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EFFECTS OF SEED PREPARATION, SOWING MEDIA, SEED SOWING RATE AND HARVESTING PERIOD ON THE PRODUCTION OF CHIA MICROGREENS

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ABSTRACT: Chia (*Salvia hispanica* L.), a species of seeds with high essential fatty acids and nutraceutical content has encouraged increased crop production worldwide. Keeping value-added products in consideration, four experiments were conducted with the CRD method. In the first experiment, seed preparation was done by soaking the seeds in water, followed by sowing them in media. In the first treatment, T1, seeds were sown without soaking. In T2, seeds were sown after being soaked for 6 hours at room temperature (temperature) and, in T3 for 12 hours. In T4, after being soaked at 70-80°C, the seeds were allowed to cool down at room temperature for 6 hours and in T5 for 12 hours, before sowing. According to the results, T4 treatment produced the highest germination percentage, microgreen height and fresh weight. In the second experiment, seeds were sowed in 5 different seeding medias for 7 days. The mix of coconut coir with sand and rice husk ash (1:1:1) produced the highest percentage of germination, microgreen height and fresh weight. The third experiment was conducted to study the best seed sowing rate amongst 56, 93, 130, 167 and 204 g/m^2. The results showed that the seed sowing rate of 204 g/m^2 gave the highest fresh weight. The fourth experiment was to study the effect of harvesting period, by focusing on the harvesting periods of 5, 6, 7, 8 and 9 days, after sowing. The results showed that the period of 6-9 days after sowing gave the highest fresh weight.

Keywords: Chia, Microgreens, Seed Preparation, Sowing Media, Harvesting Period

1. INTRODUCTION

Today, more attention is given to healthy nutrition to prevent certain diseases [1]. As public health awareness is increasing day by day, throughout the world, the demand for functional food with multiple health benefits is also increasing.

Microgreens are considered “functional foods” which are food products that possess particular health promoting or disease preventing properties, that are additional to their normal nutritional values [2]. These are also classified as a good source of minerals in the human diet [3].

Microgreens are a new class of edible vegetables, a very specific type which includes seedlings of edible vegetables, herbs or other plants [3]. The commonly cultivated microgreens are spinach, mustard, buckwheat, arugula, bull’s blood beet, celery, cilantro, amaranth, golden pea, basil, spinach, mizuna, peppercress, popcorn shoots, red mustard, red beet, red cabbage, red orach, sorrel, red sorrel, wasabi, cabbage, broccoli, radish, lettuce. The size of these greens is within 3-10 cm in height which usually occurs within 7–14 days after germination, depending on the plant species. Over the past few years, microgreens have gained increasing popularity as new culinary ingredients due to their wide range of intense flavors, attractive colors and tender texture. Microgreens can be served in salads, soups, sandwiches and main dishes [3], [4], [5].

Chia *(Salvia hispanica* L.) is an annual plant belonging to the Lamiaceae family, native to Mexico and Guatemala [5]**.** Recently, chia seeds have become important for human health and nutrition because it has a high content of ω-3 fatty acids and high antioxidant properties that promote beneficial health effects [7]**.** Itis considered as a Dietetic Nutritional Supplement by the Food and Drug Administration (FDA) [8]**.** Chia is now widely cultivated. Its cultivation is not limited only to America but is also extended to other areas such as Australia and Southeast Asia [9].

The objectives of this work are to study the effects of seed preparation, sowing media, seed sowing rate and harvesting period of Chia microgreen for use as information and guidelines for the production of Chia microgreen.

2. MATERIALS AND METHODS

In these experiments, only used Chia seeds that were free from any defect and physical damage. They were obtained from a commercial microgreens seed source (Jamthong Farmshop, Thailand).

2.1 To Study the Effect of Seed Preparation and Soaking Treatments on Production of Chia Microgreens

Chia seed preparation for germination was done by soaking the seeds, followed by sowing them in media. In the first treatment, seeds were sown without being soaked. In the second and third treatment, seeds were soaked for 6 and 12 hours at room temperature In the fourth and fifth treatment, seeds were soaked in water at 70-80°C and then allowed to cool down at room temperature for 6 hours and 12 hours, respectively, before sowing it in media. They were sown in a plastic basket (20 cm×27 cm) containing coconut coir mixed with sand and rice husk ash (1:1:1) which was sprayed twice a day with the same amount of water.

