettuces.

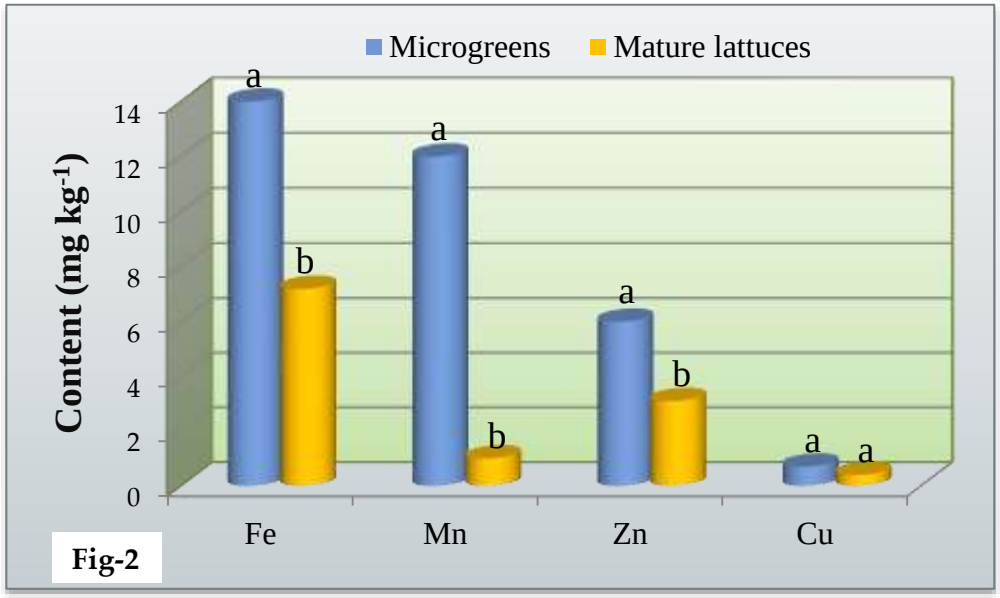
(Pinto *et al.*, 2015)

Material and Methods

- **Lettuce –** A_1, A_2, A_3.
- **Season**: Dec-Feb
- **Nitrate**: Ion Chromatography.
- **Micro nutrients:** AAS (Atomic absorption spectrometer).
- **Ammonium**: Spectrophotometric method.

(Pinto *et al.*, 2015)





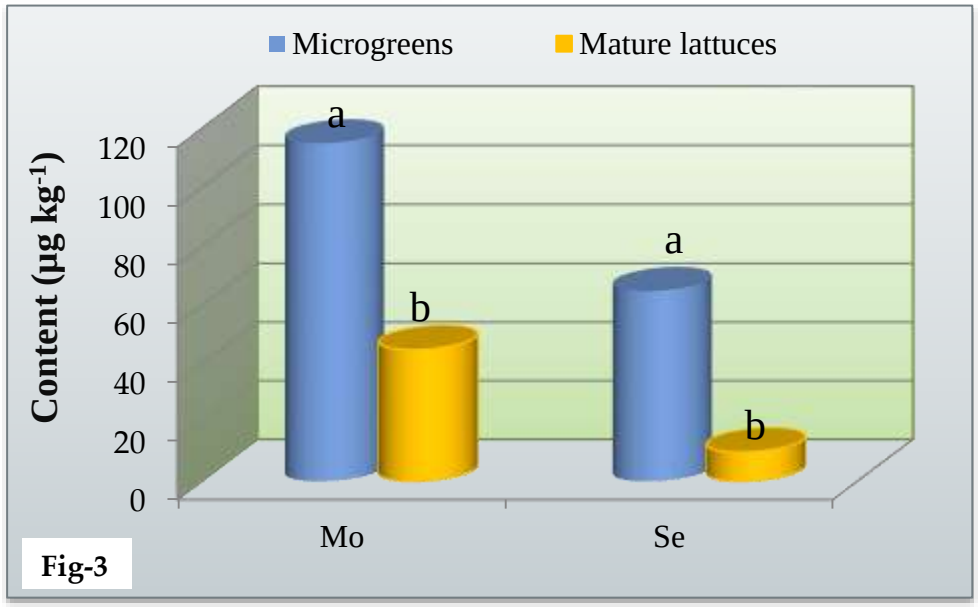


Fig:1, 2, 3 - Comparison of mineral contents between microgreens and mature lettuce.

