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Research Article

The Effect of Soaking Durations on Fenugreek Seeds (*Trigonella foenum-graceum* L.) for Microgreen Production

Zehra Demirci[1*], Muhammet Dogan[2] and Bugrahan Emsen[3]

[*1]*Department of Biology, Graduate School of Natural and Applied Sciences, Karamanoglu Mehmetbey University, Karaman, Türkiye.*
[2]*Department of Nutrition and Dietetics, Faculty of Health Sciences, Karamanoglu Mehmetbey University, Karaman, Türkiye*
[3]*Department of Biology, Kamil Ozdag Faculty of Science, Karamanoglu Mehmetbey University, Karaman, Türkiye*

zehra.demirci502@gmail.com

Zehra Demici : https://orcid.org/0009-0007-9307-7400
Muhammet Dogan : https://orcid.org/0000-0003-3138-5903
Bugrahan Emsen : https://orcid.org/0000-0002-9636-2596

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Abstract – In this study, the effects of soaking time on the production of fenugreek (*Trigonella foenum-graceum* L.) microgreens were investigated. Specifically, germination rate, microgreen height, and root length data were evaluated. According to the experimental results, soaking times of 0, 12, and 24 hours showed the highest germination rates, with no statistically significant differences found among these groups ($p>0.05$). However, a soaking duration of 48 hours led to a slight decrease in germination rate, and this group showed statistical similarity with both the high germination rate groups (0-24 hours) and the lower germination rate group (72 hours). The lowest germination rate was observed in the 72-hour soaking treatment ($p<0.05$). The results indicate that short soaking durations positively affect germination rates, while prolonged soaking decreases them. It is thought that prolonged exposure to water may adversely affect the germination process, likely due to oxygen deficiency. Furthermore, soaking times of 0-12 hours increased the height of the microgreens, while soaking durations of 24 hours or more significantly restricted root development. Soaking for 0 and 12 hours resulted in the longest root growth, while 48 and 72-hour treatments adversely affected root development. These findings demonstrate that the ideal soaking duration for optimal growth of fenugreek microgreens is within the range of 0-12 hours.

Keywords – Microgreens, Root Development, Seed Germination, Soaking Time.

I. INTRODUCTION

Plants have long been recognized for their significant contributions to human health and well-being. These plants are not only essential for traditional medicine practices but also play a crucial role in promoting healthy lifestyles (El-Ramady et al. 2022; Doğan, 2020; Bunse et al. 2022; Erkorkmaz et al., 2023; Niazi et al., 2023; Kaynak et al., 2024; Göldağ and Dogan, 2024; Baslam et al., 2024). As society becomes more health-conscious, there is a growing interest in incorporating nutritious foods into diets (Konar et al., 2022). In this context, microgreens have become increasingly popular in recent years as a result of growing

awareness of healthy eating habits and health consciousness (Ebert, 2022; Gunjal et al., 2024). These small but nutrient-rich plants are typically obtained by germinating seeds and offer significant benefits to human health due to the bioactive compounds enriched during the germination process (Sharma et al., 2022; Bhabani et al., 2024). Packed with vitamins, minerals, antioxidants, and other phytochemicals, microgreens attract attention not only in gastronomy but also in functional food production (Gupta et al., 2023; Bhaswant et al., 2023). The diversity of seeds used in microgreen production and the pre-treatments applied are key factors determining the quality and nutritional value of the final products (Hoang and Vu, 2022; Dhaka et al., 2023; Dubey et al., 2024).

In this context, fenugreek (*Trigonella foenum-graceum* L.) seeds emerge as a prominent plant-based resource (Almuzaini et al., 2024). Fenugreek is a plant commonly used in traditional medicine and various culinary applications, known for its nutritional value and biologically active compounds (Sun et al., 2021; Shahrajabian et al., 2021; Ruwali et al., 2022; Gavahian et al., 2024; Çoban, 2024). The soaking durations to which seeds are subjected during the germination process are among the primary factors influencing the success of microgreen production. Soaking is a crucial pre-treatment that enhances the germination capacity of seeds and activates metabolic activities (Li et al., 2021; Abaajeh et al., 2023).