Four replicates were used per treatment in the experiment. Chia microgreens were randomly selected from each replicate to measure the germination percentage, microgreen height and fresh weight per 100 microgreens after sowing for 7 days.

2.2 To Study the Effect of Sowing Media on Growth of Chia Microgreens

Chia seeds were soaked in water at 70-80°C and then allowed to cool down at room temperature for 12 hours, before sowing it in media. Seeds were sown in a plastic basket (20 cm×27 cm) with five medias; coconut coir, rice husk ash, sand, coconut peat mixed with rice husk ash (1:1) and coconut peat mixed with sand and rice husk ash (1:1:1) which is sprayed twice a day with the same amount of water.

Four replicates per treatment were used in the experiment. Chia microgreens were randomly selected from each replicate to measure the germination percentage, microgreen height and fresh weight /100 microgreens after sowing for 7 days.

2.3 To Study the Effect of Seed Sowing Rate on the Growth of Chia Microgreens

Chia seeds were sown at the seeding rate of 56, 93, 130, 167 and 204 g/m^2. Soaked in water initially at 70-80°C and then allowed to cool down at room temperature for 12 hours, before sowing it in media. Seeds were sowed in a plastic basket (20 cm×27 cm) containing coconut peat mixed with sand and rice husk ash (1:1:1) and which is sprayed twice a day with the same amount of water.

Four replicates per treatment were used in the experiment. Chia microgreens were randomly selected from each replicate to measure the germination percentage, microgreen height and fresh weight per 100 microgreens after sowing for 7 days.

2.4 To Study the Effect of Harvesting Period on Production of Chia Microgreens

Chia seeds were soaked in water for 12 hours at room temperature and then sown in a plastic basket (20 cm×27 cm) containing coconut coir mixed with sand and rice husk ash (1:1:1) which was sprayed twice a day with the same amount of water. In this experiment, to study the harvesting period, by focusing on the harvesting periods at 5, 6, 7, 8 and 9 days after sowing.

Four replicates per treatment were used in the experiment. Chia microgreens were randomly selected from each replicate to measure microgreen height and fresh weight per 100 microgreens.

The experiment was completely randomized by design (CRD). All data were analyzed by using the repeated measurement of the ANOVA procedure. Means were separated by Duncan's New Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 The Effect of Seed Preparation and Soaking Treatments on Production of Chia Microgreens

This was to study the influence of soaking treatments on growth characteristics of Chia microgreens after it's grown for 7 days. The results showed that different soaking treatments had significantly different effects on the germination percentage, microgreen height and fresh weight of Chia seeds. The germination percentage of soaking the seeds at different water temperature and duration of soaking ranged from 96-98%. Seeds that were soaked initially at 70-80°C and then allowed to cool down at room temperature for 12 hours had the highest microgreen height (7.25 cm) and fresh weight (1.63 g/100 microgreens) (Table 1).

The germination percentage in Chia seeds that were soaked was higher than in the seeds that weren't soaked (Table 1) agreed with published results for table beet [10], carrot, snap bean, bell pepper [11], beet and chard [12]. Khan et al., (1992a) [10] found that washing the seeds for 8 or 24 hours in running water improved table beet germination, and the subsequent osmotic priming led to further improvement.

Many species germinate easily and grow promptly while others are slow and may require pre-sowing treatments to improve, standardize and shorten the production cycle. Seed preparation used to advance the early stages of germination range from simple water soaking to physiological

treatments, such as matrix priming. The substances

inhibitory to germination are removed during seed washing [12], [13].