(Pinto *et al.*, 2015)

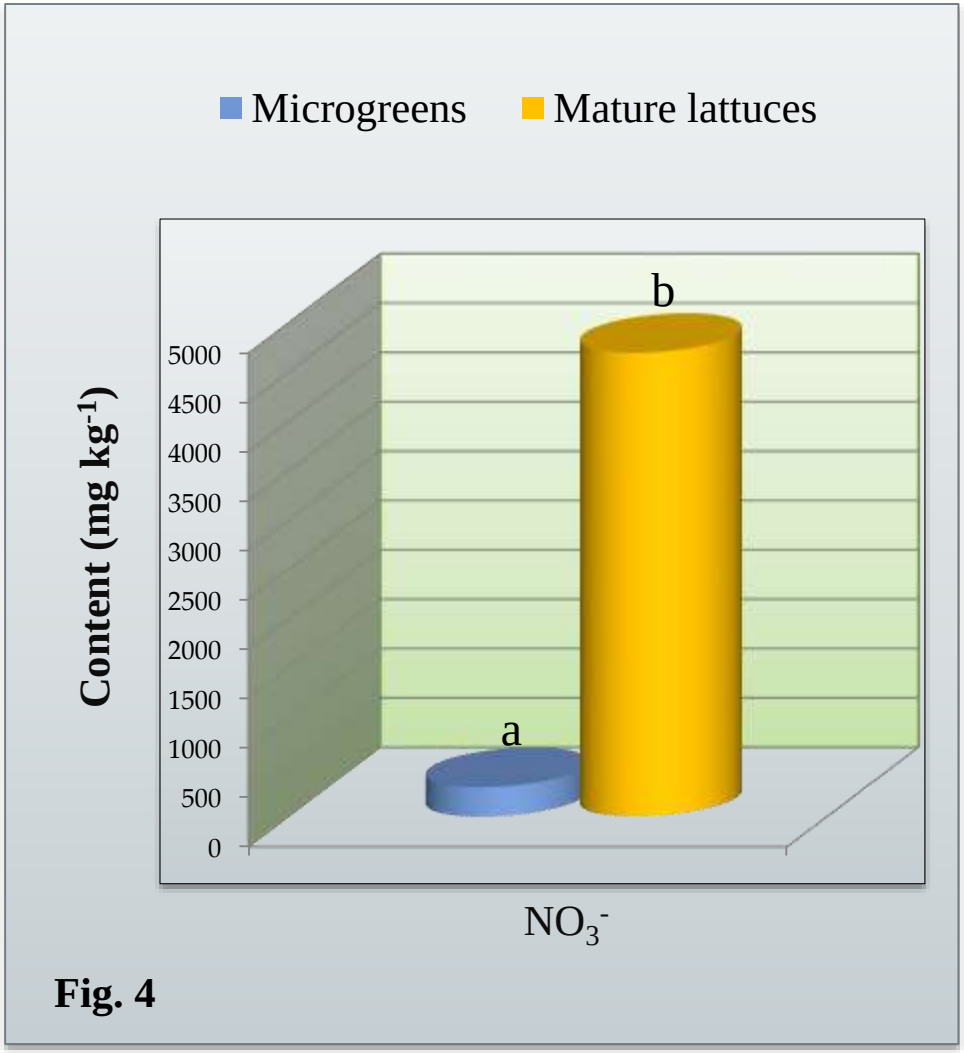


Fig. 4

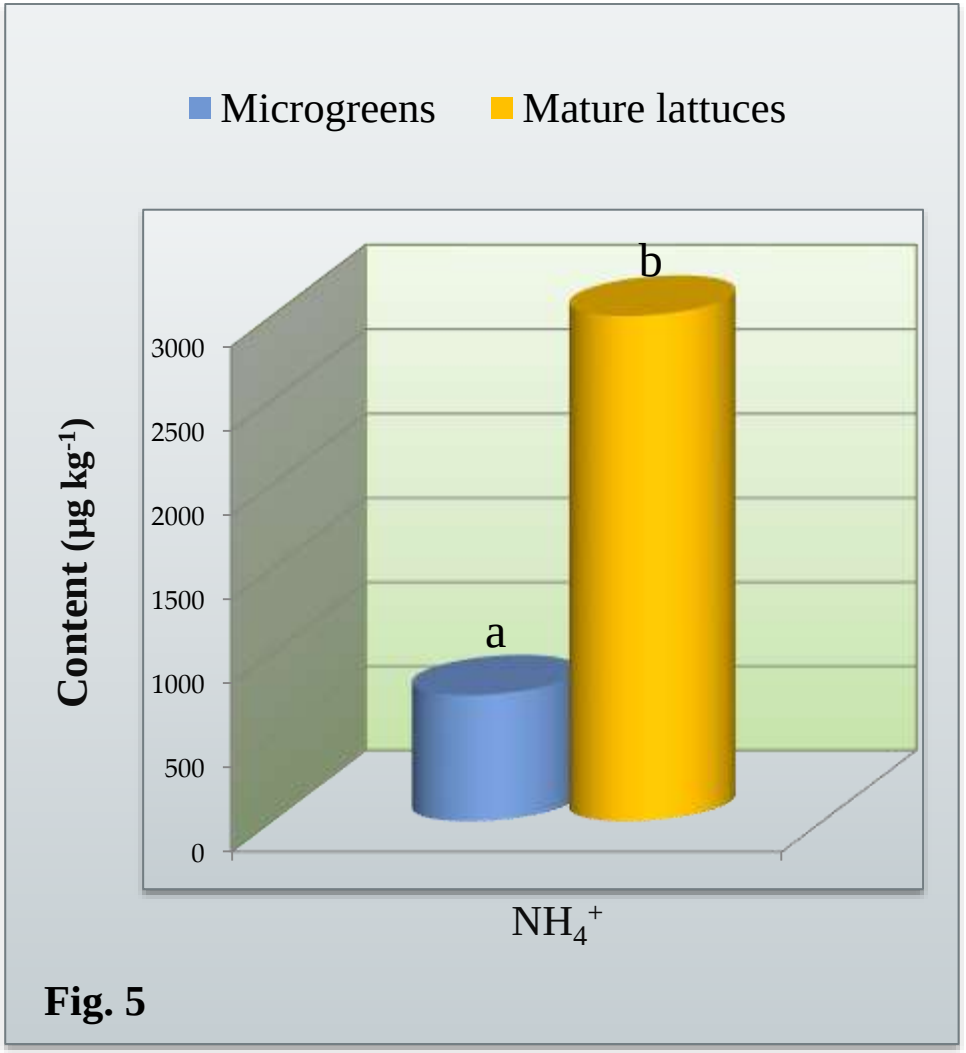


Fig. 5

Fig : 4, 5, - Comparison of nitrate and ammonia content between microgreens and mature lettuces.

(Pinto *et al.*, 2015)

Case study-5

Journal of Horticulture

Weber, J Hortic 2016, 3:4
DOI: 10.4172/2376-0354.1000190

Research Article OMICS International

Nutrient Content of Cabbage and Lettuce Microgreens Grown on Vermicompost and Hydroponic Growing Pads

Carolyn F Weber*

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Objective:

To study the nutrient contents of lettuce and cabbage microgreens grown on vermicompost and on hydroponic growing pads.