This study focuses on the production of microgreens from fenugreek seeds soaked for different durations. The aim is to investigate the effects of soaking durations on microgreen production. The findings of this study are intended to provide valuable insights for both farmers involved in microgreen production and researchers working in the academic domain of this field.

II. MATERIALS AND METHOD

Study Location and Seed Procurement

This study was conducted in the research laboratories of the Department of Biology at Karamanoğlu Mehmetbey University (KMU). Fenugreek seeds were obtained from local and certified vendors. The seeds were untreated and free from preservatives, stored at refrigerator temperature (+4°C).

Preparation of the growing medium

Vermiculite substrates were used for microgreen cultivation. Vermiculite containers were prepared to ensure uniform seed sowing. Equal amounts of seeds were evenly distributed in each container and gently pressed onto the vermiculite surface.

Soaking process and experimental design

The seeds were soaked in pure water under dark conditions for different durations (0, 12, 24, 48, and 72 hours). After the soaking process, the seeds were transferred to containers filled with vermiculite for microgreen production. These containers were then placed under white LED lights (550 nm). To ensure uniform water distribution, all containers were watered evenly. Consistency in light intensity and application was maintained. Each lighting cycle consisted of 16 hours of light followed by 8 hours of darkness. Parameters such as irrigation, temperature, and humidity were standardized for all experiments.

Statistical analysis

The experiments were conducted with three replicates. Data collected during the study were analyzed using SPSS software. One-way analysis of variance (ANOVA) was applied to determine differences between groups. Duncan's multiple comparison test was used for detailed comparisons of statistically significant results. A significance level of $p<0.05$ was considered for all statistical analyses.

III. RESULTS AND DISCUSSION

The effects of different soaking durations on the germination rate of fenugreek microgreens were investigated (Figure 1). The results indicate that soaking durations of 0, 12, and 24 hours exhibited the highest germination rates, with no statistically significant differences found among these groups ($p>0.05$). However, a soaking duration of 48 hours resulted in a slight decrease in the germination rate, and this group showed statistical similarity with both the groups demonstrating high germination rates (0-24 hours) and the group with a lower germination rate (72 hours). The lowest germination rate was observed in the 72-hour soaking treatment, which was significantly different from the other groups ($p<0.05$).

The results suggest that short soaking durations positively affect the germination rate, while prolonged soaking decreases it. This may indicate that prolonged exposure to water can create stress on the seeds or that environmental factors, such as oxygen deficiency, may adversely affect the germination process. Similarly, Haj Sghaier et al. (2021) investigated the effects of temperature and water on the germination and seedling development of the oilseed plant rapeseed (*Brassica napus* L.). The study examined the impact of different temperature conditions and water levels on seed germination rates, germination duration, and seedling development. The findings showed that optimal temperatures and appropriate water levels enhance seed germination and seedling growth, while low temperatures or water stress negatively affected germination rates and seedling health.

