

IV RESULTS AND DISCUSSION

The results and discussion of the study titled “**Cultivation and Nutritional Profiling of Selected Varieties of Microgreens and their Acceptability in Incorporated Recipes**” are discussed under the following headings

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4.1. Phase I: Analysis of Growth and Cultivation of Microgreens

In phase I of the study, the growth and cultivation of microgreens were discussed. This includes selection of a variety of microgreens, minor tools and other

accessories used. Further the growing media used for the cultivation process were identified. Also the analysis of different lighting conditions and watering methods were performed and the results are projected.

4.1.1. Selection of Samples, Minor Tools and Other Accessories

The microgreens though rich in nutrients and affordable are substantially less consumed among the public, hence were selected for the study. Microgreens generally require a short span of time and can be grown easily in a small space. These does not require any land resources instead can be cultivated using urban farming techniques (Khatton and Singh, 2022). It contains a significantly higher amount of nutrients when compared to normal greens. Due to its superior nutritional profile it is claimed as a better substitute for sprouts (Pucinelli *et al.*, 2019). In addition, microgreens are also claimed to contain a higher amounts of minerals, vitamins and phytochemicals in comparison to their mature counterparts (regular greens) (Yadav *et al.*, 2019, Xiao *et al.*, 2012). A study by Flores *et al.*(2014) states that microgreens are free from toxic heavy metals and low in nitrate content in comparison with the matured greens.

Microgreens have a peculiar flavor and texture which is completely different from the normal greens making it more acceptable for consumption. Also, these microgreens are very tender and delicate making it is a very suitable ingredient to be added in any type of recipes especially salads. Studies state that due to their aroma, flavor, soft texture, brilliant color, sensory qualities and fast production or cultivation, microgreens are in high demand and among consumers' top choices (Bhaswant *et al.*, 2023). Chefs are increasingly using microgreens to enhance the flavor and texture of sandwiches, salads, and other dishes and hence microgreens are on high demand in high end restaurants (Khatoon and Singh, 2012, Bhaswant *et al.*, 2023). According to a project report by California State university, Chefs prefer microgreens more for their range of colors, textures, and flavors and are more likely to be found on the menus of local mid- to high-end sit-down restaurants, juice bars and brewpubs (Enssle, 2020).

Hence, microgreens were selected for the present study. The following microgreen seed samples (N=6) were selected and the study was conducted.

Mustard Microgreen (*Brassica juncea*) from Brassica family, Chia Microgreen (*Salvia hispanica*) from Mint family, Fenugreek Microgreen (*Trigonella foenum-graecum*) from the Fabaceae family, Beetroot Microgreen (*Beta vulgaris*) from the Amaranthaceae family, Sesame Microgreen (*Sesamum indicum*) from Pedaliaceae family and Radish Microgreen (*Raphanus sativus*) from Brassicaceae family.

4.1.2. Results of Pilot Study

The pilot study was conducted to analyze the best growing media suitable for the growth of microgreens and also to analyze the better growth conditions, especially the lighting method and the watering method suitable for the growth of microgreens.

4.1.2.1. Cultivation Process of Microgreens

The cultivation process of microgreens is as follows:

The first step is filling the containers with different mediums like black soil mixed with sand, vermicompost mixed with sand and cocopeat mixed with sand. Then the Microgreen seeds are spread on the surface of the media evenly. After the spreading of seeds, an adequate amount of water was sprayed. The different watering methods administered were top and bottom watering method. The lighting methods administered were direct lighting (sunlight), partial lighting and Light-Emitting Diode (*LED*) lighting. The entire tray was then covered with aluminium foil for two days. Proper observation was done in the midst to see the moisture level. After two days, the seeds were uncovered. After a week, the container was full of healthy microgreens. Once the plants are 2-3 inches tall, they are ready to harvest (Treadwell *et al*, 2010; Xiao *et al*, 2012, Treadwell *et al*, 2020). The harvested microgreens were washed and can be used to enhance the meal.

4.1.2.2. Determination of Optimal Growing Medium for Cultivation of Microgreens

Three growing medias were selected to cultivate the selected microgreens. Mediums used for the cultivation were vermicompost, black soil, and coco peat mixed with sand in the ratio 1:1,2:1 and 3:1. The mustard microgreens were selected for the testing of growth medias as it had the higher growth rate at limited time. The production rate was also high in mustard microgreens (Naik *et al.*, 2022). Mustard Microgreens were having higher yield in short period of time compared to other microgreens (Verlinden, 2020). The effect of growth media is discussed in the Table III.

Table III depicts the different media used for the growth of mustard microgreens.

Table III

Growth Pattern of Mustard Microgreens Cultivated in Different Growing Medium

Microgreen	Growth media	Effect
Mustard Microgreens	Vermicompost	Microgreens were weak and unsuitable for consumption.
Mustard Microgreens	Black soil	Microgreens were found to be having yellow discoloration at 3 rd day of cultivation
Mustard Microgreens	Coco peat	Adequate growth was seen in terms of increase in leaf size and stem length

Mustard microgreens were selected for growing in different mediums. The growing patterns of microgreens in vermicompost was studied for seven days. The effects were analyzed and found that the microgreens are not growing well in the medium of vermicompost . The vermicomposting process helps to stabilize active organic materials and transform them into a useful soil supplement and source of plant nutrition (Domínguez *et al.*, 2010).

Study on the growth of microgreens with black soil was studied and found that there was no significant growth seen in the microgreens. Black soil has got good water retention capacity which makes it super fertile and best for growing crops that require a good amount of water to grow (Lau, 2019).

Cocopeat was discovered to be the optimum medium for microgreen cultivation. Analyzing the growth of mustard microgreens from day 1 to day 7 in cocopeat ,it was clear that the best yield was from the microgreens cultivated with coco peat .

Coco peat is naturally antifungal, making it an excellent choice to start seeding but it is also used in rugs, ropes, brushes, and as stuffing. It can store and release nutrients to plants for extended periods of time. Therefore, Cocopeat were selected for the further conduct of the study. The cocopeat was the best medium identified for the growth of microgreens. Microgreens were reported to grow very well in cocopeat. (Ramya *et al.*, 2022). Cocopeat medium combined with soil and water medium had a

higher yield and a shorter harvesting period than the other two mediums like just soil and water medium.

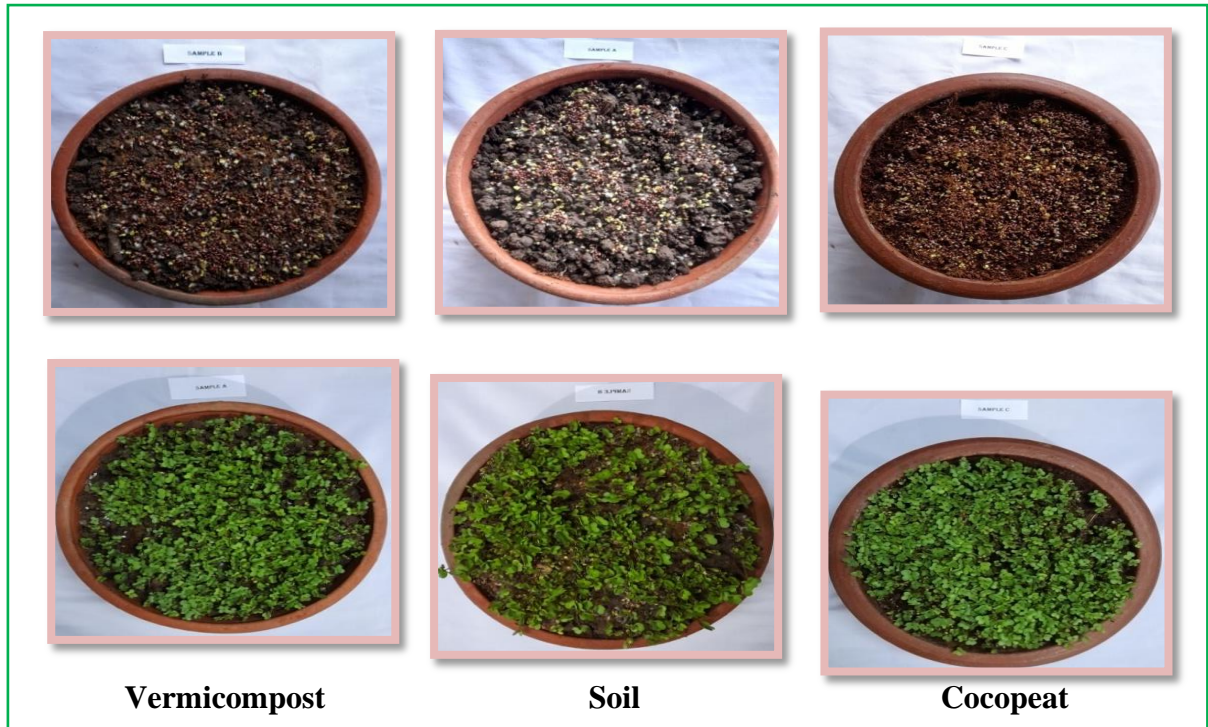


Plate XXVI: Day 3 and 7 Growth of Mustard Microgreens in Different Growth Medias

4.1.2.3 Analysis of the Growing media used for the Cultivation of Microgreens

The growing media is one of the primary expenses for microgreen cultivation. It has a significant impact on the quantity and quality of microgreens produced as well as the environmental sustainability of the manufacturing process. The laboratory analysis of the growth media was done. The cocopeat was tested to determine the nutrient content of the medium in which the microgreen was grown. The test was also done to elicit the microbial count in the growth media.

4.1.2.3.1 Physiochemical Analysis of the Growth Medium (Cocopeat)

The physiochemical content of the cocopeat was analyzed and recorded in Table IV.

Table IV
Physiochemical Composition of Cocopeat

Parameter	Sample Value
pH	7.2
Average Phosphorous(P)(mg/kg)	12.6 - 13.01
Average Potassium(K)(mg/kg)	4.1 - 4.31
Total Nitrogen (N) (%)	4.09
Organic carbon (OC) (%)	47.4

The table IV shows the nutrient content of cocopeat. The pH value of the medium was 7.2, the peat is basic in nature. The average Phosphorus content in the growth medium was 12.6-13.01 mg/kg. Phosphorous plays a major role in photosynthesis and respiration. It plays a vital role in energy storage and transfer as ADP and ATP (Silva and Uchida, 2000). Application of Phosphorus increases the uptake of Calcium in plants. Xiao *et al.*, 2013 have reported that the uptake of calcium was higher in *Apium graveolens* L. after phosphorous application.

The average Potassium content in the growth medium was 4.1-4.31 mg/kg. Potassium plays a vital role in the metabolism of nitrogen (Xu *et al.*, 2020). It is Essential for ensuring optimal plant growth (White and Karley, 2010). It is also very much necessary for cell growth, which is an important process for the function and development of plants (Hepler *et al.*, 2001).

The growth medium contains the total nitrogen content of 4.09 percent. Nitrogen is required for all enzymatic activities in a plant since it is a key component of the chlorophyll molecule, which is essential for photosynthesis. Since all plant enzymes are proteins, nitrogen is also required for all enzymatic reactions (Silva and Uchida, 2000).

The organic carbon present in cocopeat was 47.4 percent. Plant-derived carbon (PDC) emitted by roots has a substantial influence on the bacterial population associated with roots, which is crucial for plant fitness in natural environments (Zohu *et al.*, 2020).

4.1.2.3.2 Determination of Microbial Count in Growth Medium (Cocopeat)

The count of microorganisms present in the cocopeat was analyzed and recorded.

Table V
Microbial Count of Cocopeat Growth Medium

Microorganisms	CFU/g of sample		
	Day 5	Day 6	Day 7
Total bacteria (10^5)	74	68	76
Total fungi (10^3)	21	23	18
Actinomycetes(10^2)	7	5	7
Phosphobacteria(10^5)	36	32	41
<i>Pseudomonas</i> sp.(10^5)	64	67	61
<i>Azotobactersp.</i> (10^2)	26	23	27
<i>Azospirillum</i> sp.(10^2)	0	0	0
<i>Rhizobium</i> sp.(10^2)	0	0	0

Microbiological analysis was done to determine the microbial load in the growth media. The table V projects the microbial count in the cocopeat growth media. Cocopeat is reported as a medium which is relatively resistant to harmful microbial and fungal growth, and an ideal medium for germinating seeds (Hyder *et al.*, 2009).

The total bacteria found in peat was maximum (76 CFU/g of sample) on the 7th day. The total fungi was high on Day 6 that was 23 CFU /g of sample. Cocopeat was found to be having higher microbial population which makes it a suitable medium for growing crops (Priyadharshini, 2022).

The nitrogen fixing bacterias like *Azotobactersp* and Actinomycetes were present in the growth media. The actinomycetes was found to be 7 CFU/g of sample on Day 5 and 7, and on Day 6 the actinomycetes count was 5 CFU/g of sample. The Phosphobacteria was present in more on the 7th day with a 41 CFU/g of medium. The amount of *Pseudomonas* sp. were high (67 CFU/g of the sample) in the 6th Day of

cultivation. The count of *Azotobacter* was reported to be high on day 7 with CFU of 27 per gram of sample. The count of *Azospirillum* and *rhizobium* was 0 CFU/g of sample.

Azotobacteris a Gram-negative, nitrogen-fixing, free-living aerobic bacterium. These bacteria are known to use nitrogen from atmosphere for cellular protein synthesis, which is mineralized in the soil, providing crop plants with a significant amount of the nitrogen available from the soil source. *Azotobacter* spp. is sensitive to high salt concentrations, acidic pH, and temperature (Aquilanti *et al.*, 2004). The number of *Azotobacter* strains in soils is generally low ($<10^4$ CFU g⁻¹ soil). However, they are found throughout the world typically in 30 to 80 percent of sampled soils (Kennedy *et al.*, 2004).

Actinomycetes are aerobic, spore-forming gram-positive bacteria that improve nutrient and mineral availability, increase metabolite synthesis, and stimulate plant growth regulators. They are the most prevalent organisms in the soil that create thread-like filaments and are responsible for the characteristic "earthy smell of freshly turned healthy soil (Bahatti *et al.*, 2017).

Pseudomonas sp. strain S3 has the potential to be an excellent plant growth promoter, stimulating growth and improving resilience in tomato plants grown insaline condition (Pandey and Gupta, 2020).

Therefore, great attention is required in selection of the growing media, and particular care should be taken regarding the microbiological characteristics of the substrate, to ensure the production of high quality microgreens.

4.1.2.3. Determination of Optimal Lighting Condition and Watering Methods for Microgreen Cultivation

Microgreens were cultivated under different lighting pattern and watering methods and the growth pattern was noted. Changes in visual appearance of the microgreens was observed. The different growing conditions were carried out to find out the best environmental conditions suitable for the growth of the microgreens. The growth of mustard microgreens under different environmental conditions is presented in Table VI.

Table VI
Growth Pattern of Mustard Microgreens under Selected Lighting Conditions and Watering Methods

Mustard Microgreens	Lighting Conditions and Watering Methods Selected	Changes in Visual Appearance
Treatment I A	Direct Sunlight (Direct lighting)-Top Watering	Slight Bending at the 7 th day. Leaves and stems appear to be thin and weak.
Treatment I B	Direct Sunlight (Direct lighting)-Bottom Watering	Severe Bending at the 7 th day. Long and frail stem.
Treatment II A	Indirect Sunlight (Partial Lighting)-Bottom Watering	Bending at the 7 th day. Leaves appear to shrink at 6 th day.
Treatment II B	Indirect Sunlight (Partial Lighting) -Top Watering	Perfect stature
Treatment III A	LED lighting-Top Watering	Slight Bending at the 7 th day. Leaves appears to be smaller than usual size.
Treatment III B	LED lighting-Bottom Watering	Severe Bending at the 7 th day. Watered tends to clog at the bottom and the stems were seen to rot.

Plants exhibits different changes based on the environmental stimuli. The changes could be physiological or morphological. The above Table VI presents the morphological changes of microgreens under different environmental conditions, which was observed visually.

Microgreens were grown in the cocopeat medium under different environmental conditions. The different environmental conditions were categorized into three treatments based on the lighting such as Direct Sunlight (Treatment I), Indirect Sunlight (Treatment II) and LED Light (Treatment III) and each treatment was categorized into two, in which one set of microgreens was top watered and other bottom watered.

In treatment I, microgreens were cultivated in cocopeat with direct lighting (sunlight) and top watering method was administered. It was noticed that the microgreens were not having a good growth pattern in this type of condition. The plants were bending at the seventh day of its growth. The microgreens which were grown in cocopeat with direct lighting and bottom watering method (Treatment I B) was reported to have bending and resulted in loss of some microgreens which reduced the total yield of cultivation. The stem appeared to be very fragile and weak. The bottom watering method tends to rot the stems due to water clogged in the bottom part of the microgreens (Nath, 2015). The growth of microgreens was reported to be suitable in top watering method and hence this method was selected for further conduct of the study.

The mustard microgreens were grown in cocopeat with indirect sunlight (partial lighting) and top watering method (Treatment II A) and the growth changes were observed. This method was found to be the best condition suitable for the growth of the microgreens as it resulted in best yield and stature at the time of cultivation.

While cultivating microgreens in cocopeat with indirect lighting and bottom watering method (Treatment II B), the perfect growing pattern was not obtained. The same was with the case of cultivating microgreens with cocopeat in LED lighting along with top and bottom watering (Treatment II A & B). The greens tend to bend and were not suitable for consumption. The microgreen growth was reported to be minimal while subjecting to LED lighting (Putri, 2022).

Hence, the pilot study revealed that cocopeat is the best suitable media for positive growth of microgreens. The lighting method suitable for the growth of microgreens was partial/ indirect lighting. The microgreen growth was superior in top watering method. Hence further conduct of the study was carried out the optimal growing medium, lighting condition and watering method.

Based on the results of pilot study, all the six selected microgreens (Mustard Microgreen, Chia Microgreen, Fenugreek Microgreen, Beetroot Microgreen, Sesame Microgreen, RadishMicrogreen) were cultivated in the cocopeat medium under indirect lighting and top watering. After cultivation the growth was analysed in terms of stem length, leaf size and leaf length.