3.2 The Effect of Sowing Media on Growth of Chia Microgreens

The seeding media influences the growth characteristics of Chia microgreens after grown for 7 days. The result showed that Chia seeding media were significantly different in germination percentage, microgreen height and fresh weight. Seeds are sown in coconut coir and coconut coir mixed with sand and rice husk ash (1:1:1) provided the highest germination percentage range from 96-98%. Especially, seeds that were sown in coconut coir with sand and rice husk ash (1:1:1) provided the highest microgreen height (7.02 cm) and fresh weight (1.12 g/100 microgreens) (Table 2).

Muchjajib, et al. (2015) [14], Di Gioia et al. (2016) [15] had documented the same result on a comparison of alternative media to provide maximum yield. Natural fiber-based media have also been developed and currently commercialized for microgreens. Low-cost alternatives of natural and renewable origin (e.g. cellulose pulp, cotton, jute, kenaf and sunn hemp fibers) and mixtures of materials combining desirable properties constitute potential as growing media for microgreens [15].

3.3 The Effect of Seed Sowing Rate on the Growth of Chia Microgreens

The result of the effect of seed sowing rate on the growth of Chia microgreens after grown for 7 days, presented that there was no significant difference ($P \leq 0.05$) in the microgreen height. While fresh weight showed statistically different in seed sowing rate. Chia seeds with sowing rate of 204 g/m^2 had the highest fresh weight (1.83 g/100 microgreens) (Table 3). On arugula and table beet, Murphy and Pill (2010) [16] and Murphy et al., (2010) [17] observed a linear increase in fresh yield per unit area by increasing sowing rate. Increasing sowing rate to maximize yield will reflect on the cost of production, while excessive stand density may produce undesirably elongated shoots and limited air circulation, conducive to the development of fungal diseases. Optimal sowing rate is crop-specific, based on average seed weight, germinability and desired shoot population density, ranging from 1 seed/cm^2 in large-seeded species such as peas, chickpeas and sunflower. And up to 4 seeds/cm^2 in small-seeded species like arugula, watercress, mustard [18].

3.4 The Effect of Harvesting Period on Production of Chia Microgreens

Different harvesting periods affect the growth of Chia microgreens. Results showed harvesting after 5, 6, 7, 8 and 9 days of sowing had significant difference the height and fresh weight of the microgreens, respectively

The results showed that the seeds harvested after 9 days of sowing provided the best results of the highest microgreen height (7.5 cm) whereas the seeds harvested after 6 - 9 days of sowing gave the highest fresh weight (1.43-1.45 g/100 microgreens) (Table 4). This crop has a quick production cycle (one to three weeks) and occupies very little space in production. However, to shorten the production cycle and thus to reduce the production cost is one of the major goals of the current production [19], [20]. So, the best harvesting period of Chia microgreen is harvesting after 6 days of sowing.

This study, in agreement with the published results for lettuce [21] found that young lettuce seedlings, 7 days after germination, had the highest fresh weight and total phenolic concentration and antioxidant capacity in comparison to the older seedling. Unlike the result of Murphy et al., (2010) [17] found that at 15 days after planting table beet gave the highest shoot fresh weight.

Microgreens are edible greens having two or more developed cotyledonary leaves. Harvesting of microgreens at the right stage is one of the most important production strategies. They are harvested at 7-14 days after germination with short crop cycle and usually with the average height of 2.5-7.6 centimeters, depending on the species [17], [2], [3].

4. CONCLUSION

Study of the effect of seed preparation, sowing media, seed sowing rate and harvesting period of Chia microgreen can be concluded as follows:

Chia seeds that were soaked initially at 70-80°C and then allowed to cool down at room temperature for 12 hours had the highest germination percentage (98%), microgreen height (7.25 cm) and fresh weight (1.63 g/100 microgreens).

Chia seeds sown in coconut coir with sand and rice husk ash (1:1:1) provided the best results of highest germination percentage (98%), microgreen height (7.02cm) and fresh weight (1.12 g/100 microgreens).

Chia seeds sown at the rate of 204 g/m^2 provided the highest fresh weight (1.83 g/100 microgreens).

The harvest of 6 days after sowing gave highest fresh weight (1.45 g/100 microgreens).