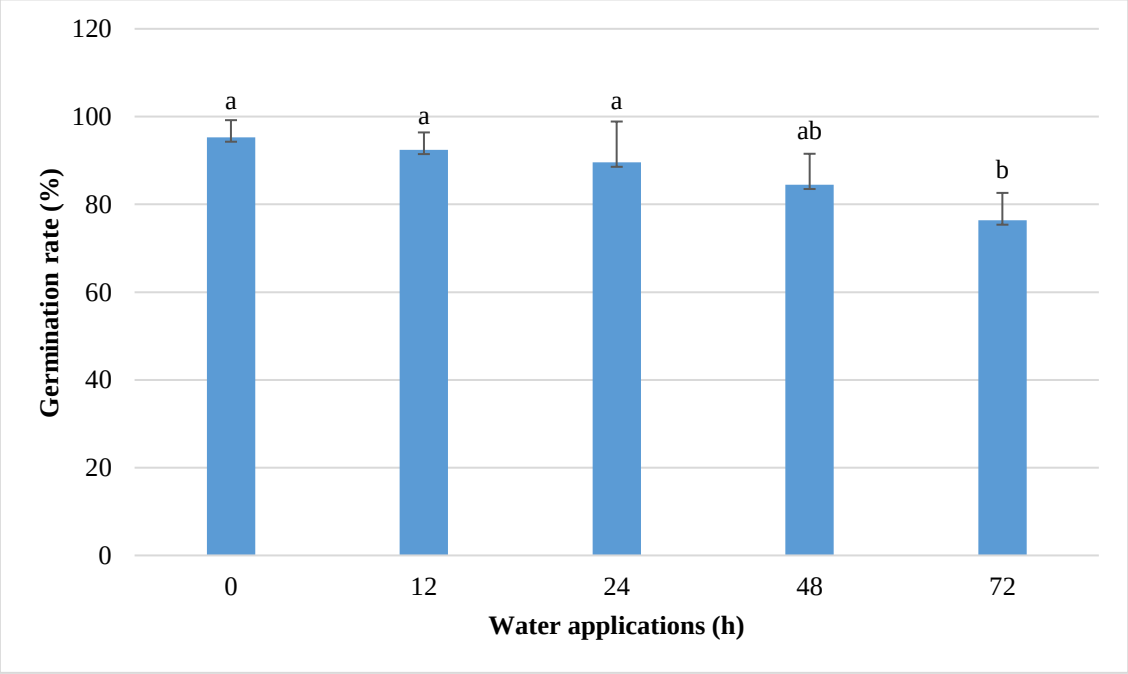

Figure 1. Effects of different soaking durations on the germination of fenugreek seeds

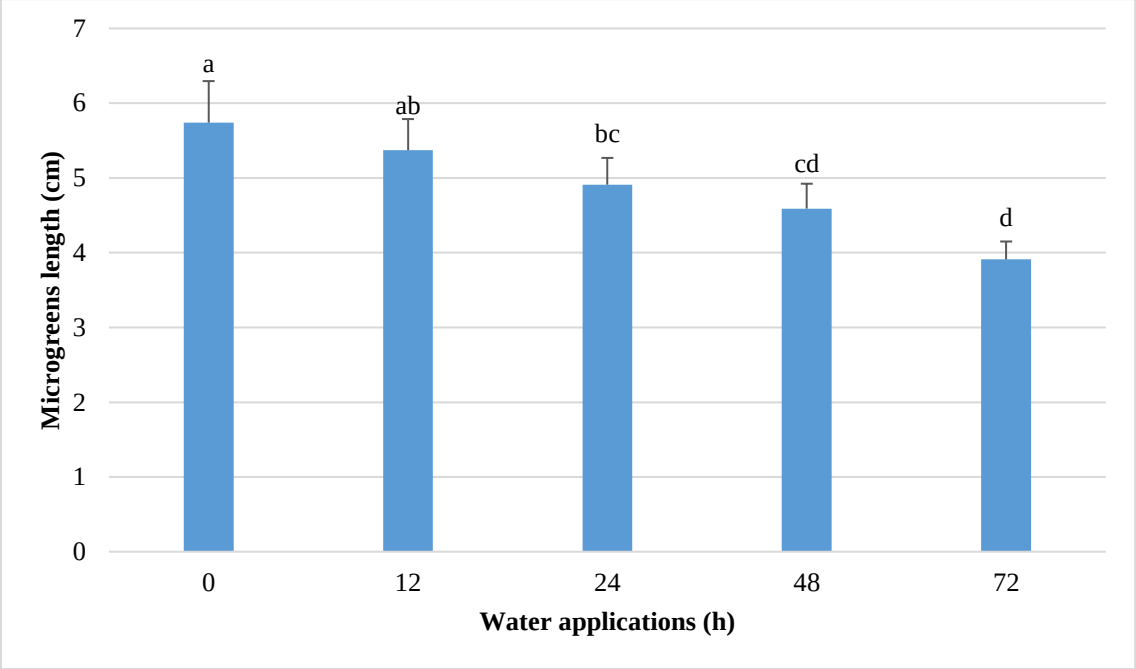

Figure 2. Effects of different soaking durations on the length of fenugreek microgreens