Plate XXVII: Cultivated Microgreens in the Cocopeat Medium, Indirect Lighting and Top Watering (Day 1 & 7)

4.1.3. Analysis the Growth of Cultivated Microgreens

4.1.3.1. Growth of Mustard Microgreen

The growth of mustard microgreens was analyzed and the results are projected in Table VII. The stem length, leaf size and leaf length were measured after the germination of seeds. Table VII shows the growth of mustard microgreens.

Table VII

Length and Size of Mustard Microgreen

Day	Stem Length (Inches)	Leaf Size (Inches)	Leaf Length (Inches)
Day 1	0	0.03	0.07
Day 2	0.19	0.13	0.11
Day 3	0.78	0.19	0.15
Day 4	1.26	0.19	0.15
Day 5	1.57	0.19	0.19
Day 6	2	0.236	0.19
Day 7	2.36	0.275	0.236

The growth of the mustard microgreens was observed for 7 days. On day 1, the leaf size was 0.03 inches and the leaf length was 0.07 inches, on day 2, the stem length increased and it was 0.19 inches and the leaf size and length were 0.13 inches and 0.11 inches respectively. On day 3 and day 4, the stem length has increased from 0.78 inches to 1.26 inches. The total length of the microgreens increased from 1.57 inches to 2.36 inches from day 5 to day 7, and the leaf length and size have increased from 0.19 inches to 0.236 inches and 0.19 inches to 0.275 inches respectively.

Due to its quick growth that is about 5-8 days and presence of a variety of rich flavors and hues, microgreens from the genus Brassica have gained popularity (Xiao *et al.*, 2012).

4.1.3.2. Growth of Chia Microgreen

The growth of Chia microgreen was analyzed and reported. The stem length, leaf size and leaf length were measured after the germination of seeds and projected in Table VIII.

Table VIII
Length and Size of Chia Microgreen

Day	Stem Length (Inches)	Leaf Size (Inches)	Leaf Length (Inches)
Day 1	0	0.019	0.03
Day 2	0.31	0.05	0.05
Day 3	0.39	0.05	0.15
Day 4	0.9	0.07	0.15
Day 5	1.65	0.11	0.19
Day 6	2.03	0.12	0.19
Day 7	2.51	0.15	0.23

Chia microgreens are more popular in the food industries (Szopa *et al.*, 2023). It has also been analyzed for its lipid extraction properties by the researchers (Castellaneta *et al.*, 2015, Castellaneta *et al.*, 2022). Hence analyzing the growth of the chia microgreen is essential to determine the yield. The growth of chia microgreen was observed for 7 days. On day 1, the leaf size was 0.019 inches and the leaf length was 0.03 inches, on day 2, the stem length increased and it was 0.31 inches and the leaf size and length were same that is 0.05 inches. On day 3 and day 4, the stem length increased to 0.9 inches. Finally on day 7, the stem length was 2.51 inches.

4.1.3.3. Growth of Beetroot Microgreen

The growth of beetroot microgreens was analyzed and tabulated in table IX. The stem length, leaf size and leaf length were measured after the germination of seeds.

Table IX
Length and Size of Beetroot Microgreen

Day	Length (Inches)	Leaf size(Inches)	Leaf length(Inches)
Day 1	0	0.01	0.03
Day 2	0.03	0.09	0.11
Day 3	1.18	0.12	0.15
Day 4	1.37	0.16	0.15
Day 5	1.65	0.196	0.15
Day 6	2.04	0.196	0.196
Day 7	2.36	0.196	0.196

Beetroot microgreen is one of the most often used and highly valued microgreen for both its strong flavour and its nutrient-dense qualities featuring betalains and polyphenols (Rocchetti *et al.*, 2020). The length and size of beetroot microgreens was observed for 7 days. On day 1, the total stem length of the microgreen was 0 inches, the leaf size was 0.01inches and the leaf length is 0.03 inches, on day 2, the stem length was increased and it 0.03 inches and the leaf size and length are 0.09 inches and 0.11 inches. On day 3 and day 4, the stem length has increased from 1.18 inches to 1.37 inches. The total stem length of the microgreen has increased from 1.65 inches to 2.36 inches from day 5 to day 7, the leaf length remained same at0.196 inches from day 5 to 7. The leaf size increased from 0.15 inches to 0.196 inches.

4.1.3.4. Growth of Sesame Microgreen

The growth of Sesame microgreens was analyzed and reported in the table X. The stem length, leaf size and leaf length were measured after the germination of seeds.

Table X
Length and Size of Sesame Microgreen

Day	Stem Length (Inches)	Leaf Size (Inches)	Leaf length (Inches)
Day 1	0	0.015	0.015
Day 2	0.74	0.06	0.04
Day 3	0.94	0.08	0.15
Day 4	1.25	0.11	0.16
Day 5	1.57	0.157	0.196
Day 6	1.77	0.157	0.20
Day 7	1.96	0.20	0.216

Sesame microgreens are popular for its nutrient content. (Ebert, 2022). It has been recognized and reported for its high antioxidant activity (Senevirathne *et al.*, 2018). It can used as an ingredient in various recipes to make them nutritious as well as tasty. The Table X highlights the growth of sesame

microgreens. The growth was observed for 7 days. On day 1, the leaf size and the leaf length of sesame microgreens was 0.015 inches. On day 3 and 4, the stem length of the microgreen increased to 1.25 inches. On day 7, the stem length measured a maximum of 1.96 inches whereas the leaf size and length measured 0.20 and 0.216 inches respectively.

4.1.3.5. Growth of Fenugreek Microgreen

Fenugreek is an indigenous green leafy vegetable which is commonly used (Reema *et al.*, 2023). Fenugreek is known to have hypo-glycemic effect. It can be included in dishes prepared for diabetics. The growth of fenugreek microgreens was analyzed till day 7 and reported in Table XI. The stem length, leaf size and leaf length were measured after the germination of seeds.

Table XI
Length and Size of Fenugreek Microgreen

Day	Stem Length (Inches)	Leaf Size (Inches)	Leaf length (Inches)
Day 1	0	0.03	0.11
Day 2	0.31	0.03	0.11
Day 3	0.39	0.08	0.15
Day 4	0.9	0.12	0.20
Day 5	1.65	0.15	0.21
Day 6	2.16	0.17	0.23
Day 7	2.5	0.19	0.27

Table XI shows the growth of fenugreek microgreens. The growth was observed for 7 days. On day 1, the leaf size was 0.03 inches and the leaf length was 0.11 inches. The stem length of the microgreen increased from 0 inches from day 1 to 1.65 inches on day 5 and 2.5 inches on day 7. The leaf length increased from 0.23 inches to 0.27 inches and leaf size increased from 2.16 inches to 2.5 inches between day 6 and 7.

4.1.3.6. Growth of Radish Microgreen

The growth of radish microgreens were analyzed and reported. The stem length, leaf size and leaf length were measured after the germination of seeds. The below Table XII presents the growth pattern of radish microgreens.

Table XII
Length and Size of Radish Microgreen

Day	Stem Length (Inches)	Leaf Size (Inches)	Leaf length (Inches)
Day 1	0	0.01	0.03
Day 2	0.59	0.11	0.11
Day 3	1.17	0.17	0.16
Day 4	1.45	0.21	0.17
Day 5	1.6	0.23	0.19
Day 6	2.17	0.25	0.23
Day 7	2.48	0.28	0.23

Table X elucidates the growth of radish microgreen. The growth of the microgreen was observed for 7 days. On day 1, the leaf size and length of the microgreen was 0.03 and 0.01 inches. Comparing day 4 and 5, the stem length of the microgreen increased from 1.45 inches to 1.6 inches. The leaf size increased from 0.23 inches to 0.28 inches between day 5 and 7 and leaf length increased from 0.19 inches to 0.23 inches between day 5 and day 7. Gioia *et al.* (2017) reported, radish as one of the fast growing microgreens.

4.1.3.7. Comparison of Growth of the Selected Microgreens (N=6)

The growth of each microgreen was compared for its leaf and stem length from day 3,5 and 7. The weight of each variety of microgreens was also analyzed and recorded. The table XIII presents the growth comparison of different microgreens based on leaf size and stem length and also the weight at the time of harvest.

Table XIII

Growth Comparison of Cultivated Microgreens

Microgreen	Leaf size (Inches) 3 rd day	Leaf size (Inches) 5 th day	Leaf size (Inches) 7 th day	Stem length (Inches) 3 rd day	Stem length (Inches) 5 th day	Stem length (Inches) 7 th day	Weight at time of harvest (g)
Mustard	0.10	0.23	0.5	0.75	1.01	1.52	28.34
Fenugreek	0.19	0.26	0.72	0.83	1.45	1.78	27.12
Beetroot	0.08	0.20	0.43	0.61	1	1.03	18.32
Chia	0.05	0.12	0.33	0.45	0.98	1	15.02
Sesame	0.02	0.11	0.21	0.54	1.32	1.62	24.5
Radish	0.10	0.24	0.82	0.82	1.32	1.74	22

The leaf size and stem length of fenugreek microgreens was maximum compared to the other microgreens on day 3 and day 5. On the 7th day, the radish microgreen had the largest leaf that was 0.82 inches. And the stem length of fenugreek microgreen was the maximum (1.78 inches) on day 7. In regard with the weight of microgreens at the time of harvest, the mustard microgreen weighed the most that is 28.34g followed by fenugreek microgreens (27.12g) and sesame microgreen (24.5g). The chia microgreen weighed the least, that is 15.02g. Kopsell *et al.* (2015) highlighted that the growth of microgreens are regulated by the quality and intensity of light.

Table XIV
Mean Difference Between Stem Length of the Selected Microgreens on Day 1

Variables		Mean	SE	F-value	Sig
Stem length (Day 1)	Mustard Microgreen	2.34 ± 0.15	0.07	14.787	.000*
	Chia Microgreen	2.42 ± 0.13	0.06		
	Beetroot Microgreen	2.08 ± 0.08	0.04		
	Sesame Microgreen	2.08 ± 0.08	0.04		
	Fenugreek Microgreen	2.66 ± 0.24	0.11		
	Radish Microgreen	2.06 ± 0.09	0.04		

* Significant at 1% level

The mean difference between Stem Length and the type of Microgreen (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 1 were analyzed in One-Way ANOVA and. The Table XIV presents the mean difference between stem length of different microgreens. The data present in the Table XV denotes a significant mean difference between the variables as the significance (p - value) value is 0.000 (at 1% level). On the day I, the stem length of fenugreek microgreen was found to be tall and radish microgreen was short than other microgreens.

Table XV
Mean Difference between Leaf Size of the Selected Microgreens on Day 1

Variables		Mean	SE	F-value	Sig
Leaf Size (Day 1)	Mustard Microgreen	0.26 ± 0.11	0.05	4.891	.003*
	Chia Microgreen	0.04 ± 0.02	0.01		
	Beetroot Microgreen	0.22 ± 0.10	0.04		
	Sesame Microgreen	0.17 ± 0.06	0.03		
	Fenugreek Microgreen	0.19 ± 0.05	0.02		
	Radish Microgreen	0.24 ± 0.10	0.04		

* Significant at 1% level

Mean difference between leaf size and microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 1 were elucidated in the Table XV. One-way ANOVA was used to analyse the data. The above table clearly shows the mean difference between the leaf size of different microgreens. The estimated f value was 4.891 and the data was statistically significant. On Day 1 leaf size of mustard microgreen were largest and chia microgreen was smallest among the selected Microgreens.

Table XVI
Mean Difference between Stem Length of the Selected Microgreens on Day 2

Variables		Mean	SE	F-value	Sig
Stem length (Day 2)	Mustard Microgreen	3.18 ± 0.31	0.14	63.040	.000*
	Chia Microgreen	3.20 ± 0.10	0.04		
	Beetroot Microgreen	2.38 ± 0.13	0.06		
	Sesame Microgreen	2.34 ± 0.11	0.05		
	Fenugreek Microgreen	3.36 ± 0.11	0.05		
	Radish Microgreen	3.84 ± 0.11	0.05		

* Significant at 1% level

The Table XVI reports the mean difference between Stem Length and Microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 2. The mean difference was determined using One-Way ANOVA. The data was significant with the estimated f value of 63.040 and p value of .000. On Day 2 Stem Length of Radish Microgreen was higher and the sesame microgreen was shorter than other microgreens.

Table XVII
Mean Difference between Leaf Size of the Selected Microgreens on Day 2

	Variables	Mean	SE	F-value	Sig
Leaf Size (Day 2)	Mustard Microgreen	0.30 ± 0.10	0.04	1.889	.134 ^{NS}
	Chia Microgreen	0.20 ± 0.12	0.05		
	Beetroot Microgreen	0.19 ± 0.09	0.04		
	Sesame Microgreen	0.27 ± 0.08	0.03		
	Fenugreek Microgreen	0.19 ± 0.09	0.04		
	Radish Microgreen	0.32 ± 0.09	0.04		

* Significant at 1% level

The mean difference between leaf size of the selected microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) based on the Day 2 observations were projected in the Table XVII. One-way ANOVA was used to analyse the data. The above table clearly shows that there is no significance between the variables, as the p value was .134 at 1 percent level. On Day 2 the leaf size of Radish Microgreen was large in comparison to other Microgreens.

Table XVIII
Mean Difference Between Stem Length of the Selected Microgreens on Day 3

	Variables	Mean	SE	F-value	Sig
Stem length (Day 3)	Mustard Microgreen	4.74 ± 0.15	0.07	279.219	.000*
	Chia Microgreen	4.20 ± 0.07	0.03		
	Beetroot Microgreen	2.94 ± 0.09	0.04		
	Sesame Microgreen	2.94 ± 0.09	0.04		
	Fenugreek Microgreen	3.94 ± 0.11	0.05		
	Radish Microgreen	4.82 ± 0.13	0.06		

* Significant at 1% level

The Table XVIII highlights the mean difference between stem length of the selected microgreens based on day 3 observations. One way ANOVA was used to determine the mean difference of the data. The stem length of the selected

microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) had significance as the p value was .000 at 1 percent level. On Day 3 Stem Length of Radish Microgreen was high than other Microgreens.

Table XIX
Mean Difference Between Leaf Size of the Selected Microgreens on Day 3

	Variables	Mean	SE	F-value	Sig
Leaf Size (Day 3)	Mustard Microgreen	0.44 ± 0.09	0.04	1.029	.423 ^{NS}
	Chia Microgreen	0.48 ± 0.31	0.14		
	Beetroot Microgreen	0.40 ± 0.10	0.04		
	Sesame Microgreen	0.30 ± 0.16	0.07		
	Fenugreek Microgreen	0.30 ± 0.16	0.07		
	Radish Microgreen	0.30 ± 0.16	0.07		

* Significant at 1% level

The Mean Difference between leaf Size of Microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 3 were analyzed through One-Way ANOVA and the results were tabulated in the Table XIX. The estimated F value was 1.029. And the above table clearly states that there is no significance between the variables as the p value was .423 at 1 percent level. The Chia Microgreen had large leaf size than selected microgreens.

Table XX
Mean Difference Between Stem Length of the Selected Microgreens on Day 4

	Variables	Mean	SE	F-value	Sig
Stem length (Day 4)	Mustard Microgreen	4.72 ± 0.41	0.18	54.821	.000*
	Chia Microgreen	5.02 ± 0.08	0.04		
	Beetroot Microgreen	3.12 ± 0.35	0.16		
	Sesame Microgreen	3.22 ± 0.34	0.15		
	Fenugreek Microgreen	4.98 ± 0.19	0.09		
	Radish Microgreen	5.26 ± 0.23	0.10		

* Significant at 1% level

The Mean Difference between Stem Length of Microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 4 were analyzed through One-Way ANOVA and the result were projected in the Table XX, it is clear that there is significance between the variables with a p value of .000 at 1 percent level. On Day 4 Stem Length of Radish Microgreen was high compared to other Microgreens.

Table XXI

The Mean Difference Between Leaf Size of the Selected Microgreens on Day 4

	Variables	Mean	SE	F-value	Sig
Leaf Size (Day 4)	Mustard Microgreen	1.12 ± 0.26	0.12	1.254	.316 ^{NS}
	Chia Microgreen	1.20 ± 0.07	0.03		
	Beetroot Microgreen	1.22 ± 0.13	0.06		
	Sesame Microgreen	1.32 ± 0.18	0.08		
	Fenugreek Microgreen	1.24 ± 0.15	0.07		
	Radish Microgreen	1.34 ± 0.11	0.05		

* Significant at 1% level

The mean difference between leaf size of the selected microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) based on the Day 4 observations were interpreted using One way ANOVA and the data were projected in the Table XXI. The table clearly shows that there is no significance between the variables, as the p value was .316 at 1 percent level. Hence, it is interpreted that there is no mean difference between the leaf size of the microgreens and the leaves are uniform. On Day 4 the leaf size of Radish Microgreen was comparatively large than other Microgreens.

Table XXII**Mean Difference Between Stem Length of the Selected Microgreens on Day 5**

	Variables	Mean	SE	F-value	Sig
Stem length (Day 5)	Mustard Microgreen	5.32 ± 0.13	0.06	168.741	.000*
	Chia Microgreen	5.38 ± 0.13	0.06		
	Beetroot Microgreen	3.96 ± 0.15	0.07		
	Sesame Microgreen	4.14 ± 0.23	0.10		
	Fenugreek Microgreen	5.96 ± 0.11	0.05		
	Radish Microgreen	5.96 ± 0.11	0.05		

* Significant at 1% level

The mean difference between stem length of the selected microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) based on the Day 5 observations were interpreted using One way ANOVA and the data were projected in the Table XXII. The data shows significance between the variables, as the p value was .000 at 1 percent level. On Day 5 the stem length of Fenugreek Microgreen and Radish Microgreen was large in comparison to other Microgreens.

Table XXIII**The Mean Difference Between Leaf Size of the Selected Microgreens on Day 5**

	Variables	Mean	SE	F-value	Sig
Leaf Size (Day 5)	Mustard Microgreen	1.50 ± 0.16	0.07	2.106	.100 ^{NS}
	Chia Microgreen	2.48 ± 1.42	0.64		
	Beetroot Microgreen	1.76 ± 0.11	0.05		
	Sesame Microgreen	1.44 ± 0.11	0.05		
	Fenugreek Microgreen	1.64 ± 0.23	0.10		
	Radish Microgreen	2.02 ± 0.19	0.09		

* Significant at 1% level

The Table XXIII elucidates the mean difference between leaf size of the selected microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 5.