Table 1 Effect of soaking treatments on the germination percentage, microgreen height and fresh weight /100 microgreens of Chia seeds after sowing for 7 days

soaking treatments	germination percentage (%)	microgreen height (cm)	fresh weight (g)/100 microgreens
without soaking	92 b	5.97 d	0.83 d
6 hours at room temperature	96 a	6.30 c	1.15 c
12 hours at room temperature	97 a	6.75 b	1.12 c
initial temperature at 70-80°C until cool down at room temperature for 6 hours	96 a	6.50 b	1.43 b
initial temperature at 70-80°C until cool down at room temperature for 12 hours	98 a	7.25 a	1.63 a
F-test	*	**	**
CV (%)	2.38	7.12	22.09

**Significantly different at P<0.01, *Significantly different at P<0.05. Means within the same column with the different letters are significantly different to DMRT at P<0.05

Table 2 Effect of sowing media on the germination percentage, microgreen height and fresh weight /100 microgreens of Chia seeds after sowing for 7 days

soaking media	germination percentage (%)	microgreen height (cm)	fresh weight (g)/100 microgreens
coconut coir	96 ab	6.27 b	0.97 b
rice husk ash	88 c	5.67 c	0.90 c
sand	92 cb	5.70 c	0.93 c
coconut peat : rice husk ash (1:1)	94 b	6.32 b	1.08 ab
coconut peat : sand : rice husk ash (1:1:1)	98 a	7.02 a	1.12 a
F-test	*	**	*
CV (%)	3.36	9.13	3.33

**Significantly different at P<0.01, *Significantly different at P<0.05. Means within the same column, the different letters are significantly different to DMRT at P<0.05

Table 3 Effect of seed sowing rateon microgreen height and fresh weight /100 microgreens of Chia seeds

seed sowing rate g/m^2	microgreen height (cm)	fresh weight (g) / 100 Microgreens
56	7.62	1.63 c
93	7.51	1.63 c
130	7.36	1.65 c
167	7.34	1.70 b
204	7.23	1.83 a
F-test	ns	**
CV (%)	9.89	1.98

**Significantly different at P<0.01, *Significantly different at P<0.05. Means within the same column, the different letters are significantly different to DMRT at P<0.05

Table 4 Effect of harvesting period on microgreen height and fresh weight of microgreens of Chia seeds

harvesting period (days after sowing)	microgreen height (cm)	fresh weight (g) /100 microgreens
5	3.62 e	0.78 b
6	4.56 d	1.45 a
7	5.38 c	1.42 a
8	7.22 b	1.43 a
9	7.57 a	1.43 a
F-test	**	**
CV (%)	9.23	10.58

**Significantly different at P<0.01. Means within the same column, the different letters are significantly different to DMRT at P<0.05

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6. REFERENCES

[1] Marton M., Mandoki Zs., Csapo J., Evaluation of biological value of sprouts. Fat content, fatty acid Composition, Acta Univ. Sapientiae Alimentaria, Vol. 3, 2010, pp. 53-65.

[2] Xiao Z., Lester, G. E., Luo, Y. and Wang, Q., Assessment of vitamin and carotenoid concentrations of emerging food products: Edible microgreens, Journal of Agricultural and Food Chemistry, 60(31), 2012, pp. 7644–7651.

[3] Pinto E., Almeida, A. A., Aguiar, A. A., and Ferreira, I. M. P. L. V. O., Comparison between the mineral profile and nitrate content of microgreens and mature lettuces, J. Food Compos Anal., 2015, pp. 37: 38-43.

[4] Sun J., Xiao Z., Lin L., Lester G.E., Wang Q., Harnly J.M., Chen P., Profiling polyphenols in five *Brassica* species microgreens by UHPLC-PDAESI/HRMS. J. Agric. Food. Chem., Vol. 61, 2013, pp. 10960-10970.

[5] Bhatt P. and Sharma S., Microgreens: A Nutrient Rich Crop that can Diversify Food System, International Journal of Pure & Applied Bioscience, Volume 6, issue 2, 2018, pp. 182-186.

