Journal of Medicinal and Industrial Plant Sciences (2025) 3 (4): 13- 26
P-ISSN: 2959 – 121X
E-ISSN: 3106 – 5406
DOI: https://doi.org/10.32894/MEDIP.25.3.4.2

Effect of soaking durations of bitter melon (*Momordica charantia*) seeds in selected plant extracts on germination, growth, and its total phenol content

Ruaa Abdul Hussien Ali Al-Asadi[1], Ziena Mohammed Abdul-Qader[2], Waffa Abdullah Fadhil[1], Zina Ismail Khalil[3]

[1] *Medicinal and Aromatic Plants Research Unit, College of Agricultural Engineering Sciences University of Baghdad, Iraq*
[2]*Department of Horticulture and landscape Design, College of Agricultural Engineering Sciences University of Baghdad, Iraq*
[3]*Department of Desertification Combat, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq.*
[*] *Corresponding author: E-mail: ruaa.abd1005@coagri.uobaghdad.edu.iq*

ABSTRACT

The experiment was carried out in one of the plastic houses of the College of Agricultural Engineering Sciences, University of Baghdad, during the fall season of 2023–2024, with aim of the study germination, plant growth, and biochemical attributes of Bitter melon seeds as treated with various Moringa and sweet Fennel extract soaking Durations and concentrations. A Completely Randomized Design (CRD) with three replications was used. The study included two factors: The first was seed soaking duration (**3**, **6**, and **9**Ours), and the second was treatment with plant extracts. These extracts were: sweet Fennel extract at concentrations of 0, 1, 2, 3, and 4 g L^{-1}, and Moringa extract at the same concentrations. Seeds were then planted in trays to obtain seedlings, and the required measurements were recorded. Results showed that the interaction treatment T3M7 produced the highest germination percentage (100%), WhileT2M8 recorded the fastest germination rate (3.327 days $seed^{-1}$). The interaction treatment T3M4 gave the tallest seedling height (16.13 cm), whereas T3M3 recorded the highest number of leaves and fresh plant weight (10.500 leaves $plant^{-1}$ and 4.857 g, respectively). The treatment T2M3 gave the highest values for dry weight (1.096 g), dry matter percentage (383%), total chlorophyll concentration, nitrogen, protein, and phosphorus content (21.14%, respectively). Regarding soaking duration, treatmentT2 resulted in the highest germination percentage (86.67%), germination speed (3.891 days $seed^{-1}$), and dry weight (0.939 g). Treatment T3 recorded superiority in seedling height (12.27 cm), number of leaves (8.225 leaves $plant^{-1}$), dry matter percentage (4.244 g), nitrogen content (2.401%), and protein (15.00%). In contrast, T1 gave the highest percentage for seedling emergence (5.728 cm).As for plant extracts, treatment M1 outperformed in germination speed (3.521 days $seed^{-1}$), germination percentage (98.44%), and seedling height (13.51 cm).

KEYWORDS: Bitter melon, seed soaking duration, Moringa extract sweet Fennel extract, germination and seedling growth.

Received: 13/10/2025; **Accepted**: 30/11/2025; **Available online:** 31/12/2025

تأثير مدد نقع بذور القرع المر *Momordica charantia* ببعض المستخلصات النباتية لتحسين الانبات والنمو ومحتواه من الفينولات الكلية

رؤى عبد الحسين علي الاسدي، زينة محمد عبد القادر، وفاء عبد الله فاضل، زينة اسماعيل خليل
[1]وحدة بحوث النباتات الطبية والعطرية، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق.
[2]قسم البستنة وهندسة الحدائق، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق.
[3]قسم مكافحة التصحر، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق.

