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Microgreen production in herbal spices

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Abstract
A study was conducted to find out the essential nutrients which is available in the herbal spices of microgreens. Major seed spices *viz*., coriander, fenugreek, basil and their five developmental stages from seed to mature green stages were used as treatments. Among the different treatments, the mean value of vitamin E- α (40 mg/g) and γ (12.2 mg/g), vitamin K (4.53 µg/g) and carotenoids (11.2 mg/g) were recorded highest in the treatment C_1S_3 (Coriander @ microgreen stage).The vitamin C (5.89 mg/g) was found highest in C_2S_3 (Fenugreek @ microgreen stage) which is the best among the other treatments. Phenol (76.35 mg/g), iron (42.44 mg/g) and antioxidant activity (1020.69 µg/g) were recorded highest in the treatment C_1S_5 (Coriander @ mature green stage).The result revealed that the coriander microgreens and mature greens are having more potential nutrients and bioactive compounds are being utilized.

Keywords: Microgreens, coriander, fenugreek, basil, bioactive compounds, carotenoids, vitamins

Introduction
Microgreens are a new generation of smart food with full of nutrition and flavor. Microgreens is a stage in between the germinating seeds and baby greens. The usage of microgreens was first started during 1990 and later in 1998 it is termed as 'Microgreen'. Microgreens have three basic parts: a central stem, cotyledon leaves and typically the first pair of very young true leaves. They vary in size depending upon the specific variety grown, with the typical size being 1 to 1.5 inch (25 to 38 mm) in total length. The microgreens are essential for healthy human diet in a day to day life. The microgreens are called as a package of essential nutrients in a sole food. The raw and fresh microgreens are used for consumption because which are more nutritious when compared to the cooked food items. It is consumed by humans whenever and where ever possible. There are more than 25 microgreens commercially being grown all over the world. Phytonutrient levels differ according to growth stages of the plant and often decrease from the seedling to the fully developed stage (Ebert *et al*., 2014) [2]. Microgreens are 4-6 times more nutrient dense than their mature counterparts (Xiao *et al.*, 2012) [12].
Now a days, there is a great demand for fresh microgreens due to various health issues in human beings. Microgreens are young tender shoots which have high nutritive value and so it is mainly preferred for consumption. Raw vegetables are replaced by microgreens due to its nutritional property. To meet out the availability of essential nutrients in our daily diet it is important to grow the microgreens at micro scale level. Microgreens acts as a good vitalizer and so it has the ability to increase the nutrition level in human beings. In this backdrop, the present study was conducted in three herbal spices in four stages to find out the best stage with potential nutrients.

Materials and Methods
The experiment was conducted in Tamil Nadu Agricultural University. A pot culture study was carried out in the green house with the factorial completely randomized design. The pots are filled with red soil and well decomposed coir pith in the ratio of 1:1.The duration of this study is about 30 days. Totally 15 treatments with three replications are followed. Treatment details are given below: C_1 - Coriander, C_2 - Fenugreek, C_3 - Basil and S_1 - Seed stage, S_2 - Sprout stage, S_3-Microgreen stage, S_4 - Baby green stage, S_5 - Mature green stage.
The varieties used are coriander: CO (CR) 4, Fenugreek: CO_2 and Basil: Lime basil (*Ocimum americanum*) was used for this study. The seeds were sown in the pots and the observations recorded. Harvesting of spice herbs were done at different stages *viz*. sprout stage -7th to 10th day, microgreen stage - 10th to 14th day, baby green stage - 14th to 21th day, mature green stage - 30th day. Harvesting was done by cutting at the base of the plant by using scissors.

Result and Discussion
Effect of treatments on bioactive compounds
Among the different treatments, C_1S_3 (Coriander @ Microgreen stage) was recorded the highest level of vitamin E, vitamin K and carotenoids.

The mean values of vitamin E (tocopherols), α tocopherol (40 mg/g) and γ tocopherol (12.2 mg/g), vitamin K (phylloquinone) (4.53 µg/g) and carotenoids (11.2 mg/g) were showed in Table 1. The vitamin C (ascorbic acid) was found highest in C_2S_3 (Fenugreek @ Microgreen stage) which is the best among other treatments. Vitamin C is synthesized in plants as a response to oxidative stresses and through the l-galactose pathway using mannose or galactose. Therefore, the growth conditions, including nutrition in soil and hydroponic growing media, and environmental stresses may all impact vitamin C biosynthesis in microgreens (Giovannoni *et al*., 2007) [4]. Increased nutritional value of microgreens can be also achieved by light management as demonstrated results of Kopsell *et al*., (2012).