(Webber , 2016)

Material and Methods

- **Lettuce and cabbage**
- **Insert trays, growing trays,**
- **Humidity domes,**
- **Micro-mat hydroponic growing pads.**
- **Vermicompost**
- **Standard acid digestion procedure**

(Webber , 2016)

Table:10 - Average nutrient content of Lettuce vegetable, hydroponically grown lettuce microgreens and vermicompost grown lettuce microgreens

Element	LV	LHP	LC
	mg $(gdw)^{-1}$		
P	5.58	13.34	8.66
K	41.06	13.92	60.14
Ca	8.48	2.61	8.50
Mg	3.49	6.48	5.78
S	2.76	4.48	5.89
Na	5.02	1.80	2.71
	µg $(gdw)^{-1}$		
Mn	28.99	48.61	118.03
Fe	99.59	232.75	2327.45
Cu	9.44	21.22	17.49
Zn	42.65	143.49	200.97
Standard deviation(Sd)	0.056	0.059	0.056

LV- Lettuce vegetable

LHP- Hydroponically grown lettuce microgreens

LC- Vermicompost grown lettuce

(Webber , 2016)

Tabel:11 - Average nutrient content of cabbage vegetable, hydroponically grown cabbage microgreens and vermicompost grown cabbage microgreens

Element	CV	CHP	CC
	mg $(gdw)^{-1}$		
P	1.28	14.76	12.95
K	24.22	12.34	42.99
Ca	2.93	7.88	13.22
Mg	0.90	4.75	5.82
S	5.74	15.77	19.39
Na	1.07	2.61	3.49
	µg $(gdw)^{-1}$		
Mn	34.34	41.84	64.96
Fe	21.83	121.35	187.19
Cu	1.42	3.69	5.07
Zn	13.84	60.78	160.02
Standard deviation	0.120	0.096	0.070

CV- Cabbage vegetable

CHP- Hydroponically grown cabbage microgreens

CC- Vermicompost grown cabbage

(Webber , 2016)

Success stories

microgreens FARMER

Krishi Cress – International chef turned micro greens farmer!

Posted July 14, 2015 by editorial team (THE HINDU)

Hobby by chance led chef to take up farming as parallel profession!

- Chef Achintya Anand grows 15 varieties of microgreens and supplies across New Delhi and Gurgaon.
- Some of the microgreens grown at his farm are mustard, radish, basil, coriander, red cabbage, lettuce and broccoli etc.

❑ **Packaging is done in two ways.**

✓ First using live box

✓ Another way is to cut, wash, dry and pack in food grade polythene bags with holes.

✓ He takes contract with five star hotels and restaurants.

✓ Some price quotes are Rs. 150/50 gms for mustard and radish.

‘Terra Farms’ Microgreens

They follow the concept of vertical urban farming in microgreens.(Mumbai)

Adhithya Organic – Urban organic farming

Posted December1,2014 by editorial team(THE HINDU)

•Mr. N. Vidhyadharan and his wife Mrs. M. Jayarani grows micro-greens at their farm, **Adhithya Organics,Vengaivasal**, Chennai.

•Grows micro-greens in soil-less medium.

•Targets 5-stars hotels and organic stores for sale

Media - vermicompost, fermented plant extracts and organic fertilizer that is produced at their farm.

•Capital investment - approximately spent Rs. 35,000

•Profit - Rs.18000 to 20,000 per month.


trueleafmarket.com


urbanproduce
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MICROGREENS
Kale-ifornia
SUPERFOOD BLEND
LOCALLY GROWN
USDA
ORGANIC


ENVIRONMENT FRIENDLY
100%
ORGANIC
NO HARM TO NATURE

Conclusion

- Bioactive compounds and minerals
- Taste and flavor
- Less cost and more income
- Pesticide residue free


Grow
Own it!
Microgreens
at Home


THANK
Q.....