الملخص

نفذت التجربة في احدى البيوت البلاستيكية التابعة لكلية علوم الهندسة الزراعية – جامعة بغداد للموسم الخريفي 2023 – 2024 ضمن تصميم العشوائي **CRD** وبثلاث مكررات وشملت التجربة عاملين : العامل الاول نقع البذور للمد (3 و6 و9) ساعة ، أما العامل الثاني المعاملة بمستخلصي الحبة الحلوة بالتراكيز (0، 1 ،2، 3 ،4) غم / لتر وبمستخلص المورنجا بالتراكيز (0، 1 ،2، 3 ،4) غم / لتر بعدها تم زراعتها في اطباق للحصول على دايات وتم اخذ القياسات المطلوبة .اظهرت نتائج التجربة ان معاملة التداخل **T3M7** اعطت اعلى نسبة مئوية للانبات بلغت 100% وان معاملة التداخل **T2M8** كانت اسرع انباتا واعطت اعلى تركيز للفينولات الكلية بلغت **3.327** يوم .بذرة$^{-1}$ و **8.033** ملغم.غم$^{-1}$وتفوقت معاملة التداخل **T3M4** بأعطاءها اعلى ارتفاع للشتلة بلغ **16.13** سم وتفوقت معاملة التداخل **T3M3** بأعطاءها اعلى عدد اوراق والوزن الطري للنبات والتي بلغت **10.500** ورقة.نبات$^{-1}$و**4.857**غم على التوالي و اعطت معاملة التداخل **T2M3** اعلى قيمة الوزن الجاف للنبات والنسبة المئوية للمادة

الجافة وتركيز الكلوروفيل الكلي والنسبة المئوية للنتروجين والبروتين والفسفور التي بلغت **1.096**غم و**383**% و**21.14**% على التوالي، أما في مدد النقع تفوقت المعاملة **T2** باعطاءها اعلى نسبة انبات وسرعة انبات و الوزن الجاف للنبات بلغت **86.67**% و**3.891** يوم .بذرة$^{-1}$ و **0.939**غم بالتتابع وتفوقت المعاملة **T3** في صفة ارتفاع الشتلة وعدد الاوراق والنسبة المئوية للمادة الجافة والنسبة المئوية للنتروجين والبروتين والفسفور والفينولات الكلية والتي بلغت **12.27** سم و **8.225** ورقة.نبات$^{-1}$و **4.244**غم و **2.401**% و**15.00**% و3.992 ملغم .غم $^{-1}$بالتتابع وتفوقت المعاملة **T1** باعطاءها اعلى نسبة مئوية للانبات بلغت **5.728** سم ،أما من حيث المستخلصات النباتية تفوقت المعاملة **M1** في سرعة الانبات والنسبة المئوية للانبات وارتفاع الشتلة والتي بلغت **3.521** يوم .بذرة$^{-1}$ و**98.44**% و**13.51**رقة.نبات$^{-1}$ بالتتابع.

الكلمات المفتاحية: القرع المر، مدة نقع البذور، مستخلص المورينجا، مستخلص الحبة الحلوة، الإنبات ونمو الشتلات.

INTRODUCTION

Bitter melon *(M. charantia*), also known as bitter melon, karela, or balsam pear, is a plant common in tropical and subtropical regions of Asia, South America, India, and East Africa (Joseph and Jini, 2013; Chekka and Mantipelly, 2020). Bitter melon is a folk medicine to treat tumors, asthma, skin infections, hypertension, and toothache pain (Jia *et al* , 2017; Kole et al., 2020). It has long been used as a traditional medicine in China, India, Africa, and the southeastern United States (Chekka and Mantipelly, 2020; Gayathry and John, 2022).

Nutritionally, bitter melon is a good source of thiamine, beta-carotene, folic acid, riboflavin, vitamins A, C and K, and minerals such as Calcium, Iron, magnesium, Potassium, Phosphorus, Zinc, and dietary fiber. Regular consumption of bitter melon juice enhances physical endurance, prevents chronic fatigue, and its beta-carotene content supports eye health and vision. Additionally, it exhibits antitumor, anti-inflammatory, antioxidant, antidiabetic, hypolipidemic, and hypoglycemic properties (Ee Shian *et al.*, 2015; Shubha *et al.*, 2018; Janagal *et al.*, 2018).