Treatments	Treatment details
C_1S_1	Coriander @ Seed stage
C_1S_2	Coriander @ Sprout stage
C_1S_3	Coriander @ Microgreen stage
C_1S_4	Coriander @ Baby green stage
C_1S_5	Coriander @ Mature green stage
C_2S_1	Fenugreek @ Seed stage
C_2S_2	Fenugreek @ Sprout stage
C_2S_3	Fenugreek @ Microgreen stage
C_2S_4	Fenugreek @ Baby green stage
C_2S_5	Fenugreek @ Mature green stage
C_3S_1	Basil @ Seed stage
C_3S_2	Basil @ Sprout stage
C_3S_3	Basil @ Microgreen stage
C_3S_4	Basil @ Baby green stage
C_3S_5	Basil @ Mature green stage

Effect of treatments on biochemical compounds

Among the different treatments, C_1S_5 (Coriander @ Mature green stage) was recorded the highest level of phenol, iron and antioxidant activity. The mean values of phenol (76.35 mg/g), iron (42.44 mg/g) and antioxidant activity (1020.69 µg/g) were showed in Table 1.These results are in line with the findings of Puthusseri *et al*., (2013) in coriander leaves which recorded the highest biochemical compounds like iron and antioxidants. Similar results were observed by Wong and Kitts (2006) and reported that the coriander leaf and stem contain highest total phenols such as 110, 63.2 and 89.3, 51.6 mg/100 g of TPC, respectively.

The TPC of plants depends on the balance between its synthesis and oxidation. The effects of growth environment, harvesting condition, and post-harvest interventions on the synthetic or oxidation pathway of phenolic compounds in plants will provide insights into the key factors that determine the TPC level of microgreens. The phenolic compounds could be the main contributor to the total antioxidant capacity (Pellegirni *et al*., 2007).

Calcium

Among different treatments C_3S_3 (Basil @ Micro green stage) (198.49 mg/g) showed highest calcium content and lowest range of calcium was observed in C_2S_3 (Fenugreek @ Microgreen stage) (105.17 mg/g), Pinto *et al*., (2015) reported that lettuce microgreens has huge amount of calcium content when compared to the mature lettuce. Calcium is higher in microgreens due to its role in regulating many stress-responsive genes (El-Nakhel *et al*., 2019) [3].

Table 1: Content of bioactive compounds in various spice herbs in different growth stages

Parameters / Treatments	Vit C (mg/g)	Vit E (mg/g)		Carotene (mg/g)	Phenol (mg/g)	Ca (mg/g)	Fe (mg/g)	Vit K (µg/g)	Antioxidant Activity (µg/g)
		α	γ						
C_1S_1	3.42	25.9	8.26	8.02	12.01	94.48	9.64	2.27	307.97
C_1S_2	3.70	35.3	9.30	10.1	12.84	107.42	14.62	2.86	315.95
C_1S_3	4.30	40.0	12.2	11.2	15.21	113.38	15.86	4.53	329.44
C_1S_4	4.03	33.4	11.1	9.40	16.19	126.18	18.32	3.83	335.30
C_1S_5	4.15	17.2	5.80	5.87	76.35	309.26	42.44	3.50	1020.69
C_2S_1	3.26	1.30	1.43	2.17	11.82	79.11	12.96	2.63	202.73
C_2S_2	4.31	2.84	2.67	2.83	15.60	92.51	16.55	3.80	284.43
C_2S_3	5.89	4.80	3.57	1.60	16.37	105.22	18.41	3.73	343.30
C_2S_4	5.07	3.57	3.00	3.97	27.43	91.81	18.80	3.60	348.69
C_2S_5	5.39	2.30	1.33	9.53	41.90	105.17	27.94	3.53	433.10
C_3S_1	3.34	1.77	2.00	1.20	10.12	177.08	15.87	2.37	133.66
C_3S_2	3.43	2.57	2.70	7.63	13.63	182.51	18.57	3.50	167.22
C_3S_3	4.32	4.97	3.90	9.07	16.68	198.49	20.83	3.83	242.78
C_3S_4	3.57	3.70	2.73	6.87	22.26	190.53	15.19	2.67	214.39
C_3S_5	4.08	2.67	2.03	5.87	30.26	344.67	17.09	1.50	564.82