The effects of different soaking durations on the growth performance of microgreens were investigated (Figure 2). The results demonstrate that the duration of water application is a critical factor for plant development. According to the findings, the 0-hour water application served as the control group and produced the longest microgreen height (~6 cm), while the 12-hour water application exhibited similar but slightly reduced growth (Figure 3). With a 24-hour water application, a noticeable decrease in microgreen height was observed, and growth was significantly restricted in the 48-hour and especially the 72-hour water application groups. Prolonged exposure to water likely negatively affects metabolic processes due to oxygen deficiency, hindering germination and healthy development. These findings indicate that an optimal soaking duration of 0-12 hours is ideal for the growth performance of fenugreek microgreens, while longer water exposure may adversely affect growth.

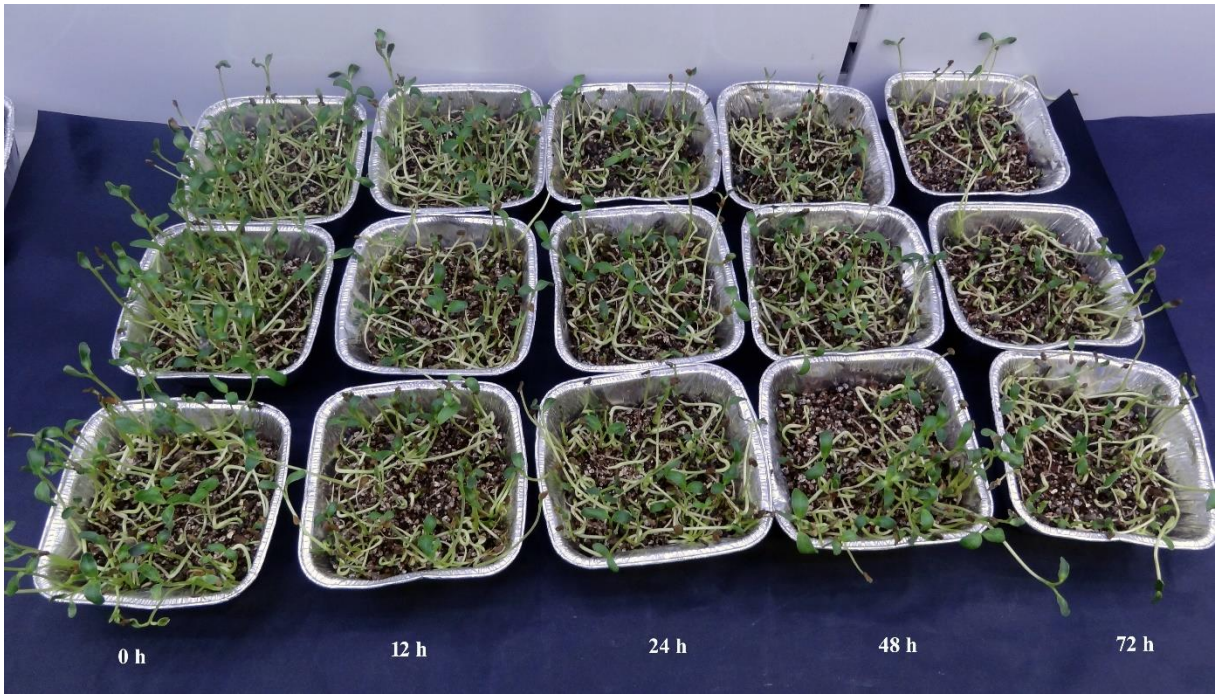

Figure 3. General overview of microgreens produced from fenugreek seeds soaked for different durations

The effects of different soaking durations on the root development of microgreens are illustrated in Figure 4. The results indicate that the duration of water application is a significant factor for root length. According to the findings, both the 0-hour and 12-hour water applications achieved the longest root development (~5.2 cm), while a noticeable reduction in root length was observed with the 24-hour water application. Prolonged exposure to water (48 and 72 hours) significantly restricted root development, yielding the lowest values (~3 cm). This suggests that extended water exposure negatively impacts root development during the germination process due to oxygen deficiency. The results demonstrate that the optimal soaking duration for root development in fenugreek microgreens is within the range of 0-12 hours, while water applications of 24 hours or more restrict root growth.