Seed germination is a fundamental physiological process and a prerequisite for the successful cultivation of most crops. Several environmental and physiological factors regulate seed germination. In modern agriculture, plant extracts are increasingly used as alternatives to synthetic pesticides or plant growth regulators because they are natural, safe for human health, and environmentally friendly. Among these, Moringa and sweet Fennel extracts have gained considerable interest. They stimulate enzymatic activity that converts complex compounds into simpler forms (Fayad , 2005; Ayoub, 2018; Sultan *et al.*, 2020) and enhance the hormonal balance in plants, thereby improving growth (Shakir and Al-Rawi, 2017; Mohamed *et al.*, 2022). Moringa leaf extract, in particular, is considered one of the most effective natural plant growth stimulants. Moringa leaf Moringa leaf extract is one of the plants with nutrients, vitamins, Amino acids, and plant Growth Hormones (Ibrahim and Ameen, 2017; Szopa *et al*., 2020; Sardar *et al*., 2021. Otherwise, Moringa extract enhances the photosynthetic rate, and the translocation of assimilate to the fruits. It also possesses Cytokinin that lower respiratory rates (Al Kikhani and Al-Asady, 2019. Ahmed *et al*. 2017) observed a positive impact of the application of Moringa extract on foliar tissues on the vegetative growth of Pepper plant, and the same results presented by Mohammed and Majeed (2024) to strawberry plant.

Sweet Fennel extract, however, is known to have a number of bioactive compounds (flavones and flavonoids) which are known to have antibacterial and antiviral activity (Khalil *et al*., 2018). Similar results were reported by Sultan et al. (2023), which showed that soaking the Basil in the black seed extract has a pronounced effect on the traits studied and was significant.

The objective of this research is to study germination, plant growth, and biochemical attributes of bitter melon seeds as treated with various Moringa and sweet Fennel extract soaking durations and concentrations to augment seed behavior for sustainable production strategies using an eco-friendly and natural treatment.

MATERIALS AND METHODS

This experiment was conducted in a greenhouse at the College of Agricultural Engineering Sciences - University of Baghdad during the autumn season of 2023-2024, using a Completely Randomized Design (CRD) with three replicates. The experiment included two factors: the first factor was the seed soaking period (3, 6, and 9 Ours), and the second factor was the treatment with sweet fennel extracts at concentrations of (0, 1, 2, 3, 4) g/L and Moringa extracts at concentrations of (0, 1, 2, 3, 4) g/L. Afterwards, the seeds were sown in trays to obtain seedlings, as shown in Figure 1.

Figure 1. Bitter melon seedlings after soaking in plant extracts and planting in trays

The required measurements were taken, which included measuring the germination percentage, germination speed, seedling height, number of leaves, root length, fresh and dry weight, chlorophyll concentration, total phenolic content, and the percentages of Nitrogen, phosphorus, and potassium, as illustrated in Figure 2.

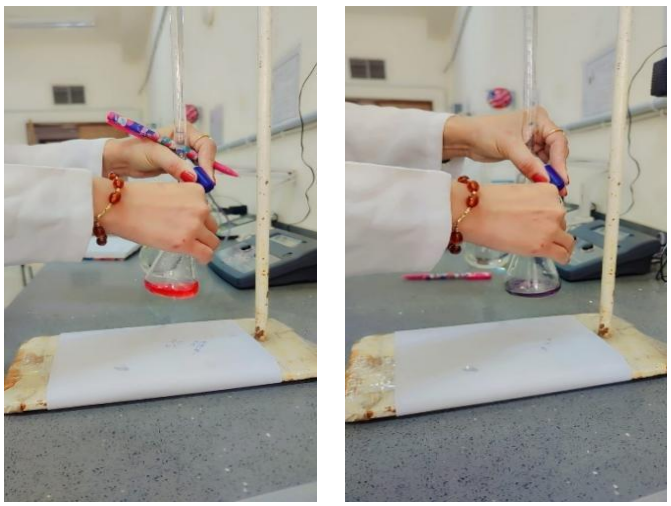

Figure 2. Estimation of the percentage of nitrogen, phosphorus, and potassium

Preparation of Plant Extracts

The extracts were prepared by grinding the Moringa leaves and sweet fennel seeds separately. This was done by soaking 1, 2, 3, and 4 g of each plant part, from which the active compounds were to be extracted, in one liter of distilled water at a temperature of 50°C until the extract was homogeneous for one hour. It was then left for 24Ours, after which the extract was filtered through cheesecloth. The treatments were then applied with these extracts

RESULTS AND DISCUSSION

The results presented in Table 1 show significant differences in germination percentage due to the interaction between seed soaking duration and plant extracts (Sweet Fennel and Moringa). The interaction treatment T3M7 recorded the highest germination percentage (100%) compared with T1M0, which gave the lowest value (27.67%). With respect to soaking duration, treatment T2 produced the highest germination percentage (86.67%), whereas T1 gave the lowest value (68.67%). Regarding plant extracts, all extract treatments outperformed the control, with M1 recording the highest germination percentage (98.44%) compared to M0 (61.33%).