One-way ANOVA was used to analyze the data and the f value was 2.106. The p value of .100 clearly shows that there is no significance between the variables. On Day 5 leaf size of chia microgreen was largest and sesame microgreen was smallest among the selected Microgreens.

Table XXIV

Mean Difference Between Stem Length of the Selected Microgreens on Day 6

Variables		Mean	SE	F-value	Sig
Stem length (Day 6)	Mustard Microgreen	5.84 ± 0.11	0.05	136.422	.000*
	Chia Microgreen	5.76 ± 0.11	0.05		
	Beetroot Microgreen	5.16 ± 0.11	0.05		
	Sesame Microgreen	4.58 ± 0.19	0.09		
	Fenugreek Microgreen	6.60 ± 0.24	0.11		
	Radish Microgreen	6.66 ± 0.09	0.04		

* Significant at 1% level

The Mean Difference between Stem Length and Microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 7 were analyzed through One-Way ANOVA and the result were projected in the Table XXIV. From the table, there is significance between the variables with a p value of .000 at 1 percent level. On Day 6 Stem Length of Radish Microgreen was high compared to other Microgreens.

Table XXV

Mean Difference Between Leaf Size of the Selected Microgreens on Day 6

Variables		Mean	SE	F-value	Sig
Leaf Size (Day 6)	Mustard Microgreen	1.82 ± 0.08	0.04	8.138	.000*
	Chia Microgreen	1.74 ± 0.42	0.19		
	Beetroot Microgreen	2.08 ± 0.08	0.04		
	Sesame Microgreen	1.70 ± 0.07	0.03		
	Fenugreek Microgreen	2.10 ± 0.12	0.05		
	Radish Microgreen	2.40 ± 0.23	0.10		

* Significant at 1% level

The Table XXV projects the mean difference between leaf size of the selected microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on the Day 6. One-way ANOVA was used to analyze the data and the F value was 8.138. The table clearly shows that there is significance between the variables, as the p value was .000 at 1 percent level. On Day 6 the leaf size of Radish Microgreen was comparatively large than other Microgreens.

Table XXVI

Mean Difference Between Stem Length of the Selected Microgreens on Day 7

Variables		Mean	SE	F-value	Sig
Stem length (Day 7)	Mustard Microgreen	6.26 ± 0.11	0.05	105.639	.000*
	Chia Microgreen	6.22 ± 0.22	0.10		
	Beetroot Microgreen	5.80 ± 0.29	0.13		
	Sesame Microgreen	5.26 ± 0.27	0.12		
	Fenugreek Microgreen	7.58 ± 0.16	0.07		
	Radish Microgreen	7.52 ± 0.04	0.02		

* **Significant at 1% level**

The mean difference between Stem Length and the type of Microgreen (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 7 were analyzed using One-Way ANOVA and. The Table XXVI presents the mean difference between stem length of different microgreens. The data represents a significant mean difference between the variables as the significance (p- value) value is 0.000 (at 1% level). On the day 7, the stem length of fenugreek microgreen was found to be tall and Beetroot microgreen was short than other microgreens.

Table XXVII
Mean Difference Between Leaf Size of the Selected Microgreens on Day 7

Variables		Mean	SE	F-value	Sig
Leaf Size (Day 7)	Mustard Microgreen	2.48 ± 0.15	0.07	10.676	.000*
	Chia Microgreen	2.38 ± 0.13	0.06		
	Beetroot Microgreen	2.12 ± 0.11	0.05		
	Sesame Microgreen	2.28 ± 0.16	0.07		
	Fenugreek Microgreen	2.48 ± 0.08	0.04		
	Radish Microgreen	2.70 ± 0.16	0.07		

* Significant at 1% level

Mean difference between leaf size of microgreens (Mustard Microgreen, Chia Microgreen, Beetroot Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) on Day 7 were analyzed using One-Way ANOVA and the results were elucidated in the Table XXVII. The above table clearly shows the mean difference between the leaf size of different microgreens were statistically significant (p value - .000). The estimated f value was 10.676. On Day 7, the leaf size of radish microgreen was large and beetroot microgreen was small among the selected Microgreens.

4.1.3.8. Association of the growth pattern of microgreens with different variables

The growth pattern of the microgreens was analyzed with design of experiments for determination of the impact of different variables on the growth of microgreens.

i. Association of Different Factors on Stem Length of Selected Microgreens

A. Association of Microgreens Type on Stem Length

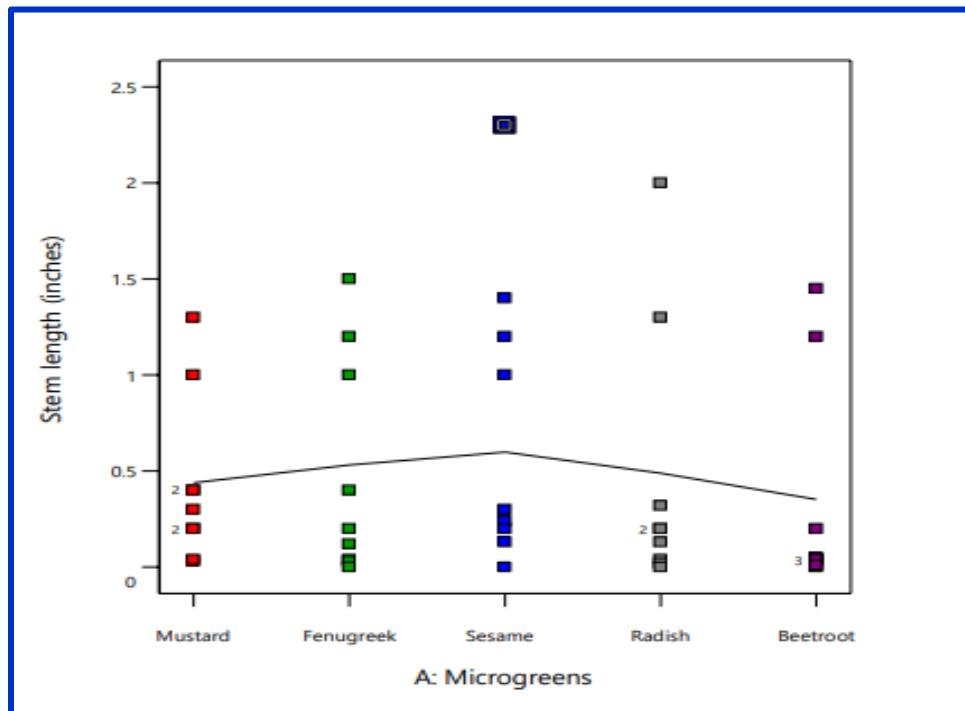


Figure 2: Comparison of Stem Length of Micro Greens

Plant morphology is heavily influenced by genetics. Many species germinate and develop quickly, but others are sluggish and perform poorly in contrast (Paradiso *et al.*, 2018). The morphological characters like shoot length and leaf length were measured in the study. Figure 2 depicts the stem length of all the selected microgreen seeds. As per the data analysis, the stem length of radish microgreen was maximum. The sesame microgreen attained the least length.

B. Effect of Direct Sunlight on Stem Length

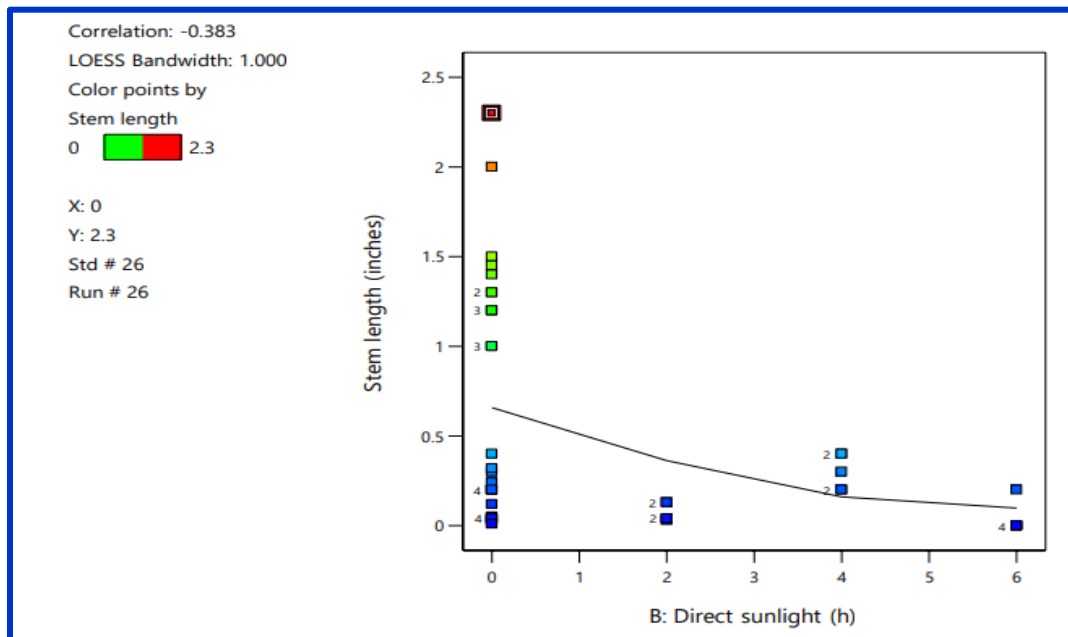


Figure 3: Effect of Direct Sunlight on Stem Length

Light quality is one of the major factors of plant environment. It functions through specialized photoreceptors sensitive to different light wavelengths (phytochromes, cryptochromes, phototropins, and UVR8), directly affecting physiological and chemical processes in plants (Ouzounis *et al.*, 2015, Piovene *et al.*, 2015, Folta and Childers, 2008).

Figure 3 presents the correlation of the stem length of different microgreens grown under direct sunlight. The stem length was found to be decreasing as the growth of microgreens progressed, making it unsuitable for the cultivation process. In association with this, studies by Ouzounis *et al.*, 2015 and Piovene *et al.*, 2015 highlights the importance of indoor plant cultivation without natural light or in areas where the natural light is low like the greenhouses.

C. Effect of Indirect Sunlight on Stem Length

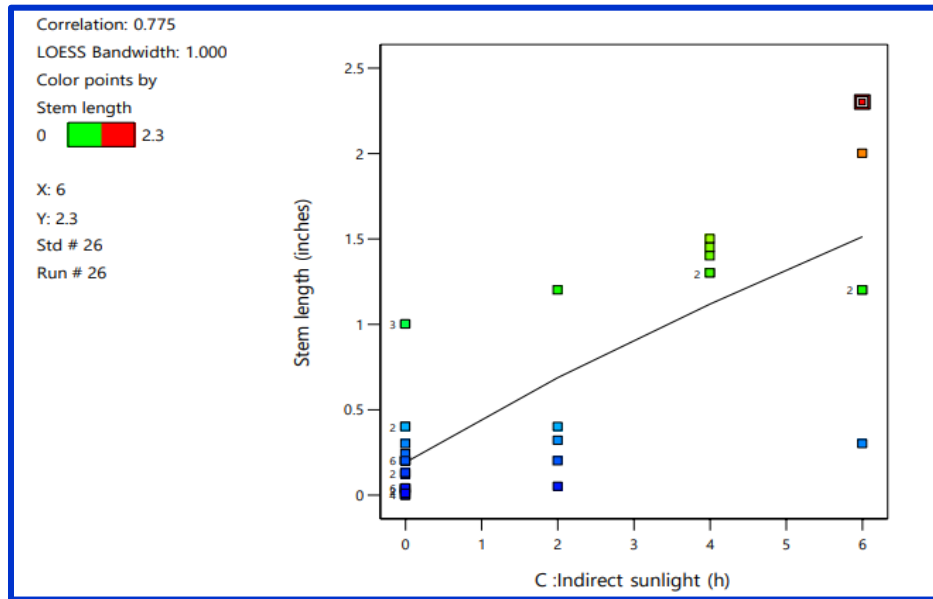


Figure 4: Effect of Indirect Sunlight on Stem Length

Figure 4 shows the effect of indirect sunlight on stem length, the microgreen growth was increased to 1.5 inches as the light intensity increase. Hence the growth of the microgreens was found to be satisfying and was showing a positive growth pattern while exposed to indirect sunlight.

D. Effect of LED on Stem Length

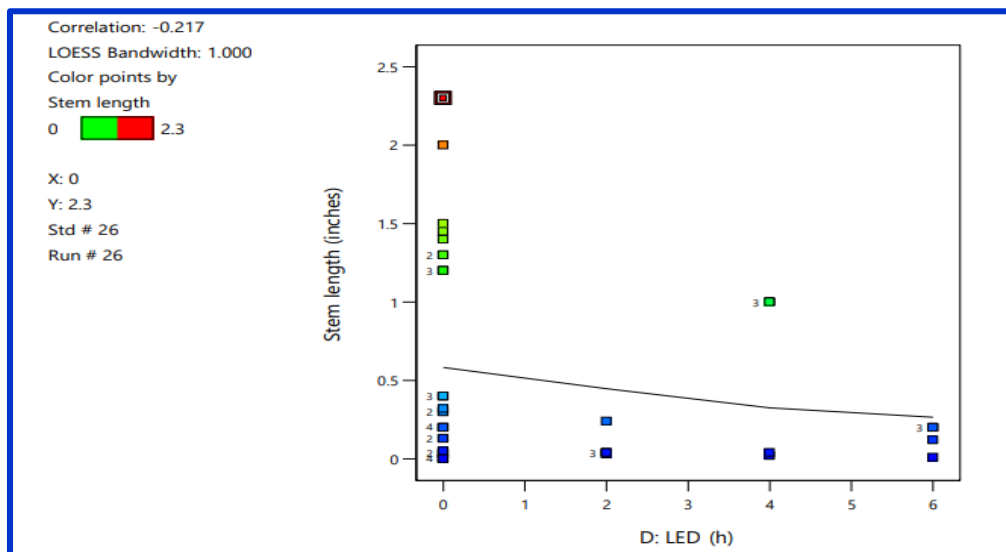


Figure 5: Effect of LED on Stem Length

Figure 5 shows the growth of microgreens under LED light. Decrease in growth is observed under LED light. The growth reduced gradually as the intensity of the light increases. Also a study by Sirtautas, 2012 claims that microgreens growth was not appreciable in LED lighting.

E. Effect of Top Watering on Stem Length

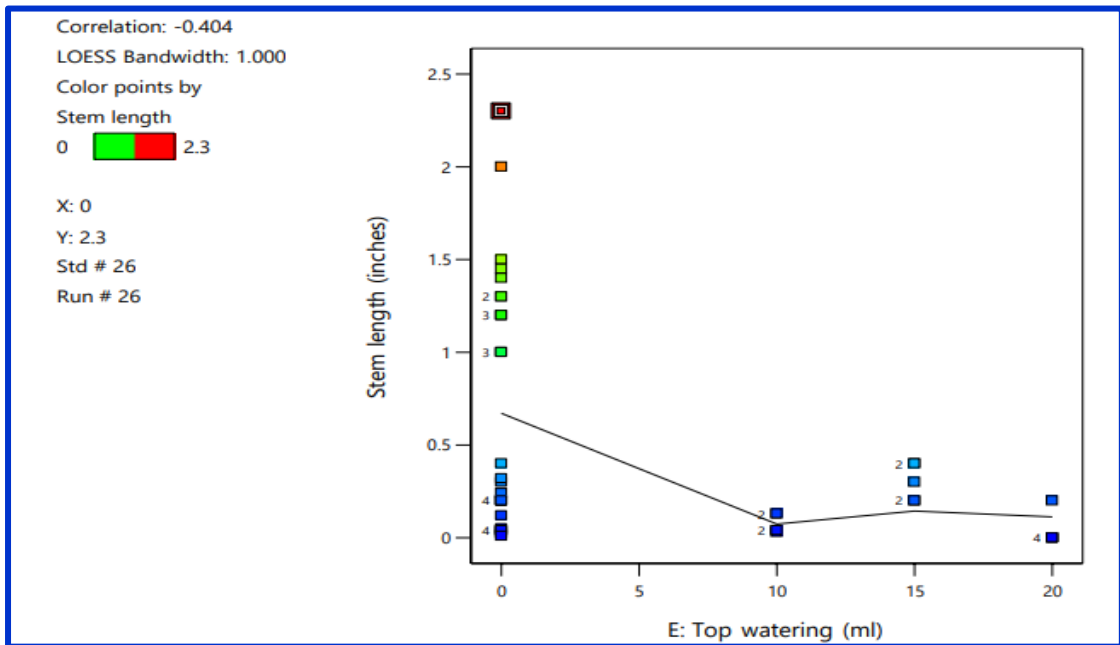


Figure 6: Effect of Top Watering on Stem Length

Microgreen cultivation needs an ample supply of neutral to slightly acidic water (Turner *et al.*, 2020). Figure 6 shows the correlation of the stem length of microgreens and top watering cultivation. As the level of water increases, the stem length also varies. The stem length of microgreens decreased initially. After 10 ml water supply the growth was gradual.