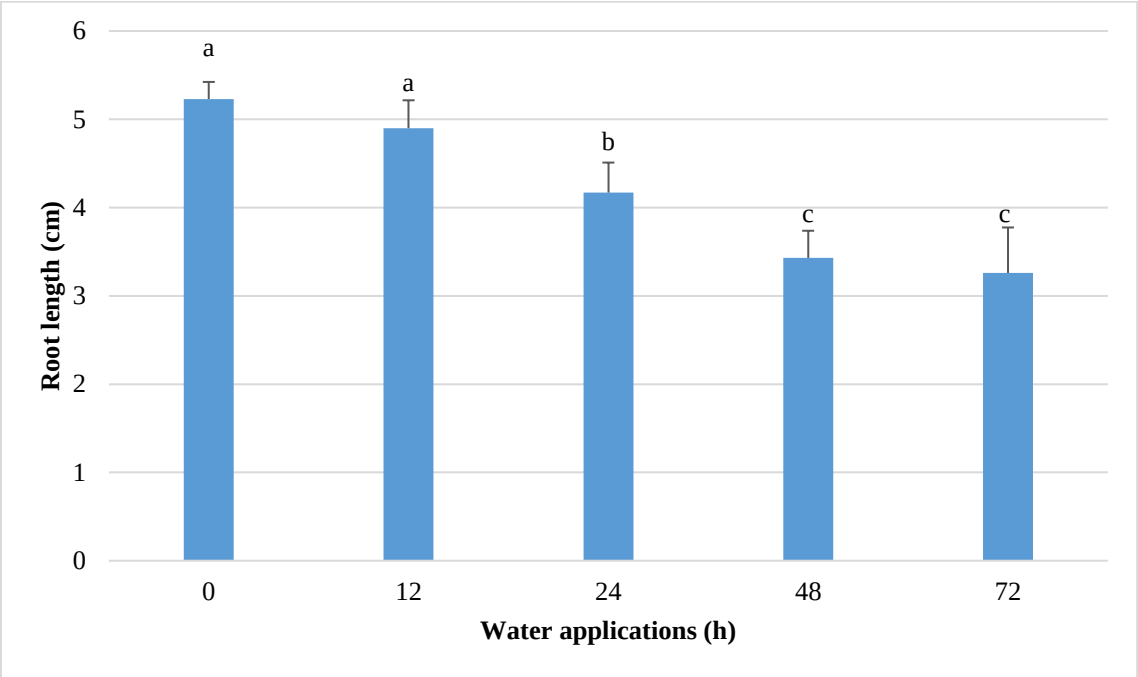

Figure 4. Effects of different soaking durations on the root length of fenugreek microgreens

IV. CONCLUSION

This study highlights the significant effects of soaking durations on the development of fenugreek microgreens. Soaking durations of 0, 12, and 24 hours achieved the highest germination rates, while a 48-hour duration led to a slight decrease in germination rates. The lowest germination rate was observed with the 72-hour soaking treatment. It is understood that prolonged exposure to water restricts the oxygen intake of the seeds, negatively affecting germination and root development. Overall, the optimal soaking duration was determined to be within the range of 0-12 hours. In light of these results, a soaking duration of 0-12 hours is recommended to achieve the best germination and root development for fenugreek microgreens. Additionally, it would be beneficial to conduct further experimental research to examine the effects of different water temperatures and environmental conditions on germination and root development.

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