Table 1. Effect of soaking durations of bitter melon seeds in selected plant extracts on germination percentage

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	27.67	98.33	77.67	99.33	74.00	48.67	53.67	61.00	77.67	**68.67**
T2	79.33	98.33	97.33	52.33	78.67	76.00	99.33	99.00	99.67	**86.67**
T3	77.00	98.67	98.67	72.00	98.67	77.00	80.67	100.00	53.33	**84.00**
Mean	**61.33**	**98.44**	**91.22**	**74.55**	**83.78**	**67.22**	**77.89**	**86.67**	**76.89**	
L.S.D 5%		T=0.816			M= 2.108			MT=3.488		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1%

,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Germination speeds

The results in Table 2 indicate that soaking bitter melon seeds for 3, 6, and 9 hours with different concentrations of sweet Fennel and Moringa extracts had a significant effect on germination speed. It is noted that the T2M8 interaction treatment had the fastest germination, at 3.327 days seed^{-1}, compared to the T1M0 treatment, which was 9.317 days seed^{-1}. Regarding the number of soaking hours, it is noted that treatment T2 was superior to the other treatments at 3.891 days seed-1, compared to treatment T3, which was the slowest at 4.042 days seed^{-1}. As for the plant extracts, the results shows that treatment M1 had the fastest germination at 3.521 days seed^{-1}, compared to treatment M0, which was 5.851 days seed^{-1}.

Table 2. Effect of soaking durations of bitter melon seeds in selected plant extracts on germination speed

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	9.317	3.663	4.408	3.7	4.241	4.43	4.713	4.477	4.057	**4.778**
T2	3.932	3.391	3.761	5.212	4.128	4.124	3.643	3.503	3.327	**3.891**
T3	4.303	3.51	3.373	3.343	3.76	4.273	4.116	3.487	6.213	**4.042**
Mean	**5.851**	**3.521**	**3.847**	**4.085**	**4.043**	**4.276**	**4.157**	**3.822**	**4.532**	
L.S.D 5%		T=0.253			M= 0.285			MT=0.345		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1%, M2= sweet Fennel extract 2%, M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Seedling height

The results in Table 3 indicate that the interaction treatment T3M4 produced the tallest seedlings (16.13 cm), in contrast to T3M8, which recorded the shortest (8.000 cm). Across soaking durations, treatment T3 was superior (12.27 cm) compared to T1, which gave the lowest seedling height (11.04 cm). With respect to plant extracts, M1 resulted in the highest seedling height (13.51 cm), whereas M6 showed the lowest value (9.710 cm).

Table 3. Effect of soaking durations of bitter melon seeds in selected plant extracts on Seedling height (cm)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	8.50	15.07	10.28	9.82	13.04	9.85	9.82	11.61	11.41	**11.04**
T2	13.68	13.07	11.07	9.00	9.10	9.82	10.28	9.97	13.97	**11.11**
T3	13.53	12.38	13.60	13.76	16.13	14.00	9.033	10.04	8.00	**12.27**
Mean	**11.90**	**13.51**	**11.65**	**10.86**	**12.75**	**11.22**	**9.71**	**10.54**	**11.13**	
L.S.D 5%		T=0.253			M= 0.285			MT=0.345		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Number of leaves

The results in Table 4 indicate that the interaction treatment T3M3 produced the highest number of leaves (10.500 leaves plant^{-1}), compared with T1M0, which recorded the lowest value (5.443 leaves plant^{-1}). With respect to soaking durations, T3 was superior (8.225 leaves plant^{-1}), whereas T2 gave the lowest value (7.529 leaves plant^{-1}). Regarding plant extracts, M3 resulted in the highest number of leaves (9.000 leaves plant^{-1}), compared with M0, which recorded the lowest (6.503 leaves plant^{-1}).