[6] Ixtaina V.Y., Nolasco S.M. and Tomas M.C., Physical properties of chia (*Salvia hispanica* L.) seeds. Ind. Crops. Prod., 28, 2008, pp. 286–293.

[7] Vuksan V, Jenkins A.L. and Dias A.G., Reduction in postprandial glucose excursion and prolongation of satiety, a possible explanation of the long-term effects of whole grain Salba (*Salvia hispanica* L.), Euro. J. Clin. Nutr., 64, 2010, pp. 436–438.

[8] Pal S. and Kumar A., Effect of Chia Seeds (*Salvia Hispanica*) Supplementation on Buckwheat Flour In The Development Of Gluten Free Bread. Int J. Nutr. Sci. & Food Tech 3:2, 2017, pp. 50-52.

[9] Jamboonsri W., Phillips T., Geneve R., Cahill J. and Hildebrand D., Extending the range of an ancient crop, *Salvia hispanica* L.—A new ω 3 sources. Gen. Res. Crop. Evo.59, 2012, pp. 171–178.

[10] Khan A.A., Abawi G.S. and Maguire J.D., Integrating Matriconditioning and Fungicidal Treatment of Table Beet Seed to Improve Stand Establishment and Yield, Crop Science, Vol. 32 **No. 1**, 1992a, pp. 231-237.

[11] Khan A.A., Maguire J.D., Abawi G.S. and Ilyas, S., Matriconditioning of Vegetable Seeds to Improve Stand Establishment in Early Field Plantings, Journal of American Society of Horticultural Science, 117, 1992b, pp. 41-47.

[12] Lee J.S., Pill, W.G., Cobb, B.B., and Olszewski, M., Seed treatments to advance greenhouse establishment of beet and chard microgreens, Journal of Horticultural Science and Biotechnology, 79(49), 2004, pp. 565-570.

[13] Kyriacou M.C., Rouphael Y., Gioia Di F., Kyratzis A., Serio F., Renna M., Pascale De S., Santamaria P., Micro-scale vegetable production and the rise of microgreens, Trends in Food Science & Technology, Vol. 57, 2016, pp. 103-115.

[14] Muchjajib, U., Muchjajib, S., Suknikom, S. and Butsai, J., Evaluation of organic media alternatives for the production of microgreens in Thailand. Acta Horticulturae, 1102, 2015, pp. 157-162.

[15] Di Gioia F., De Bellis P., Mininni C., Santamaria P. and Serio F., Physicochemical, agronomical and microbiological evaluation of alternative growing media for the production of rapini (*Brassica rapa* L.) microgreens. Journal

of the Science of Food and Agriculture, Volume 96, issue 4, 2017, pp. 1212-1219.

[16] Murphy C.J. and Pill W.G., Cultural practices to speed the growth of microgreen arugula (roquette; *Eruca vesicaria* subsp. sativa). Journal of Horticultural Science and Biotechnology, 85(3), 2010, pp. 171-176.

[17] Murphy C.J., Llort K.F., and Pill W.G., Factors affecting the growth of microgreen table beet. International Journal of Vegetable Science, 16(3), 2010, pp. 253-266.

[18] Di Gioia F. and Santamaria P., Microgreens: Novel fresh and functional food to explore all the value of biodiversity, Italy: ECO-logical srl Bari., 2015, p. 118.

[19] Kopsell D.A., Pantanizopoulos N.I., Sams C.E., Kopsell D.E., Shoot tissue pigment levels increase in 'Florida Broadleaf' mustard (*Brassica juncea* L.) microgreens following high light treatment. Scientia Horticulturae 140, 2012, pp. 96–99.

[20] Viršilė A., Sirtautas R., Light irradiance level for optimal growth and nutrient contents in borage microgreens. Rural Development, 2013, pp. 272-275.

[21] Oh M.M., Carey E.E., Rajashekar C.B. Regulated water deficits improve phytochemical concentration in lettuce, J. Am. Soc. Hortic. Sci. 2010, 135, 223−229.

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