F. Effect of Bottom Watering on Stem Length

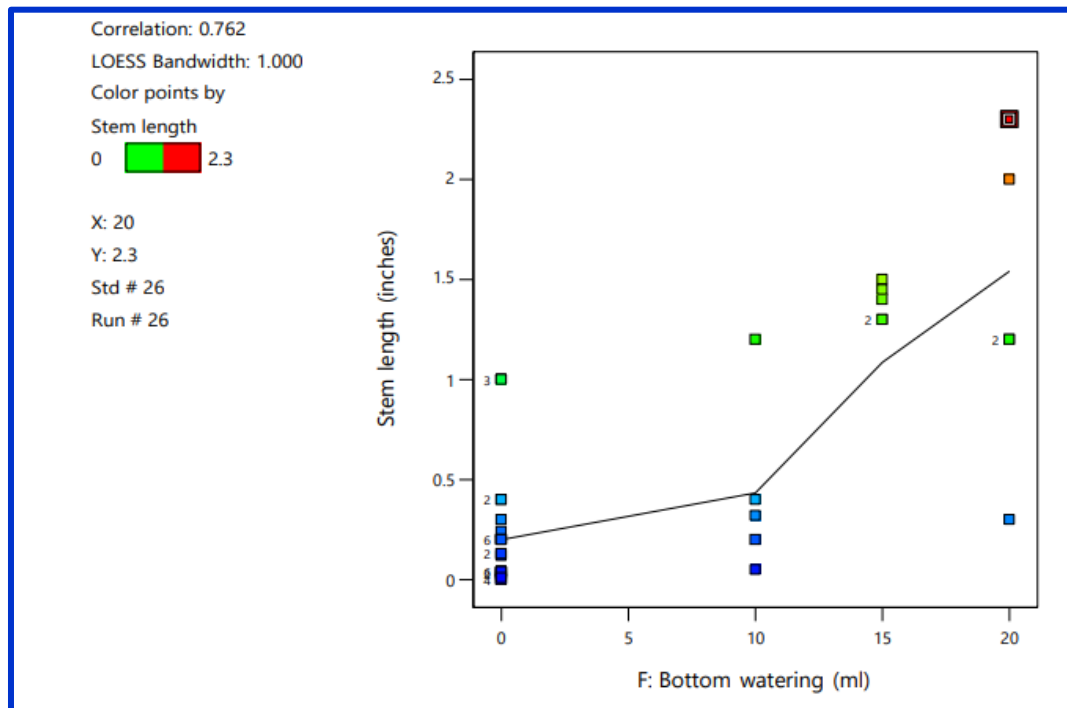


Figure 7: Effect of Bottom Watering on Stem Length

Figure 7 highlights the correlation of stem length and bottom watering. The stem length increased according to the gradual increase in Bottom watering. The drastic increase in the stem length of the microgreens resulted in bending of the microgreens. The increased stem length could be due to the homogenous supply of water (Junker *et al.*, 2014).

G. Effect of Cocopeat on Stem Length

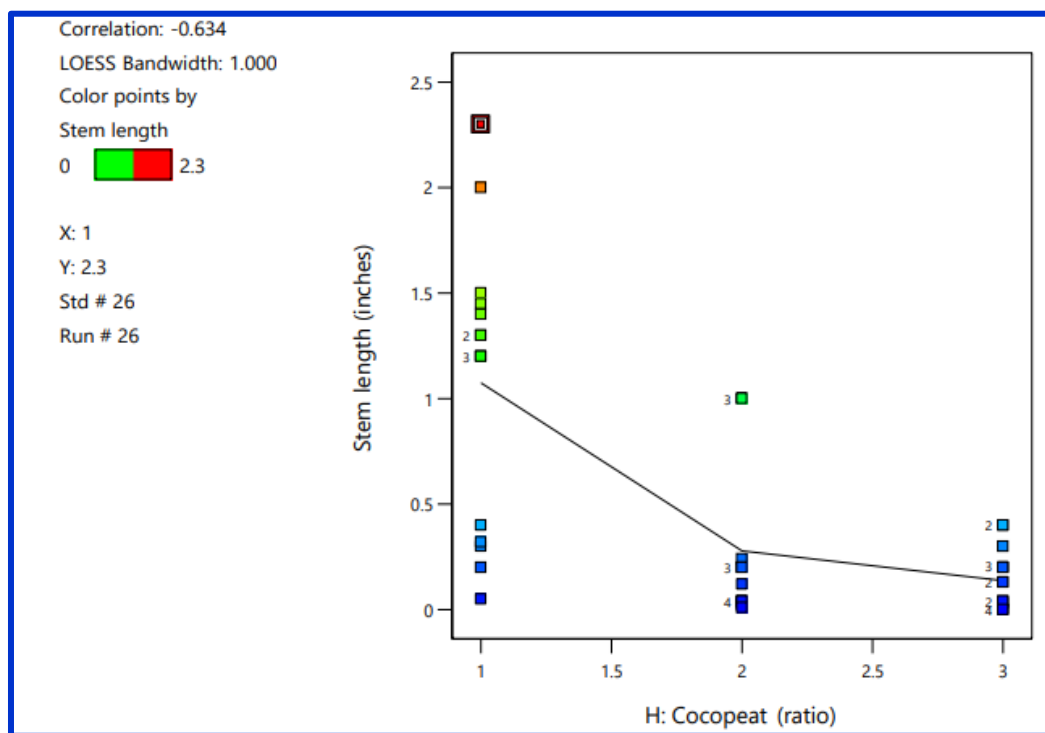


Figure 8: Effect of Cocopeat on Stem Length

Figure 8 presents the correlation between cultivation of microgreens in cocopeat media and the variation in stem length. Initially, the stem length gradually decreased on coco peat supplementation and later a gradual growth was observed. The stem length was adequate for a microgreen.

Research by Ramya *et al.*, (2022) states cocopeat as the best medium for microgreen production, which promotes early germination and high yield. Research claims cocopeat has the highest overall cation exchange load. The higher the cation exchange load, the better the crop growth and yield. As a result, cocopeat produced a high yield, the quickest initial seed germination, and an early harvest. Also a research by Naik *et al.* (2021) in mustard microgreens, reports that the microgreens attained highest plant height in the cocopeat medium.

H. Effect of Vermicompost on Stem Length

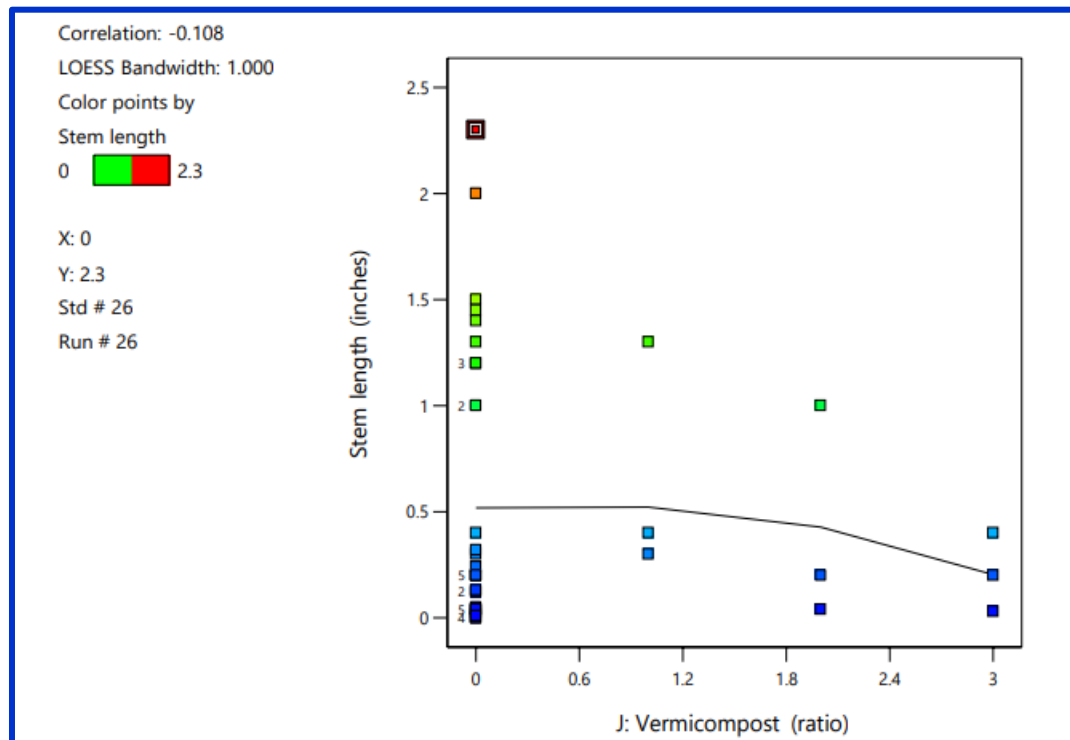


Figure 9: Effect of Vermicompost on Stem Length

Vermicompost is claimed as an appropriate medium for plant growth. It shows improved growth in several plant species (Ebrahimi *et al.*, 2021, Serri *et al.*, 2021). According to Figure 9, the stem length of the microgreen was gradual initially and decreased finally. As the pattern of growth of the microgreens tend to be inconsistent, this medium was not selected for the further investigation.

I. Effect of Black Soil on Stem Length

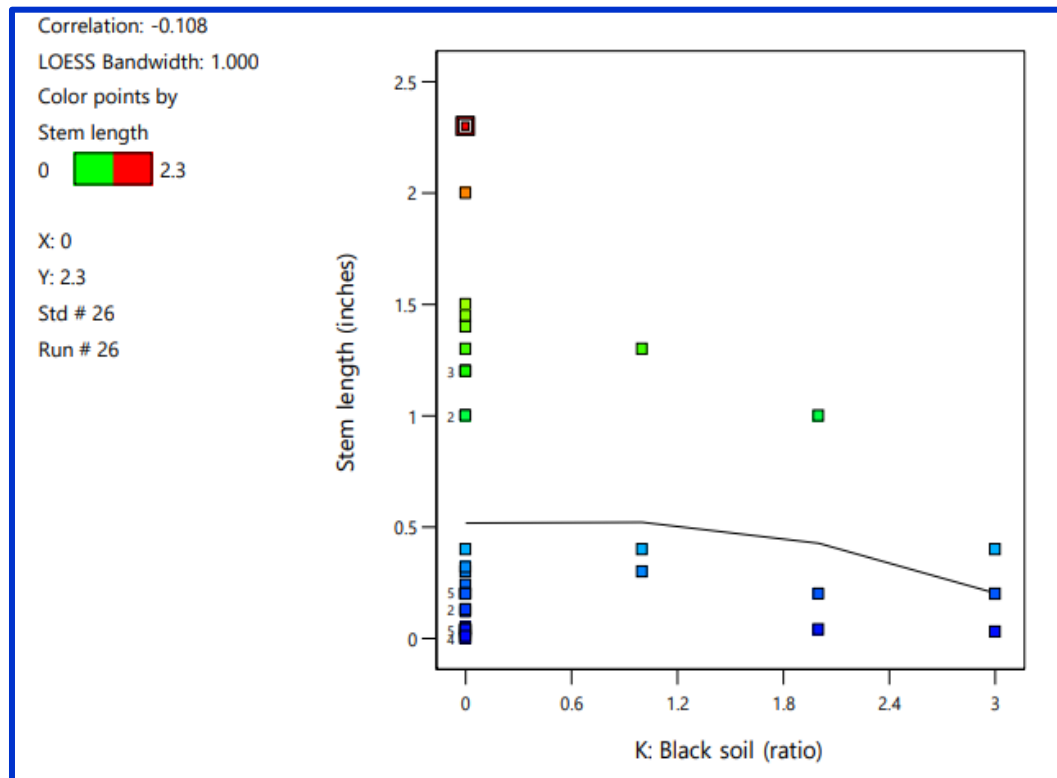


Figure 10: Effect of Black Soil on Stem Length

Figure 10 presents the correlation between stem length and microgreens cultivated in black soil. The stem length gradually decreased on increasing the ratio of black soil. As the growth was not satisfactory, the medium was not selected for cultivation of microgreens.

The study conducted by Naik *et al.* (2021), highlights that vermicompost treatment of mustard microgreen had good yield and showed an early performance. In the vermicompost treatment, the microgreens attained maturity in 6 days.

ii. Association of Different Factors on Leaf Size of Selected Microgreens

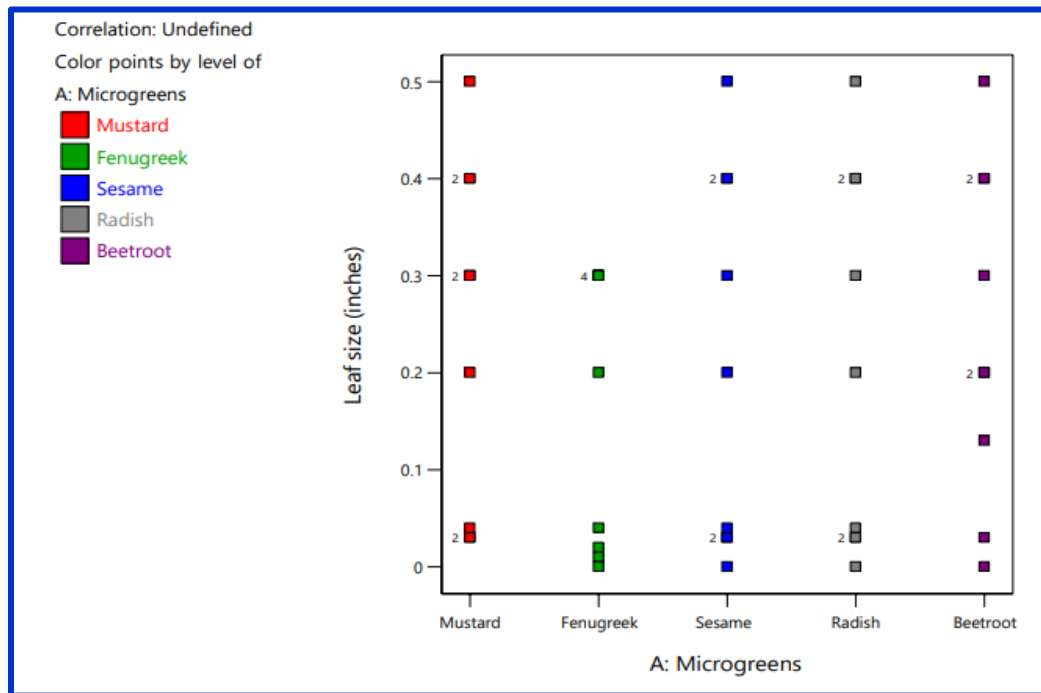


Figure 11: Leaf Size of Selected Microgreens

Figure 11 depicts the correlation of leaf size in accordance to the type of microgreens. All the microgreens namely mustard, sesame, radish, and beetroot had a similar maximum leaf size (0.5 inches). Fenugreek microgreen had the smallest leaf, sized 0.3 inches.

The leaf size is determined by the cell size and cell number (Kalve and Vos, 2014, Sarvepalli *et al.*, 2019). The plants with large leaves are claimed to have longer internodes (Westoby and Wright, 2003).

A. Effect of Direct Sunlight on Leaf Size

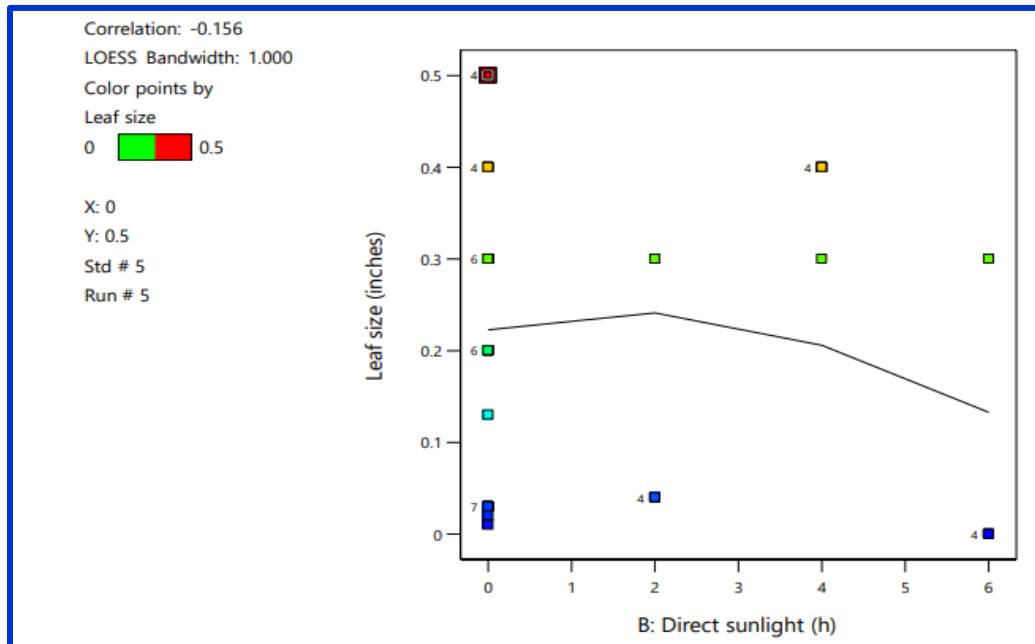


Figure 12: Effect of Direct Sunlight on Leaf Size

Figure 12 depicts the leaf size of the selected microgreens under direct sunlight. A slight increase in leaf size was observed in the beginning and then decreased as the intensity of the light increased. In connection to this Kong *et al.* (2016) states that the plant leaves under sun are smaller with low stomatal density and thicker. Plants adapt to shade situations by expanding leaf area to create a bigger surface for light absorption (Fitter and Hay, 2012). This could be inverse in direct lighting (decrease in leaf size) and hence the leaf size is decreasing and inferior in comparison with indirect lighting.

A research by Setiawati *et al.*, highlighted the average leaf area of *Tetracera scandens L* in a shaded area was more than the plants exposed to direct sun light without shade. Similarly, research on *Epimedium pseudowushanense* seedlings show relative results, in which the plant exhibits large leaves under low intensity lights than plants under high intensity lighting (Pan and Guo, 2016).