Sources	Vit C	Vit E		CN	PL	Ca	Fe	Vit K	AA
		α	γ						
SEd	0.38	2.85	1.31	1.20	5.03	15.75	5.26	2.13	38.12
CD (p=0.05)	0.79**	5.84**	2.68**	2.45**	10.29**	32.18**	10.75**	4.35 NS	77.86**

All the parameters are highly significant except vitamin K

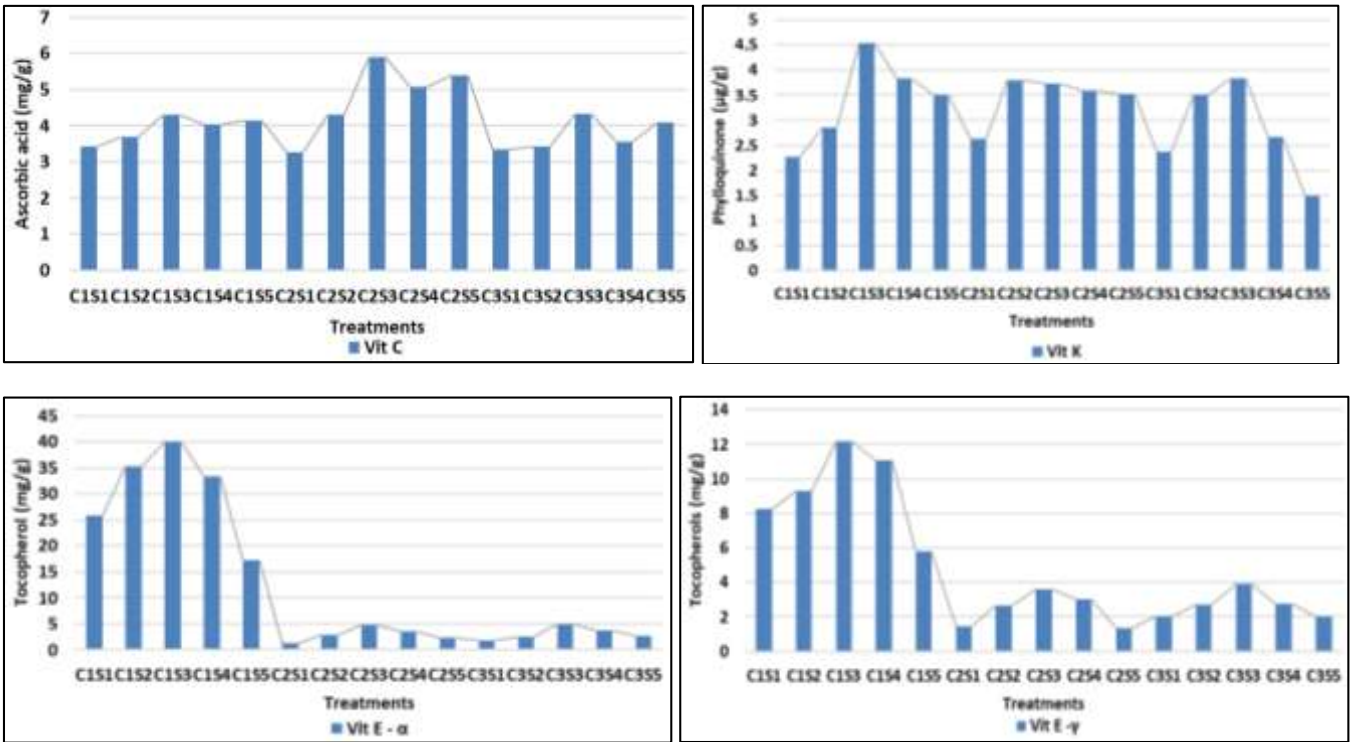

Fig 1: Content of Ascorbic acid, Phylloquinone and Tocopherols in various herbal spices in different growth stages

Conclusion

The present study revealed that the coriander microgreens and mature greens had recorded more potential nutrients and bioactive compounds. When compared to all other treatments studied. Hence, coriander microgreens and mature greens are being better utilized for enhanced potential nutritional availability.

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