B. Effect of Indirect Sunlight on Leaf Size

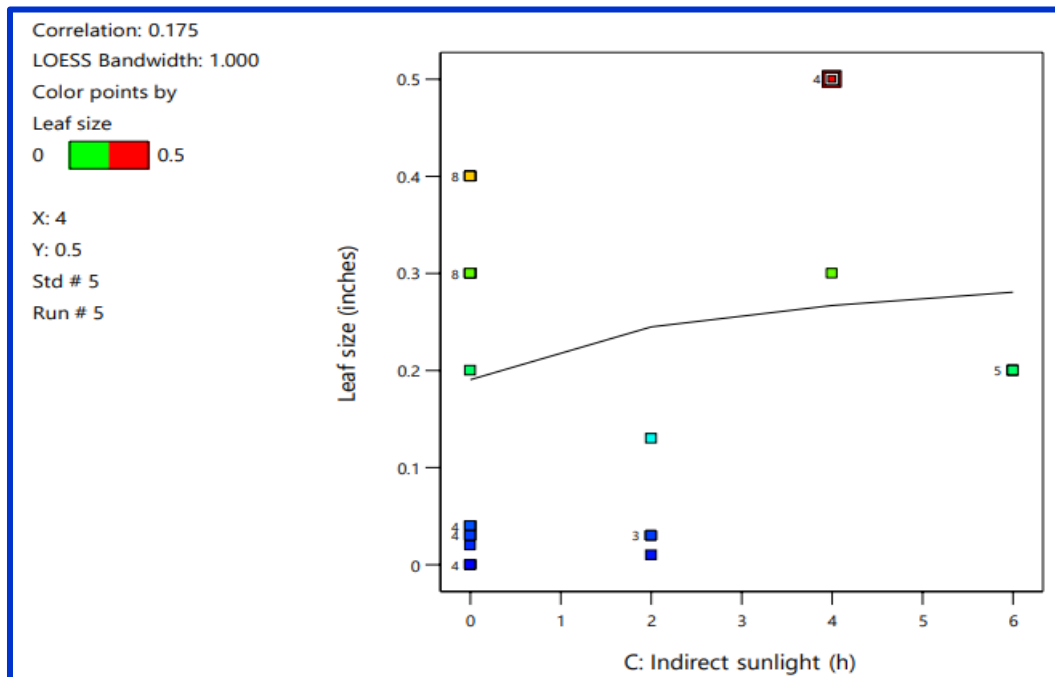


Figure 13: Effect of Indirect Sunlight on Leaf Size

Figure 13 shows the relation of microgreen's leaf size under indirect sunlight. The growth pattern was more appreciable making the indirect lighting suitable for the growth of microgreens. Compared to the direct sunlight the size of leaves in indirect light is more. This could be, due to the efficiency in diffuse light usage of plants than the direct light. Plants frequently adapt to collect more optical energy under low light conditions, such as leaf area expansion (Johnson *et al.*, 2005).

C. Effect of LED on Leaf Size

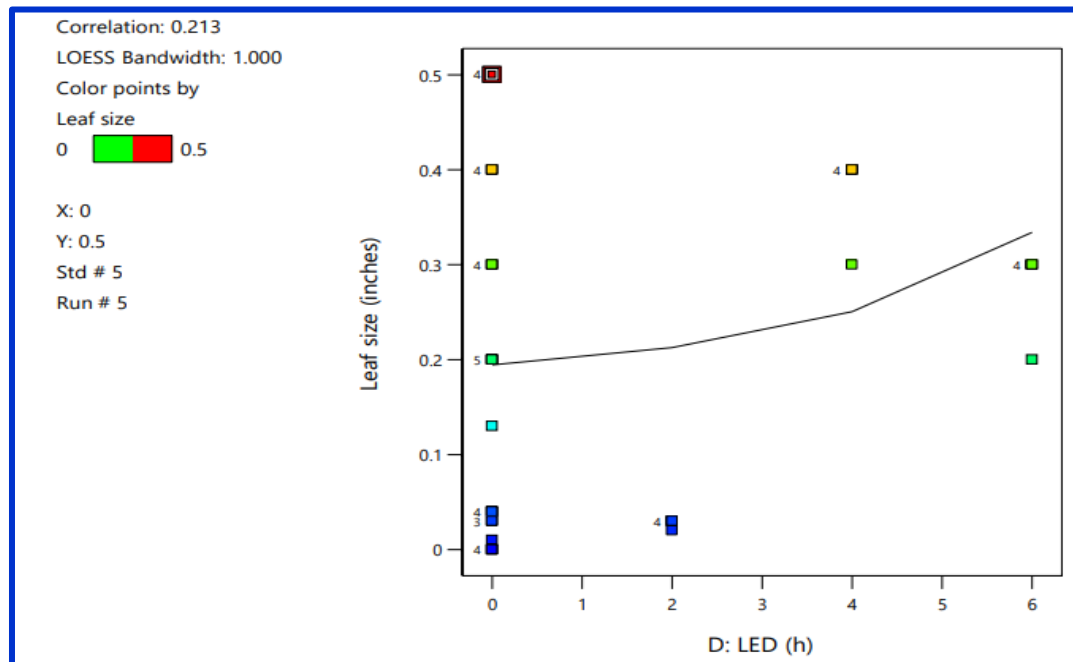


Figure 14: Effect of LED on Leaf Size

Figure 14 shows the impact of LED on the leaf size of the selected microgreens. Nowadays, microgreens are produced in greenhouses with artificial lighting (Despommier, 2010, Kozai *et al.*, 2019). LED is a common lighting used for microgreens. LEDs offer several advantages including low energy requirement, long lifespan, very fast response time, low radiant heat output, and tenability (Gerova *et al.*, 2016, Loi *et al.*, 2021). According to the figure 14 the leaf size of different microgreens increased on LED lighting.

D. Effect of Cocopeat on Leaf Size

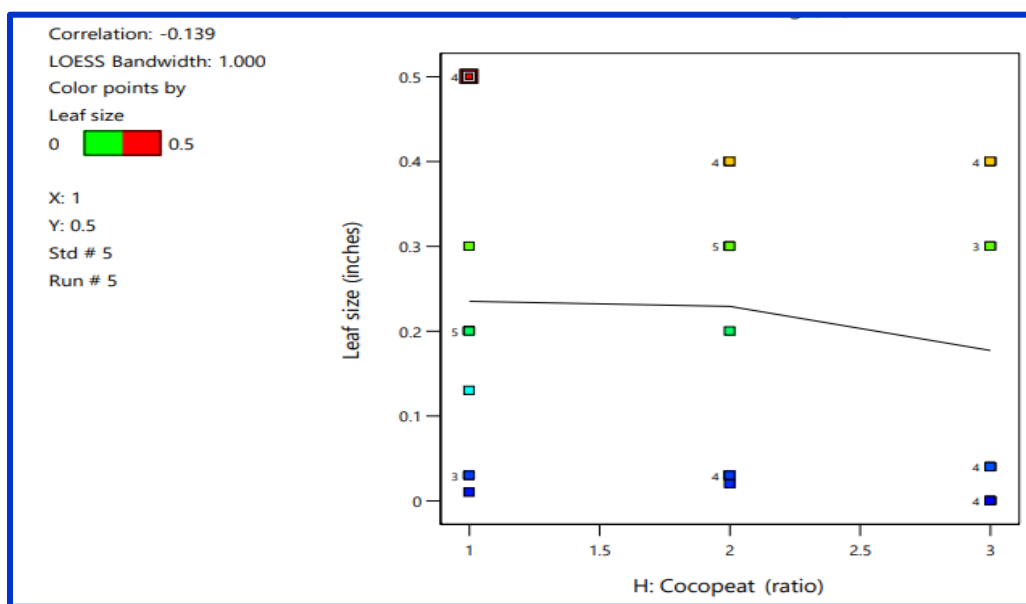


Figure 15: Effect of Cocopeat on Leaf Size

Figure 15 highlights effect of cocopeat supplementation on leaf size of microgreens. The leaf size was constant and optimal on supplementation with cocopeat. Finally a very mild decrease in leaf size was observed.

E. Effect of Vermicompost on Leaf Size

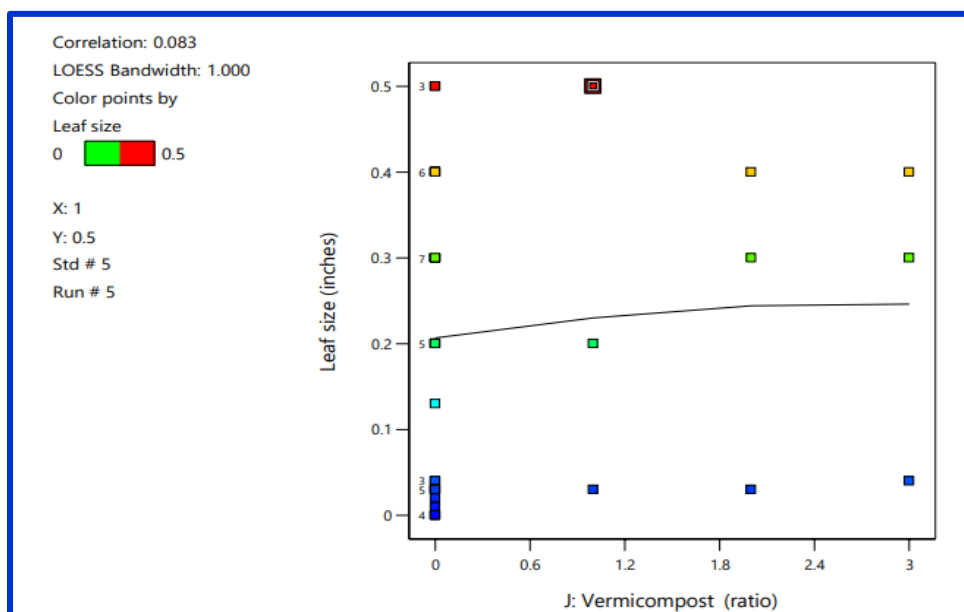


Figure 16: Effect of Vermicompost on Leaf Size

Figure 16 depicts the leaf size of microgreens in vermicompost cultivation. Here, the leaf size slightly increases according to the proportion of growth media. Vermicompost application has claimed to increase the leaf size of plants. A study by Adiloglu *et al.* (2018) shows significant rise in leaf size, leaf numbers, plant width, leaf width, and the fresh plant's weight after increasing doses of vermicompost application.

F. Effect of Black Soil on Leaf Size

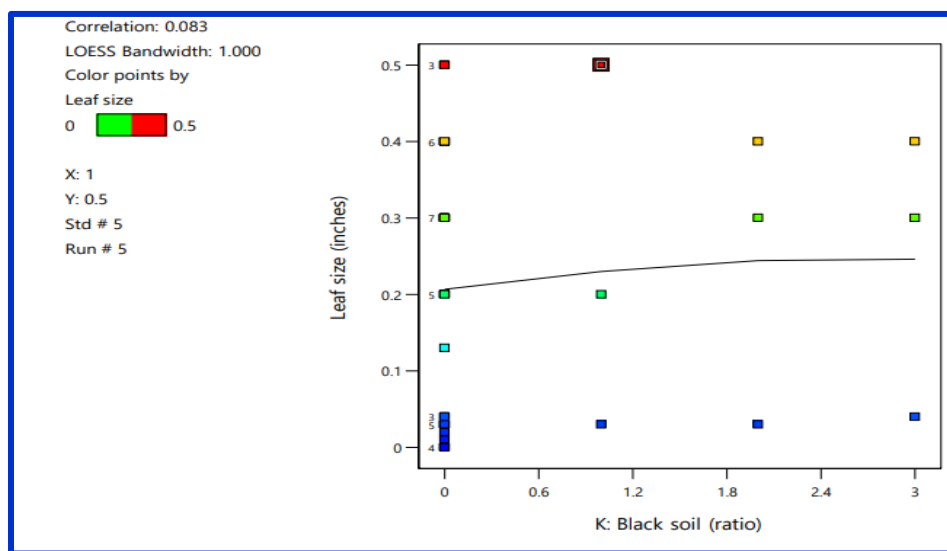


Figure 17: Effect of Black Soil on Leaf Size

Figure 17 shows the correlation of leaf size of microgreens cultivated in black soil. The pattern of leaf size increased as the ratio of black soil and sand increases. Rashid *et al.* (2015) studied, growing medicinal plant *Boesenbergia rotunda* in different combinations of black soil. The variant with high ratio of black soil resulted in high bulk density compared to other soil mixtures. The black soil and sand mixture is known to have increased the aeration porosity and water holding capacity. This aeration porosity and water holding capacity could be a reason for the gradual increase in the leaf size.

4.2. Phase II: Analysis of Microgreens and Formulation of Microgreen Based Recipes

The Phase II elucidates the analysis and recipe formulation of microgreens. Analysis for micronutrients, phytochemicals, toxic elements and shelf life of the harvested microgreens were conducted. Various recipes were prepared with the harvested microgreens and sensory evaluated to determine the acceptability. The nutritional contribution of the recipes was also calculated.

4.2.1 Analysis and Comparison of Micronutrient Content in Selected Microgreens with the Mature Counterparts (Regular Greens)

The micronutrient contents in selected microgreen were analysed and compared with the mature counterparts (regular greens). The tables in 4.2.1 part presents the analysis and micronutrient content of different selected microgreens.

Table XXVIII
Comparison of Vitamins in Microgreens and its Mature Counterparts (Regular Greens)

Samples	Beta carotene (mcg)		Vit D (mg)		Vit E (mg)		Vit K (mg)		Vit C (mg)		Vit B1 (mg)		Vit B2 (mg)		Vit B3 (mg)		Vit B5 (mg)		Vit B9 (mcg)	
	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG	MG	RG
Mustard	6.12	1.22	0	0	2.89	1.21	5.4	1.1	89.5	32.3	0.07	0.01	0.20	0.6	3.8	2.1	0	0	2.1	0
Fenugreek	40	31	0	0	0	0	31	0	15.3	9.5	8.3	0.32	3.9	0.36	4.2	1.64	3.5	0	36	11.4
Beetroot	48.8	21.4	0	0	0.21	0.10	0	0	12.4	6.7	0.02	0.5	0.17	0.2	0.43	0.1	0	0	11.52	9.6
Sesame	2.16	1.7	0	0	1.26	1.11	0	0	0	0	0	0	0	0	3.94	1.24	2.3	1.1	13	5.7
Chia	0	0	0	0	0.5	0.1	302	100	1.6	1.1	3.62	0.20	4.17	1.10	5.83	1.22	0	0	25.32	12.39
Radish	0	0	0	0	0		32	12.3	14.4	6	0	0	0	0	0	0	29.47	20.1	34.6	14.1

***MG – Microgreens, RG – Mature Counterparts (Regular Greens)**

Table XXVIII depicts the comparison of vitamins in microgreens and its mature counterparts (regular greens).

Beetroot microgreen had the highest Beta carotene (48.8 mcg) than its mature counterpart (regular greens) and all other microgreens. The microgreens had more Beta carotene than the mature parts. Chia microgreen and radish microgreen did not contain Beta carotene. Vitamin D was not present in all the selected microgreens.

Mustard microgreen has the highest amount of Vitamin E (2.89 mg) than its mature counterpart and all other microgreens. The Chia microgreen had highest amount of Vitamin K, that is 302 mg. The mature counterpart (regular greens) of Chia microgreen had more Vitamin K than other matured microgreens.

Vitamin C a potential antioxidant is present more in Mustard microgreen (89.5 mg). The Vitamin C content of the mature counter parts (regular greens) was low. Sesame microgreen did not contain Vitamin C. As microgreens are consumed fresh, vitamin C loss is prevented and largely retained without cooking (Yadav 2019, Lee *et al.*, 2018).

Vitamin B1 was high in Fenugreek Microgreens (8.3 mg) than the mature part (regular greens). Vitamin B2 (4.17 mg) and B3 (5.83 mg) was more in chia microgreen. Radish microgreen did not contain Vitamin B1, B2 and B3. Vitamin B5 was present more in radish microgreen followed by its matured part (regular greens). The Mustard Microgreen, Beet Microgreen, Chia Microgreen did not contain Vitamin B5. Vitamin B9 was present more in Fenugreek Microgreen (36 mcg) followed by Radish microgreen (34.6 mcg). On the whole, the young parts had more vitamin content than the mature counter parts.

Yadav *et al.* (2019) and Xiao *et al.* (2012) reported that microgreens contain high amount of vitamins, minerals and phytochemicals in comparison to its mature counterparts.

Table XXIX
Comparison of Minerals in Microgreens with its Mature counterparts
(Regular Greens)

Samples	Ca (mg)	P (mg)	Fe (mg)	Se (mcg)	K (mg)	Na (mg)	Mg (mg)	Fl (mg)	Mn (mg)	Zn (mg)	Cu (mg)
Mustard Micro Green	402	715	13.49	71.47	694	3.97	0	0	4.23	4.03	0
Mature Mustard	300	420	10.21	55.23	435	1.73	0	0	2.21	2.01	0
Beetroot green Micro Green	151	36.0	5.8	47.7	530	111	120	0	1.16	0.16	0.14
Mature Beet Green	122	30.0	2.2	30.3	400	100	60	0	1.10	0.09	0.6
Sesame Micro Green	600	754	15.0	12.38	460	15.43	372	0.31	1.74	7.7	1.5
Mature Sesame	400	350	10.0	9.23	300	12.0	200	0.20	1.23	5.2	1.1
Chia seed Micro Green	631	860	7.7	55.2	407	16	335	0	2.72	4.58	0.92
Mature Chia seed	250	600	3.5	35.5	210	14	150	0	1.7	3.2	0.80
Radish Micro Green	34.2	29.47	0	0	287	24.14	15.4	0	0	0	0
Mature Radish	29.9	20.32	0	0	150	20.10	9.3	0	0	0	0

Table XXIX presents the comparison of the Mineral content of the immature and mature parts of the selected microgreens. The tender chia microgreens had the highest amount of calcium (402 mg) and potassium (860 mg). The sesame microgreen had the highest amount of iron (15.0 mg). Mustard microgreen had the highest amount of selenium (71.47 mcg) and potassium (694 mg). The radish microgreen did not contain iron, selenium, fluorine, manganese, zinc and copper. The fluorine content was present only in sesame microgreens, the quantity was less but

tender part (0.31 mg) had a higher concentration of fluorine than the mature part (0.20). The Manganese content was high in chia microgreen and copper was high in sesame microgreen. On the whole the tender parts had higher mineral concentration than the matured parts. Supporting this a study by Pinto *et al.* (2015) reported that microgreens possessed a higher concentration of minerals such as calcium, magnesium, iron, manganese, selenium and molybdenum than mature lettuces.

The results of the tables (table XXVIII and XXIX) depicts the superiority of the micronutrient concentration of the microgreens in comparison to the mature counter parts (regular greens). As a significant association between the micronutrients and microgreens were observed, the null hypothesis (H_0) was rejected and the alternate hypothesis (H_1) was accepted.

4.2.2 Determination of Phytochemical Content

The phytochemical contents like the chlorophyll, carotenoids and flavonoids were analyzed and projected in Table XXX.

Table XXX
Phytochemical Content of Microgreens

Microgreen Samples	Antioxidant Activity	Chlorophyll a ($\mu\text{g/ml}$)	Chlorophyll b ($\mu\text{g/ml}$)	Flavonoids (mg/ml)
Fenugreek	8.6	0.22	2.99	362.0
Beet greens	26.3	0.098	2.29	296.2
Mustard	52.1	0.43	5.99	361.6
Sesame	58.7	0.34	6.32	465.8
Chia	52.0	0.25	4.37	409.53
Radish	39.2	0.32	3.27	322.23

Research states microgreens may contain a higher amount of vitamins, minerals and phytochemicals in comparison to their mature counterparts (regular greens) (Yadav *et al.*, 2019, Xiao *et al.*, 2012). Phytochemicals such as chlorophyll a, chlorophyll b and Flavonoids were screened. The chlorophyll a was present in higher concentration in mustard microgreens. Sesame microgreens had the higher concentration of chlorophyll b (0.43 mg) and Flavonoids (465.8 mg). The antioxidant

activity was also higher in the sesame microgreens. Hence the sesame microgreen had the highest concentration of phytochemicals than the other selected microgreens.

4.2.3 Analysis of Heavy Metals

Table XXXI

Heavy Metal Content of Selected Microgreens

Test Parameters	Mustard Microgreens	Fenugreek Microgreens	Chia Microgreens	Sesame Microgreens	Radish Microgreens	Beetgreen Microgreens
Lead	BDL (DL:0.1 mg/kg)	BDL(DL:0.3 mg/kg)	BDL(DL:0.2 mg/kg)	BDL(DL:0.01 mg/kg)	BDL(DL:0.2 mg/kg)	BDL(DL:0.1 mg/kg)
Cadmium	BDL(DL:0.0 2mg/kg)	BDL(DL:0.0 3 mg/kg)	BDL(DL:0.031 mg/kg)	BDL(DL:0.03 mg/kg)	BDL(DL:0.0 3 mg/kg)	BDL(DL:0.03 mg/kg)
Mercury	BDL (DL:0.01 mg/kg)	BDL(DL:0.0 1 mg/kg)	BDL(DL:0.1 mg/kg)	BDL(DL:0.2 mg/kg)	BDL(DL:0.0 1 mg/kg)	BDL(DL:0.1 mg/kg)
Arsenic	BDL(DL:0.0 1 mg/kg)	BDL(DL:0.0 2 mg/kg)	BDL(DL:0.05 mg/kg)	BDL(DL:0.03 mg/kg)	BDL (DL:0.04 mg/kg)	BDL(DL:0.01m g/kg)

*BDL - Below Detectable Limit

Certain heavy metals can interfere with genetic composition and metabolic processes, while other heavy metals have an impact on the development of the embryo or foetus. Cancer, neurological and behavioural abnormalities and developmental issues are frequently the outcomes of this in children (Ali *et al.*, 2013). The heavy metal content in the selected microgreens was analyzed and it is depicted in Table XXXI. Heavy metals such as lead, cadmium, mercury and arsenic were analyzed using AOAC.15.01 method. The results shows that none of the elements were in detectable level and all the microgreens were found to be safe.

4.2.4 Determination of Shelf Life

Table XXXII shows that the mustard microgreens was stored for three days in two different treatments.

Table XXXII
Shelf-life Analysis of Mustard Microgreen

Microgreen	Days	Atmospheric condition	Mediums stored in	Effect
Mustard	Day 1	In room temperature	Food grade glass container	Very fresh- firm and crisp on both leaves & stem
			Food grade Plastic container	Very fresh- firm and crisp on both leaves & stem
			Paper bag	Very fresh- firm and crisp on both leaves & stem
			Food grade Steel container	Very fresh- firm and crisp on both leaves & stem
		In refrigerator	Food grade Glass container	Very fresh- firm and crisp on both leaves & stem
			Food grade Plastic container	Very fresh- firm and crisp on both leaves & stem
			Paper bag	Very fresh- firm and crisp on both leaves & stem
			Food grade Steel container	Very fresh- firm and crisp on both leaves & stem
	Day 2	In room temperature	Food grade Plastic and Glass container	Very fresh- not wilted
			Food grade Steel container	Very fresh- not wilted
			Paper bag	Not fresh- very wilted overall
		In refrigerator	Food grade Plastic and Glass container	Very fresh- not wilted
	Day 3	In room temperature	Food grade Plastic and Glass container	Wilted, Dehydrated, Shrinkage
			Food grade Steel container	Wilted, Dehydrated, Shrinkage
			Paper Bag	Yellow discolouration and unacceptable
In refrigerator		Food grade Plastic and Glass container	Very fresh- not wilted	
		Food grade Steel container	Wilted not fresh	
		Paper Bag	Yellow discolouration and unacceptable	

One batch was stored in the refrigerator and the other stored at room temperature. Three mediums were used for storage, the food grade glass container, food grade plastic container and paper bag. The characteristics of microgreens such as appearance, color, shape and other characteristics were analyzed visually and physically for three days.

On Day 1, no changes were observed in the microgreens and the leaves were fresh both in the refrigerator and at room temperature. On Day 2, microgreens stored in paper bag were wilted very much, which made it unsuitable for consumption. Microgreens stored in plastic and glass containers were fresh till Day 3.

Kou *et al.* (2014) discovered that broccoli microgreens maintained at 5 °C for a period of 14–21 days had a longer shelf life and a delayed drop in overall quality when a 10 mm calcium chloride treatment was administered prior to harvest.

4.2.5 Formulation of Recipes with Cultivated Microgreens

Microgreens are high in nutrition in comparison with mature greens. They can be used for preparation of wide variety of foods as they offer unique flavor and taste to the food prepared. Alongside they also provide health benefits and nutritional benefits. Different courses of microgreen recipes were formulated and prepared. The course includes starters, accompaniments, main course, desserts, salads, juices, ready to eat and ready to cook foods.

4.2.6 Sensory Evaluation of the Microgreen Based Recipes

The prepared recipes were sensory evaluated to determine the product's overall acceptability. Sensory evaluation is traditionally defined as a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste, and hearing (Stone and Sidel, 1993). The products were sensory evaluated using a nine-point hedonic rating scale.

Table XXXIII
Overall Acceptability Score of Ready to Cook Products

Recipe Name	Mean Score
Soup Powder Enriched with Greens	38.8 ± 0.25
Green Leaves Steam Cake Powder	37.3 ± 0.24
Green Custard Powder	43.5 ± 0.30
Healthy Noodles	38.4 ± 0.24
Instant Green Payasam Mix	44.3 ± 0.21
Ready To Cook Green Uppuma Mix	43.5 ± 0.33
Instant Sambar Mix	44.3 ± 0.20
Instant Rasam Powder	41.3 ± 0.32
Green Pancake Mix	39.6 ± 0.30
Ready To Cook Kebab	41.5 ± 0.51

Table XXXIII projects the overall acceptability of the prepared ready to cook products.

Ready to cook products are instant in nature. These require very less time for cooking. All theready to cook products prepared, obtained good acceptability scores. Among all the products, Instant Green Payasam Mix (44.3 ± 0.21) and Instant Sambar Mix (44.3 ± 0.20) scored the highest, followed by green custard powder (43.5 ± 0.30) and Ready To Cook Green Uppuma Mix (43.5 ± 0.33). The Green Leaves Steam Cake Powder scored the least (37.3 ± 0.24).

Table XXXIV depicts overall acceptability of ready to eat products.

Table XXXIV
Overall Acceptability Score of Ready to Eat Products

Recipe Name	Mean Score
Green BhelPuri	38.1 ± 0.38
Green Pea Dip	43.6 ± 0.33
Green Fries	38.7 ± 0.29
Nutria Mix	42.3 ± 0.36
Green Mixture	41.6 ± 0.32
Green Pizza Base	39.3 ± 0.47
Green Cookies	44.5 ± 0.31
Green Jam	40.4 ± 0.53
Green Mayonnaise	38.7 ± 0.21
Green Pickle	41.4 ± 0.18

Ready to eat products are foods in eatable form, which requires no cooking. Among the ready to eat products, Green cookies were more acceptable and scored the highest (44.5 ± 0.31), followed by Green Pea Dip (43.6 ± 0.33). The Green Bhel Puri scored the least with a mean sensory score of 38.1 ± 0.38 .

Table XXXV depicts overall acceptability of Ready to Eat Products.

Table XXXV
Overall Acceptability Score of Microgreen Based Accompaniments

Recipe Name	Mean Score
Green Chutney	42.5 ± 0.42
Green Pachadi	38.24 ± 0.20
Green Buttermilk	39.52 ± 0.41
Green Thoran	42.40 ± 0.50
Green Eruchery	38.7 ± 0.21
Green Dal Curry	43.2 ± 0.32
Green Aviyal	39.6 ± 0.43
Greens Gram Curry	40.2 ± 0.41
Go Green Bowls	38.3 ± 0.35
Green Mezhukuperatty	43.2 ± 0.61

Accompaniments are courses consumed along with a main course. All the prepared accompaniments were highly acceptable. Among the accompaniments, Green Dal Curry and Green Mezhukuperatty were more acceptable and scored the highest (43.2 ± 0.32), (43.2 ± 0.61) respectively. This was followed by Green Chutney (42.5 ± 0.42). The Green Pachadi scored the least with a mean sensory score of 38.24 ± 0.20 .

Table XXXVI depicts overall acceptability of microgreen based main courses.

Table XXXVI
Overall Acceptability Score of Microgreen Based Main Courses

Recipe Name	Mean Score
Green Ela Ada	38.6 ± 0.24
Breakfast Wraps	39.3 ± 0.31
Green Chappathi	38.2 ± 0.31
Green Biryani	44.4 ± 0.49
Green Sandwich	43.3 ± 0.24
Green Idiyappam	38.6 ± 0.22
Green Kozhukatta	44.6 ± 0.31
Green Orotti	38.6 ± 0.42
Green Masala Rice	43.7 ± 0.32
Green Puttu	37.4 ± 0.44

Among the main courses, Green Kozhukatta was highly acceptable with a mean score of 44.6 ± 0.31. The Green Biryani (44.4 ± 0.49) scored the second and had a good acceptability. The Green Chappathi scored the least with a mean sensory score of 38.2 ± 0.31.

Starters are served to initiate a meal. These range from soups, kebabs, fritters etc. The Table XXXVII projects overall acceptability scores of microgreen based starters.

Table XXXVII
Overall Acceptability Score of Microgreen Based Starters

Starters	Mean Score
Vibrant Spring Soup	42.1 ± 0.31
Green Goddess Dressing	41.2 ± 0.22
Green Bajji	40.6 ± 0.31
Green Balls	44.2 ± 0.29
Green Rolls	42.2 ± 0.30
Green Kabab	43.4 ± 0.26
Green Dal Vada	44.6 ± 0.24
Green Semolina Veggie Rolls	43.4 ± 0.31
Healthy Green Momos	43.9 ± 0.33
Green Fritters	42.5 ± 0.29

Among the starters, Green Dal Vada was highly acceptable with a mean score of 44.6 ± 0.24 . The Green Balls (44.2 ± 0.29) scored the second and had a good acceptability. The Green Bajji scored the least with a mean sensory score of 40.6 ± 0.31 .

Table XXXVIII
Overall Acceptability Score of Microgreen Based Desserts

Desserts	Mean Score
Khulfi	38.4 ± 0.53
Green Fruit Yoghurt	37.2 ± 0.44
Green Mix Stuffed Gulab Jamuns	38.6 ± 0.12
Green Khoa	43.6 ± 0.49
Green Honey Cake	37.3 ± 0.47
Green Pudding	42.2 ± 0.72
Green Praline	38.1 ± 0.28
Nutrient Rich Macroons	39.0 ± 0.66
Green Custard	43.1 ± 0.70
Green Biscuit Cake	37.3 ± 0.35

Desserts are served at the end of a meal. Table XXXVIII presents the overall acceptability scores of microgreen based desserts. Among the desserts, Green Khoa was highly acceptable with a mean score of 43.6 ± 0.49 . The Green Fruit Yoghurt scored the least with a mean sensory score of 37.2 ± 0.44 .

Table XXXIX
Overall Acceptability Score of Microgreen Based Salads

Recipe Name	Mean Score
Sprouts green salad	37.6 ± 0.25
Nutri salad	38.5 ± 0.15
Protein green salad	42.3 ± 0.38
Green Fruit Salad	38.3 ± 0.29
Fish Green Salad	42.1 ± 0.14
Grilled green veg salad	38.6 ± 0.41
Chicken green salad	41.6 ± 0.02
Classic green salad	37.1 ± 0.12
Mixed green salad	43.3 ± 0.71
Roasted vegetable salad with green mix	41.4 ± 0.11

Microgreens are optimal choice for salad preparations. Its unique flavour, taste and texture improves the palatability Table XXXIX depicts the overall acceptability score of microgreen based salads. Among the recipes, the Protein green salad scored the highest (42.3 ± 0.38) and the Classic green salad scored the least (37.1 ± 0.12).

Table XL
Overall Acceptability Score of Microgreen Based Juices

Juices	Mean Score
Green Lime Juice	43.1 ± 0.37
Green Cucumber Juice	40.0 ± 0.43
Green Mojito	38.8 ± 0.21
Mustard Shot	35.5 ± 0.41
GreenSmoothie	43.6 ± 0.38
Green Mango Juice	42.1 ± 0.25
Green Passion Fruit Juice	36.9 ± 0.12
Green Apple Juice	44.4 ± 0.50
Green Freshner Juice	38.7 ± 0.21
Green Mint Juice	38.6 ± 0.46

Table XL shows the overall acceptability sensory scores of microgreen based juices. The Green Apple Juice scored the highest (44.4 ± 0.50) and Mustard Shot the lowest (35.5 ± 0.41). The unique flavour of microgreens enhanced the freshness and taste of the juice.

4.3 Phase III: Determination of Knowledge, Attitude & Practices (KAP) on Microgreens and Creating Awareness (Live training) on Cultivation and Importance of Microgreens among Selected Subjects (Self Help Groups - Kudumbashree)

Knowledge Attitude Practice on microgreens was surveyed among the selected subjects. Knowledge surveys depicts what is known about microgreens, attitude portrays the beliefs on microgreens and its consumption, Practice denotes all the activities associated with microgreens. In the phase-III, a well-structured Interview Schedule was developed and Knowledge Attitude Practices (KAP) of the selected

subjects (Self Help Groups - Kudumbashree) was assessed. Based on the assessment, awareness was created through live training sessions.

4.3.1 Assessment of Pre-Knowledge Attitude Practices (KAP) on Microgreens among Selected Subjects (Self Help Groups - Kudumbashree)

4.3.1.1 Background Information of Selected Subjects

The background details of the selected subjects such as the age, religion, educational qualification, socioeconomic status, occupation, family type and marital status were investigated.

a. Age and Religion of the Selected Subjects

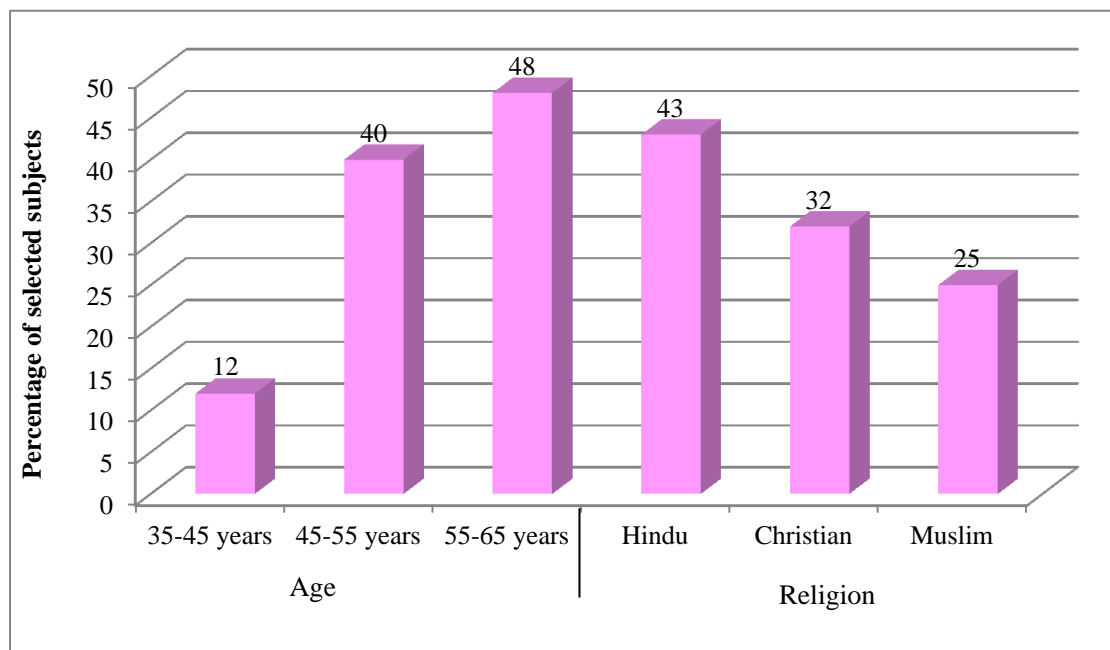


Figure 18: Age and Religion of the Selected Subjects

Figure 18 projects the age group and religion of the selected subjects. The majority (48%) of the subjects belonged to the age group of 55-65 years, 40 percent of the subjects were at the age group of 45-55 years, and the least (2%) of subjects were between 35-45 years. Most of the subjects in the age group of 35-45 contacted didn't show much willingness to participate in the study. Hence, less number of subjects were selected in the age group of 35-45 years. In regard with the

religion, majority (43%) of the subjects were Hindus followed by Christians (32%) and Muslims (25%).

b. Educational Qualification of the Selected Subjects

Table XLI
Educational Qualification of the Selected Subjects

Degree	N = 81	Percentage (%)
SSLC	9	11
HSC	8	10
Degree	20	25
PG	13	16
Diploma	16	19
Professional courses	15	19

Table XLI presents the educational qualification of the selected subjects. Majority of the subjects had an undergraduate qualification (25%). About 11 percent of the subjects had minimal qualification of SSLC. Another 10% had completed the Higher secondary examination/schooling.

c. Occupation of the Selected Subjects

Table XLII indicates the occupation of the selected subjects.

Table XLII
Occupation of the Selected Subjects

Occupation	N = 81	Percentage (%)
Homemaker	18	22
Teacher	9	11
Accountant	2	3
Chemist	6	7
Farmer	3	4
Private Job	33	40.7
Cent Govt./Govt./Semi Govt.	10	12.3

About 41 percent of the selected subjects were into private job, followed by 22 percent were home makers. And a least percentage of 3 percent were accountants and four percent were farmers, which were least among others.

d. Socio-Economic Status of the Selected Subjects

Table XLIII highlights the socio-economic status of the selected subjects.

Table XLIII

Socio-Economic Status of the Selected Subjects

Socio-Economic Status	N = 81	Percentage (%)
Upper	15	18
Upper Middle	16	20
Lower Middle	17	22
Upper Lower	14	17
Lower	2	3

The socio economic states highlights the different economic category of the selected subjects. Among the selected subjects 18 percent belonged to the upper class which was the major among other category. Further 20 percent and 22 percent belonged to the Upper middle and Lower middle class respectively. Minor percentage populations of 3 percent belong to the lower class.

e. Type of Family of the Selected Subjects

Table XLIV depicts the type of family of the selected subjects.

Table XLIV

Type of Family of the Selected Subjects

Family Type	N = 81	Percentage (%)
Joint	6	7
Nuclear	75	93
Extended	0	0

Majority of the subjects belonged to nuclear family (93%) and none of the subjects belonged to extended family. A minimum of seven percent subjects lived as a joint family.

f. Marital Status of the Selected Subjects

Table XLV depicts the marital status of the selected subjects.

Table XLV
Marital Status of the Selected Subjects

Family Type	N = 81	Percentage (%)
Married	68	84
Unmarried	3	4
Widow	10	12

Majority of the subjects were married (84%) and about 12 percent were widows. Only a minimum of four percent of the subjects were single/ unmarried.

4.3.1.2 Food Frequency Pattern of the Selected Subjects

Table XLVI shows the food frequency pattern of the selected subjects.

Table XLVI
Food Frequency Pattern of the Selected Subjects (N=81)

Food Groups	Frequency of Consumption									
	Daily		Weekly		Fort-nightly		Monthly		Never	
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Cereals and grains	81	100	0	0	0	0	0	0	0	0
Pulses and legumes	81	100	0	0	0	0	0	0	0	0
Milk and milk products	74	91.35	7	8.64	0	0	0	0	0	0
Vegetables	81	100	0	0	0	0	0	0	0	0
Roots and Tubers	67	82.71	4	4.93	3	3.70	5	6.17	2	2.46
Green Leafy Vegetables	81	100	0	0	0	0	0	0	0	0
Fruits	78	96.29	12	14.81	1	1.23	0	0	0	0
Meat ,Egg and Poultry	71	87.65	3	3.70	4	4.93	1	1.23	2	2.46
Spices and Condiments	81	100	0	0	0	0	0	0	0	0
Nuts and Oil Seeds	81	100	0	0	0	0	0	0	0	0

Cereals, grains, pulses, legumes, vegetables, green leafy vegetables, spices, condiments, nuts and oil seeds were consumed by all the subjects on a daily basis. The other food groups such as milk and milk products, roots and tubers, fruits, meat, egg and poultry were also consumed daily by majority of the selected subjects on a daily basis in comparison with other food groups. Fruits were consumed more than other foods on a weekly basis. About 2.46 percent of the subjects claim they never consume roots, tubers, meat, egg and poultry.

4.3.1.3 Assessment of Knowledge on Microgreens

Table XLVII depicts knowledge on microgreens among the selected subjects.

Table XLVII
Knowledge on Microgreens among Selected Subjects(N=81)

Knowledge on Microgreens	Aware / Yes (%)	Not Aware / No (%)
Knowledge about microgreen seeds	5	95
Knowledge on microgreen seeds availability for sales	5	95
Knowledge on micronutrients present in microgreens	3	97
The subject is a Microgreen consumer	5	95
The subject likes the taste of microgreens	2	98
Awareness on health benefits of microgreens	4	96
Knowledge on growth media of microgreens	5	95
Awareness on shelf life of the microgreens	0	100

Most of the selected subjects had no knowledge on microgreens. 95 percent of the subjects were not aware of microgreen seed, their availability for sales, growth media of microgreens and it is not surprising that they were also not consumers of microgreens. Only three percent were aware that microgreens are rich in micronutrients. And only two percent of the subjects claimed that they like the taste of microgreens. Majority (96%) of the subjects were not aware about the health benefits of microgreens. None of the selected participants had awareness on shelf life of the microgreens. Hence the awareness creation on microgreens is very much essential.

Table XLVIII shows the Knowledge on storage and cultivation of microgreens among the selected subjects.

Table XLVIII
Knowledge on Storage and Cultivation of Microgreens (N=81)

Study Parameters	Yes (%)	No (%)
Awareness on Storage techniques of microgreens	0	100
Thinks that Microgreen cultivation is costlier	1	99
Awareness on the approximate amount of money required for the microgreen cultivation	3	97
Awareness on the word 'Microgreens'	5	95
Interest in growing microgreens	92	8
Need to know more on microgreens	100	0
Willingness to grow microgreens if proper training is given	100	0
Need for booklet for future reference	92	8

According to table XLVIII all (100%) of the population had no knowledge on the storage and cultivation of microgreens. Almost all the population wanted to know more about microgreens and were ready to grow microgreens if proper training is given. About 92 percent of the subjects claimed that they need of a booklet containing all the steps of cultivation that would serve as reference for future.

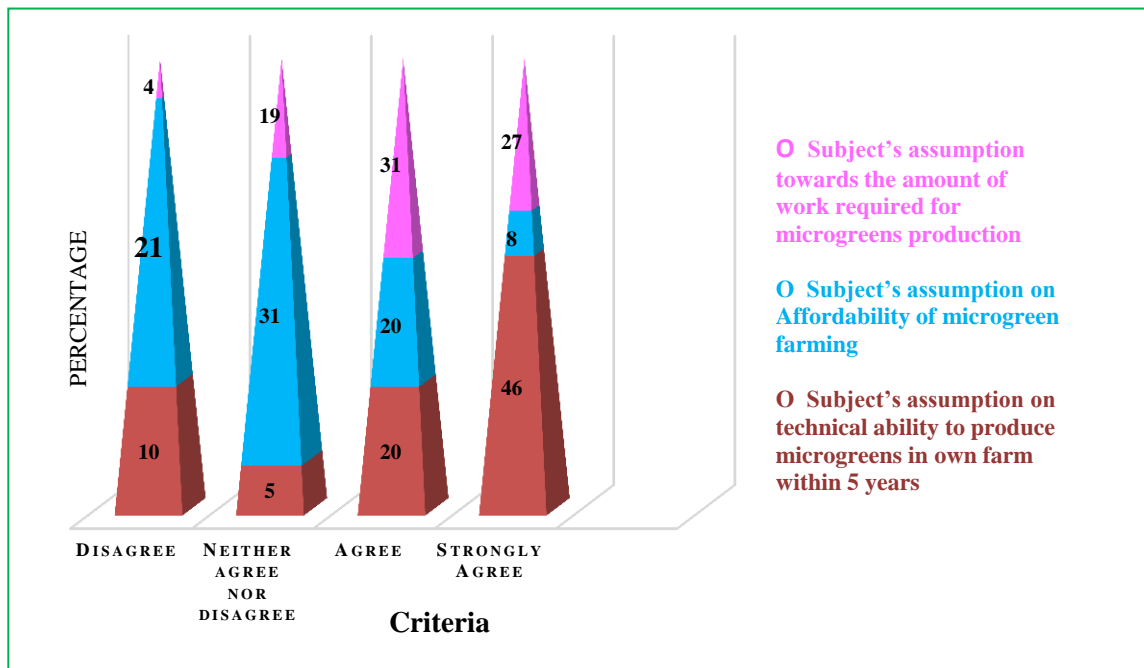


Figure 19: Knowledge towards Production of Microgreens in Kitchen Gardening Future

Figure 19 projects, the responses of the selected subjects for the given questions. About 31 percent of the subjects agree that they can put in the required amount of work needed for the production of microgreens. A majority of 31 percent of the subjects neither agree or disagree, that they can afford the cost required for microgreen farming. This is followed by 21 percent of the subjects who disagree that they can afford the cost. About 46 percent of the subjects have strongly agreed that they think, they have the technical ability to produce microgreens in their farm within next five years.

Table XLIX depicts the knowledge level on microgreens among the selected subjects.

Table XLIX
Knowledge Level on Microgreens among the Selected Subjects (N=81)

Criteria	Knowledge on Microgreens	Number (N)	Percentage (%)
Knowledge on microgreens	I am very aware of microgreens	4	5
	I am somewhat aware	7	8.6
	I have no awareness of microgreens	70	86.4
Knowledge regarding microgreens	It is a leaf	4	5
	It is a sprout	6	7.4
	It is a small plant	4	5
	Something like vegetables	4	5
	Don't know	63	77.3
Benefits of microgreens	It can be used as food	4	5
	It is good for health	4	5
	It is easy to grow	4	5
	I don't find any benefits	69	85

Majority (86.4%) of the subjects had no awareness on microgreens and only five percent of the subjects were very much aware about microgreens. The exact Knowledge regarding what a microgreen is was also collected. Maximum of the subjects claim it's a plant (5%) followed by subjects who claim it as a sprout (7.4%). About 77.3 percent of the subjects do not know what microgreens are. Knowledge on the benefits of microgreens was also investigated. Most of the participants (85%) claim that they don't find any benefits in microgreens. About 5 percent of the subjects reported that, It can be used as food.

Table L shows the awareness on microgreens among Selected Subjects.

Table L
Microgreen Cultivation, Purchase and Nutritional Prospects Awareness among Selected Subjects (N=81)

Information regarding greens		Number (N)	Percentage (%)
Types of microgreen seeds commonly used for cultivation	Fenugreek	1	1
	Mustard	3	4
Place where microgreen seeds were purchased	Online shopping site	4	5
	Nursery	0	0
	Seed Sellers	0	0
Nutrients present in microgreens	Carbohydrate and protein	2	3
	Vitamins	0	0
	Vitamins and minerals	0	0
	Don't know	0	0

From the table L it is clear that majority of the subjects had no awareness about microgreens. The subjects had nil or very less knowledge on microgreen cultivation, place of purchase and nutrients present in microgreens.

Table LI

**Knowledge on Microgreen Cultivation Methods among Selected Subjects
(N=81)**

Knowledge on Microgreen Cultivation Methods		Number (N)	Percentage (%)
Medium found to be suitable for the growth of microgreens	Coco-peat	4	5
	Normal Soil	0	0
	Soil+ kitchen waste	0	0
	Soil+ kitchen waste + Cocopeat	0	0
	Hydroponics	0	0
	Vermicompost	0	0
Type of containers used for cultivation of microgreens	Plastic containers	4	5
	Mudpots	0	0
	UV treated trays	0	0
	Glass pots	0	0
	Steel containers	0	0
	Used vegetable /fruit boxes	0	0
The watering methods adopted for cultivation of micro greens	Bottom watering	0	0
	Top watering	0	0
	Just watering	4	5
Environment best suited for growing microgreens	Typical environment (In Kitchen)	3	3.7
	Green house	0	0
	In shades	1	1.2

Table LI depicts the Knowledge on Microgreen Cultivation Methods among Selected Subjects who cultivate microgreens. The table portrays that the subjects had none or very less knowledge on microgreen cultivation methods. About five percent of the selected subjects opined that coco peat is the suitable medium for the growth of microgreens. Only five percent of the subjects recommended plastic containers for the growth of microgreens. Four of the subjects used just watering for the growth of microgreens and three of the microgreen cultivators had grown the microgreens in their kitchen itself.

Table LII depicts knowledge on the storage techniques and means of awareness of microgreens.

Table LII

Knowledge on the Storage Techniques and Means of Awareness of Microgreens
(N=81)

Storage / Media Type		Number (N)	Percentage (%)
Type of storage container used	Food Grade Containers	0	0
	Paper Bags	0	0
	Paper towels	0	0
	Polyethylene bags	0	0
		0	0
Means of awareness of microgreens	Newspaper	0	0
	Magazines and Journals	1	1.23
		4	3.24
	Social Medias	5	0
Microgreen awareness among homemakers via social media	Facebook	4	3.24
	Instagram	1	1.23
	Twitter	0	0
	Whats app	0	0
	Telegram	0	0

From the table it is clear that majority of the subjects have no awareness about microgreens. None of the subjects had awareness about the storage of microgreens. About 5 percent of the subjects claimed that they got awareness from Social Media, another 4 percent mentioned their source as journals and 1 percent learnt from magazines. Among the Home makers, about 4 percent of them received awareness through facebook and about 1 percent through Instagram.

Table LIII depicts the knowledge on microgreen recipes, taste and their opinion on microgreens.

Table LIII**Knowledge on Microgreen Recipes, Taste and Other Opinion (N=81)**

Study Parameters		Number (N)	Percentage (%)
Microgreen recipes prepared	Salads	3	3.7
	Curries	0	0
	Smoothies	0	0
	Juices	0	0
	Main Dishes	1	1.2
	Side Dishes	0	0
Taste of microgreens	Bitter	1	1.23
	Sour	0	0
	Sweet	0	0
	Juicy	0	0
	Crunchy	0	1
	Nutty	0	0
	Earthy	0	0
Opinion about the microgreens	Very interesting	12	14.81
	Thought of trying it	11	13.58
	Searched for more information	8	9.87
	Haven't found anything beneficial	19	23.45
	Haven't understood the term	30	37.03

The table clearly portrays that the knowledge and awareness about microgreens is very less among the selected participants. Only 2.46 percent of the participants were aware about the preparation of salads using microgreens. And 1.23 percent of the subjects claimed that microgreens are bitter in taste. About 37 percent of the subjects claim that they have not understood the term microgreen. And only a 12 percent population have claimed microgreens are very interesting.

4.3.1.4 Attitude towards Adoption of Microgreens

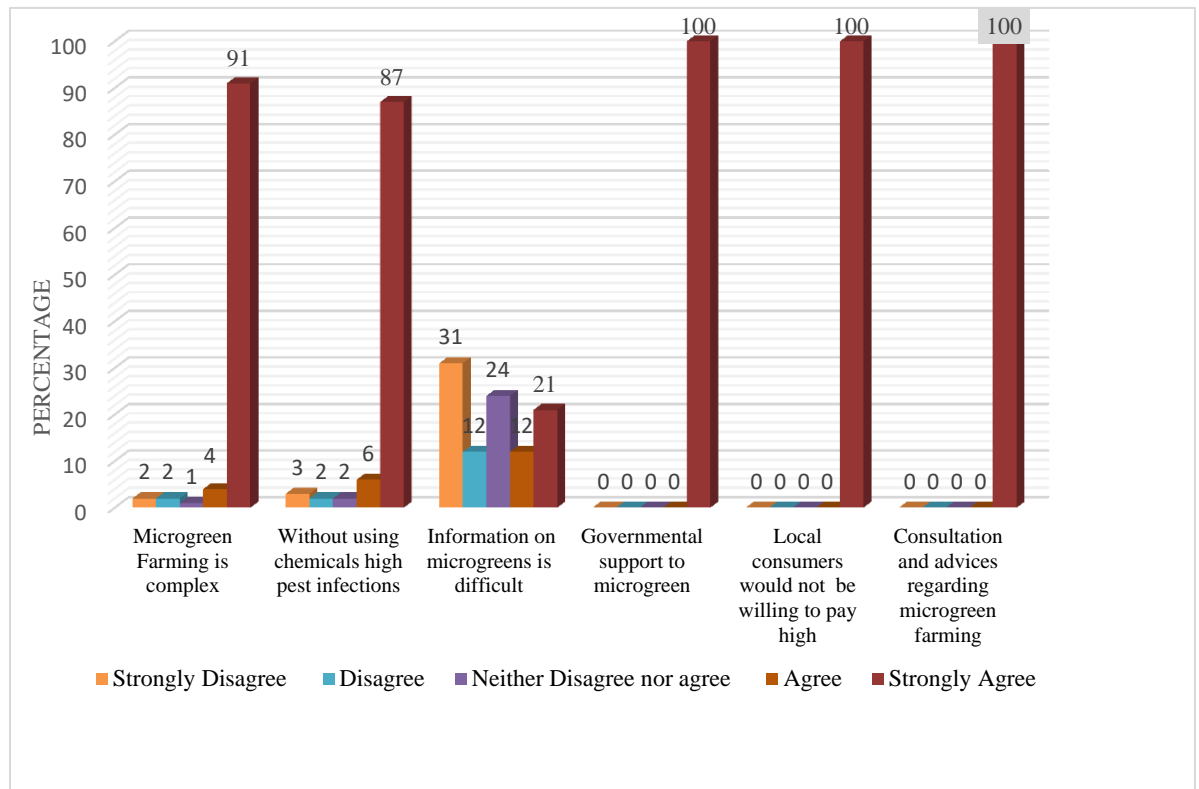


Figure 20: Attitude towards Adoption of Microgreens Farming

In Figure 20, the attitude of the selected subjects towards the cultivation of microgreens were evaluated.

Among the selected subjects majority (91%) strongly agrees that microgreen farming is complex, 4 percent agrees, 1 percent neither agree nor disagree, two percent disagrees and two percent strongly disagrees. About 87 percent of the subjects strongly agrees that without using chemicals high pest infections may occur. Twenty percent of the subjects strongly agrees that information on microgreens are very difficult.

All the selected subjects strongly agrees to the statements such as governmental support for microgreen cultivation, local consumers would not be willing to pay high for cultivation and on consultations and advices regarding microgreen farming.

Figure 21 depicts the attitude of the subjects towards the adoption of microgreens.

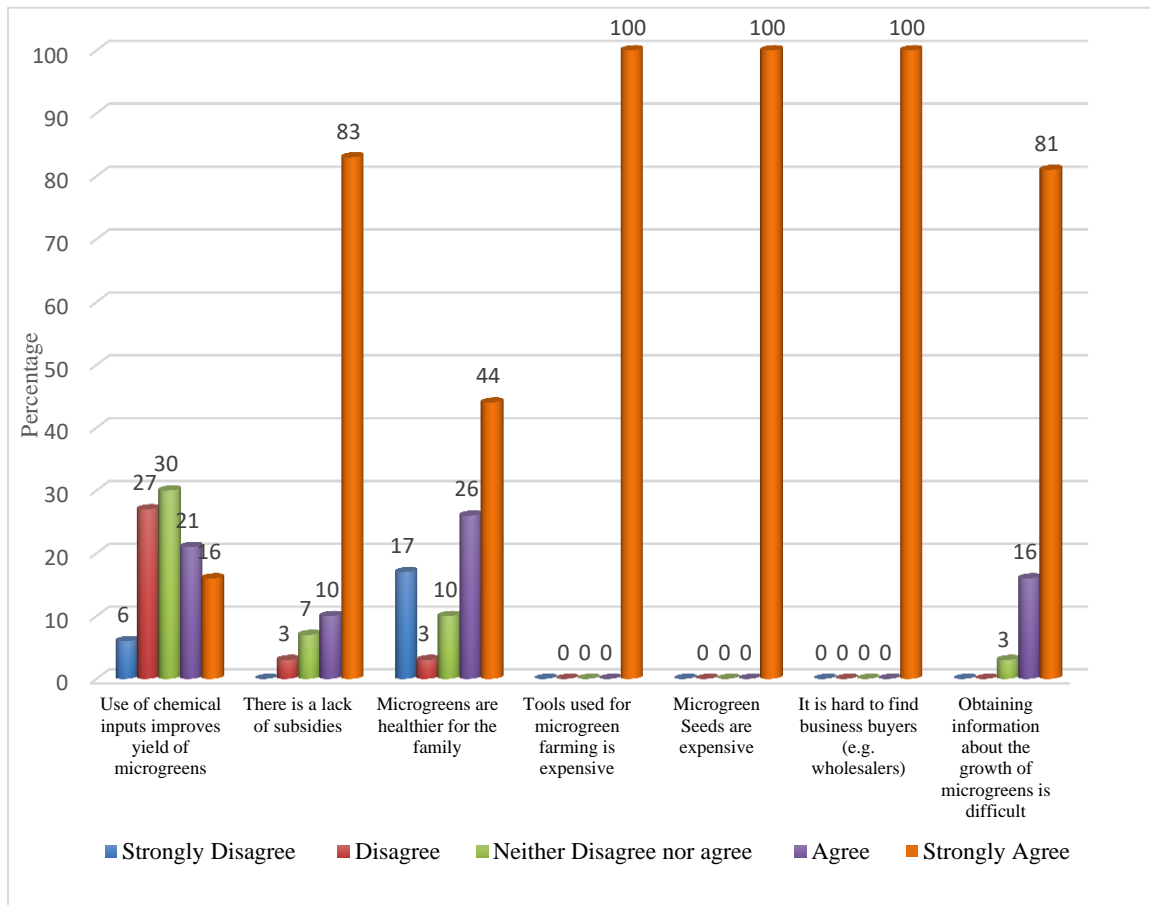


Figure 21:Attitude towards Commercialization of Microgreens

Majority of the selected subjects have opted neither agreed or disagree for the statement on the use of chemical inputs improves the yield of microgreens. About 83 percent of the selected subjects strongly agrees to the statement that there is a lack of subsidies and only a 3 percent disagreed. And again majority of the subjects (44%) strongly agrees to the statement that microgreens are healthier.

All the subjects strongly agree to the statements that cultivation of microgreen seeds and farming tools are expensive and it is also hard to find business buyers. And 81 percent of the subjects strongly agrees that obtaining information about the growth of microgreens is difficult, 16 percent agrees and three percent neither agree nor disagree.

Table LIV shows attitude towards adoption of microgreen cultivation.

Table LIV

**Attitude towards Production of Microgreens at Kitchen Garden
(N=81)**

Attitude Towards Production of Microgreens	Strongly Disagree		Disagree		Neither Agree Nor Disagree		Agree		Strongly Agree	
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Production of Micro greens at own kitchen garden is a very good idea	1	2	4	5	22	27	26	33	26	32
Family Support in cultivating Micro greens at kitchen garden	5	6	3	4	37	45	20	25	16.2	20
Encouragement for Microgreen Cultivation from best friends and colleagues	5	6	6	6	16.2	20	25	31	30	37

Even though Microgreens are considered as an upcoming food product the general attitude towards cultivating microgreens is very pathetic among the community (Chen, 2020). Hence the attitude towards adoption of microgreen cultivation was studied.

Majority (32%) strongly agreed and least (2%) strongly disagreed to the statement producing microgreens within the kitchen garden was very good idea. Majority (45%) neither agreed nor disagreed to the statement family favours the idea of the microgreen cultivation in the kitchen garden. Majority (31%) agreed and least (6%) strongly disagreed to the statement producing microgreens would be encouraged by their best friends and colleague.

4.3.1.5 Awareness on Kitchen Garden among Selected Subjects

Table LV depicts awareness on kitchen garden among selected subjects.

Table LV

Awareness on kitchen garden among selected subjects (N=81)

Study Parameters	Yes (%)	No (%)
The subject is a Green consumer	100	0
The subject owns a kitchen garden	38	61
Cultivation of green leafy vegetables in kitchen garden	29	70
Awareness on the importance of green leafy vegetables	54	46
Conception that the farming of vegetables will add to expenses .	60	51
Finds Large amount of water is lost for cultivation purpose	43	19
Usage of pesticide /insecticides for protection in kitchen garden/farm	19	80
Need of cultivation of green leafy vegetables	91	8

Kitchen Gardening is a very common in the present scenario. The practice of kitchen gardening has positive impact on the consumption pattern of nutritious food among the community (Sileshi,2022). Hence the awareness on kitchen garden among selected subjects was investigated.

All the subjects (100%) consumed greens. Majority of the subjects (61%) did not have a kitchen garden and (38%) kitchen gardens. About 70 percent of the subjects did not cultivate green leafy vegetables and (54%) knew the importance of green leafy vegetables.

About 60 percent of the subjects agree that farming of vegetables will add to expenses. And about 43 percent had the opinion that large amount of water is lost for cultivation purpose. Eighty percent of the subjects reported that they don't use pesticides or insecticides for the protection of the kitchen garden. Most of the subjects (91%) confirmed that there is need for cultivating green leafy vegetables.

Table LVI

Consumption Pattern of the Cultivated Vegetables / Microgreens by the Selected Subjects (N=81)

Greens Consumed (Type of vegetables/microgreens grown in garden/farm)	Number (N)	Percentage (%)
Mint and Coriander	8	10
Ladies finger	11	14
Drumstick	7	9
Bittergourd	3	4
Curry leaves	6	8
Amaranthus(Red)	7	9
Amaranthus(Green)	5	6
Colocassia	5	7
Tapioca	4	5
Mustard Microgreens	3	4
Fenugreek microgreens	0	0

Table LVI depicts the consumption pattern of selected subjects. Majority of the subjects (14%) had grown ladies finger in the kitchen garden and consumed. This is followed by the cultivation and consumption of mint and coriander. Fenugreek microgreens was not grown for consumption.

Table LVII
Reasons for Not Having Kitchen Garden at Home

Reason	Number (N=49)	Percentage(%)
Lack of space	13	26.5
No time	11	22.4
Not Interested	9	18.36
Don't know the how to cultivate	7	14.2
A lot of effort is needed	6	12.2
Large amount of expenses	3	6.1

Table LVI depicts the reasons for not having a kitchen garden. Majority of the subject's claims that lack of space is a reason for not adopting microgreen cultivation. And least claim that large amount of expenses are needed for having kitchen garden .

Table LVIII depicts the consumption pattern of green leafy vegetables among selected subjects.

Table LVIII
Consumption Pattern of Green Leafy Vegetables among Selected Subjects (N=81)

Consumption Pattern	Criteria	Number (N)	Percentage (%)
Number of meals prepared with greens	Less than one meal	39	48.14
	More than two meal	3	3.7
	Between two – four meal	22	27.6
	Not using much in meals	17	21
Types of green leaves used for food preparation*	Curry leaves	81	100
	Drumstick leaves	71	87
	Mint leaves	74	92
	Coriander leaves and Curry leaves	66	82
	Amaranthus (green) leaves	79	65
	Amaranthus (red) leaves	52	77
	Others	62	54
Types of green leafy recipes prepared *	Cheerathoran	54	67
	PalakPaneer	59	73
	Coriander chutney	74	92
	Murungaelathoran	55	68
	Mint chutney	66	82
	Others	49	61

***Multiple Responses**

The green leafy vegetable consumption contributes towards enormous health benefits to the host. Hence the green leafy vegetable consumption pattern was investigated.

Majority (48%) used greens in less than one meal and least (3%) used greens in two to four meals. All the subjects (100%) incorporated curry leaf for meal preparation and least (54%) used amaranth leaf for meal preparation. The dietary pattern among community has changed a lot that significantly decreased the intake of the green leafy vegetables. The decreased intake is connected with higher incidence of chronic diseases. (Bansal, 2010). Coriander chutney was the most prepared green leafy based dish, which was prepared by 92 percent of the subjects.

Table LIX depicts purchase of green leafy vegetables and budget used per day.

Table LIX

Purchase of Green Leafy Vegetables and its Expense Per day (N=81)

Consumption Pattern	Criteria	Number (N)	Percentage (%)
Amount of green leafy vegetables commonly purchased for meal preparation (per day)	Less than 100 gm	16	20
	100 - 150gm	34	43
	150 – 200 gm	25	32
	200 – 250 gm	4	5
	More than 250gm	0	0
Budget used for the purchase of green leafy vegetables (per day)	Less than Rs. 20	11	14
	Rs.20 -30	19	24
	Rs.30- 40	30	37
	Above Rs .40	20	25

Majority (43%) of the subjects purchased 100-150 gm of green leafy vegetable for meal preparation per day and least (5%) purchased 200-250 gm of green leafy vegetables. Most (24%) of the subjects spend Rs.20-30 for the purchase of green leafy

vegetables and 14 percent of the subjects spend the least amount less than Rs.20 for purchasing green leafy vegetables.

Reliability Test of the Interview Schedule Using Factor analysis

The respondent’s attitude towards adoption in microgreens was identified and the most dominating factor was analysed through factor analysis and the result is given in table LX.

Table LX

CRONBACH'S Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
.933	30

Source: Estimation based on Field survey

Table LX depicts the results of CRONBACH'S reliability test. To determine the reliability of applying factor analysis the Cronbach’s alpha test was applied and the results are projected in the table LVIII. From the table it can be found that the Cronbach’s alpha value was .933 which was greater than 0.9 indicating the internal consistency of the constructs. Hence, the instrument used in this study had a high reliability value. Factor analysis was done to determine the underlying dimensions of the constructs.

4.3.2 Imparting Awareness (Live Training) to Selected Subjects on Cultivation and Importance of Microgreens among Selected Subjects (Self Help Groups - Kudumbashree)

Awareness on microgreens and its relevance in the present scenario for rural and urban homemakers, was given through live training sessions. The training was also given to Self Help Groups. The subjects were first given an interview schedule to assess their knowledge regarding microgreens. After the awareness session, an interview schedule was also given to the same subjects to assess their knowledge and feedback on the session.

Before creating awareness, the knowledge assessments were done and the scores were categorized as less than and more than 50 percent with the help of the assessment tool. The knowledge of the subjects was assessed after the session.

4.3.2.1. Pre-Awareness Knowledge Assessment

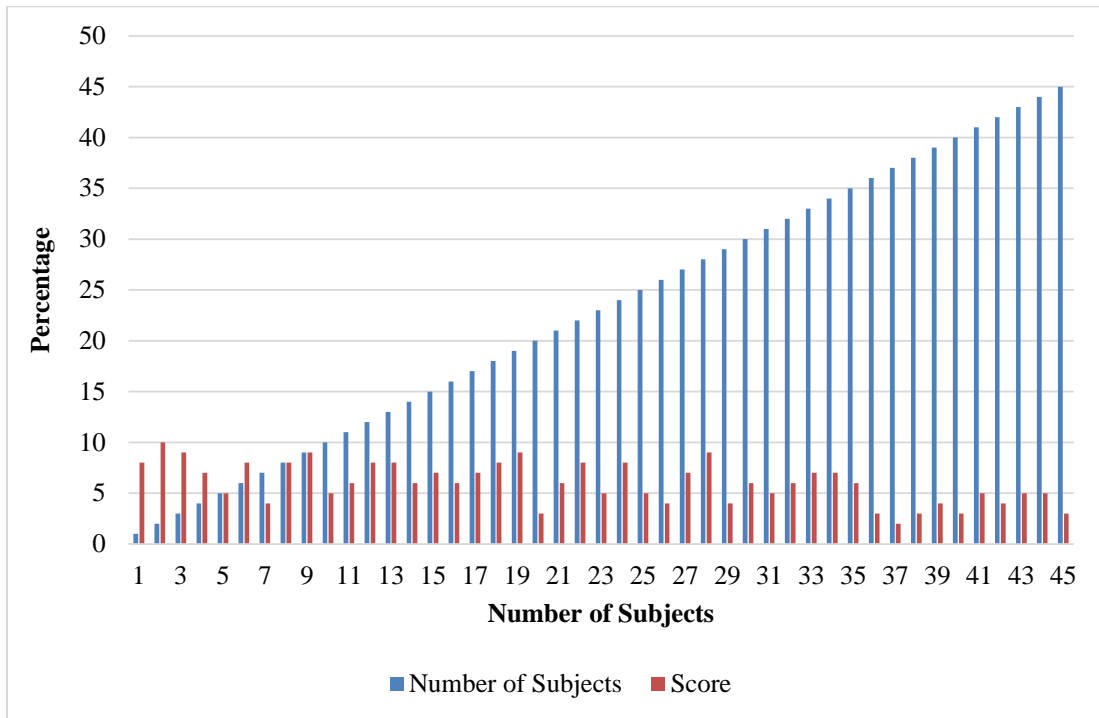


Figure 22: Pre-Awareness Knowledge Assessment

Figure 22 presents the scores obtained by selected subsamples before the awareness creation. Majority of the subjects scored 5, which is depicted as 25 percent awareness level. Among the selected subjects only one obtained the maximum score.

Table LXI depicts the KMO AND BARTLETT'S Test Measures.

Table LXI
KMO AND BARTLETT'S Test Measures

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.849
Bartlett's Test of Sphericity	Approx. Chi-Square	3057.655
	Df	190
	Sig.	.000

Source: Estimation based on Field survey

The study tried to identify the significant responses from the training programme given to the respondents on sustainable product development process by using factor analysis. As a first step two tests namely, Kaiser-Meyer-Olkin measures of sampling adequacy (KMO) and Bartlett's Test of Sphericity have been applied to test whether the relationship among the variables has been significant or not. The estimated Kaiser-Mayer-Olkin measure of sampling adequacy was 0.849 and χ^2 value for Bartlett's test for sphericity 3057.655 indicating the selected variable's factor analysis was found to be appropriate.

4.3.3 Assessment of Post Awareness Knowledge among Self-Help Groups (Kudumbashree) on the Cultivation of Microgreens

4.3.3.1 Post Awareness Knowledge Assessment

Figure 23 depicts the post knowledge assessment of the selected subjects.

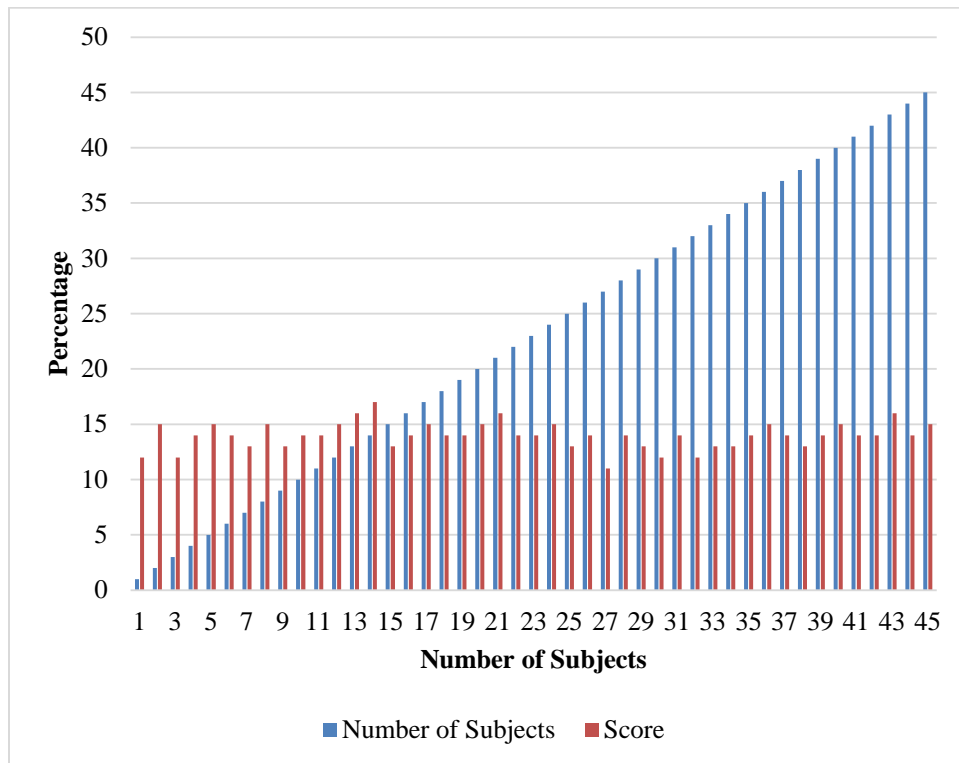


Figure 23: Post Awareness Knowledge Assessment

After the pre assessment, awareness was given through a live training session to the selected subjects. After creation of awareness a post assessment was done to determine the impact of the awareness given. Majority of subjects scored 60 percent awareness level. And most of the subjects had more than fifty percent. The intervention programme conducted has positively influenced the homemakers regarding the knowledge of microgreens and growing method of microgreens.

4.3.3.2 Comparison of Pre and post Knowledge Score of the Selected Subjects

Table LXII projects the Pre and post Knowledge Score of the Selected Subjects.

Table LXII

Pre and post Knowledge Score of the Selected Subjects (N=45)

Score	Pre - Knowledge Assessment	Post - Knowledge Assessment
Less than 50 % score	39	13
More than 50% score	6	32

From the table it is clear that the awareness created had a good impact among the subjects selected. Majority of subjects scored more than 50 percent score post awareness. And the percentage of scoring less than 50 percent is also reduced in the post awareness assessment. Hence it is understood that the awareness was effective and a positive impact had been obtained. As a significant association between the awareness created and post awareness knowledge level was observed, the null hypothesis (H_0) was rejected and the alternate hypothesis (H_1) was accepted.