Table 4. Effect of soaking durations of bitter melon seeds in selected plant extracts on number of leaves per plant

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	5.443	6.183	8.077	8.267	7.700	7.767	9.887	7.367	6.277	**7.441**
T2	6.700	8.367	7.033	8.233	6.967	7.033	7.233	7.267	6.500	**7.259**
T3	7.367	9.387	7.133	10.500	8.633	7.400	7.353	8.700	7.553	**8.225**
Mean	**6.503**	**7.979**	**7.414**	**9.000**	**7.767**	**7.400**	**8.158**	**7.778**	**6.777**	
L.S.D 5%		T=0.281			M= 0.340			MT=0.591		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Root length

Table 5 shows that soaking durations and extract treatments significantly affected root length. The interaction treatment T1M5 recorded the greatest root length (7.100 cm), whereas T1M0 gave the lowest (3.900 cm). For soaking duration alone, T1 produced the highest mean root length (5.728 cm) compared with T3, which gave the lowest value (4.863 cm). With regard to plant extracts, All treatments were superior to the control, with M8 showing the best performance (6.322cm) compared with M8, which gave the lowest value (4.533 cm).

Table 5. Effect of soaking durations of bitter melon seeds in selected plant extracts on Root Length (cm)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	3.900	5.900	5.183	6.000	7.033	7.100	5.867	6.000	4.567	**5.728**
T2	5.003	6.400	5.633	6.243	6.867	5.100	5.967	4.867	5.000	**5.676**
T3	5.033	4.487	5.033	5.367	5.067	4.267	6.217	4.267	4.033	**4.863**
Mean	**4.646**	**5.596**	**5.283**	**5.870**	**6.322**	**5.489**	**6.017**	**5.044**	**4.533**	
L.S.D 5%		T=0.095			M= 0.145			MT=0.247		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1%

,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Fresh weight

The results presented in Table 6 reveal significant differences in fresh weight of plants due to the treatments. The interaction treatment T2M3 gave the highest fresh weight (4.950 g), while T1M0 recorded the lowest (3.823 g). Among soaking durations, T2 was superior (4.344 g) compared with T1, which produced the lowest mean value (4.130 g). As for plant extracts, all treatments outperformed the control, with M3 recording the highest fresh weight (4.6123 g), while M6 gave the lowest value (4.017 g).

Table 6. Effect of soaking durations of bitter melon seeds in selected plant extracts on fresh weight (g)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	3.823	4.080	4.377	4.030	4.743	4.183	3.920	3.980	4.038	**4.130**
T2	4.165	4.497	4.087	4.950	4.363	4.203	4.187	4.190	4.473	**4.256**
T3	4.360	4.417	4.161	4.857	4.437	4.237	3.943	3.913	3.870	**4.244**
Mean	**4.116**	**4.331**	**4.208**	**4.6123**	**4.514**	**4.208**	**4.017**	**4.028**	**4.127**	
L.S.D 5%			T=0.048		M= 0.089			MT=0.150		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Dry weight

The results in Table 7 show significant differences in plant dry weight due to the interaction between seed soaking duration and plant extract treatments. The interaction treatment T2M3 recorded the highest dry weight (1.096 g), while T1M0 gave the lowest value (0.216 g). Considering soaking duration alone, T2 was superior (0.939 g) compared with T3, which had the lowest value (0.747 g). Regarding plant extracts, all treatments exceeded the control, with M3 giving the highest dry weight (0.937 g) compared with M0 (0.621 g).

Table 7. Effect of soaking durations of bitter melon seeds in selected plant extracts on dry weight (g)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	0.216	0.808	0.960	0.880	0.926	0.956	1.026	0.950	0.896	**0.846**
T2	0.840	0.950	0.880	1.096	1.066	0.946	0.900	0.916	0.856	**0.939**
T3	0.807	0.881	0.753	0.836	0.643	0.706	0.701	0.670	0.728	**0.747**
Mean	**0.621**	**0.879**	**0.864**	**0.937**	**0.878**	**0.869**	**0.875**	**0.845**	**0.827**	
L.S.D 5%			T=N.S		M= 0.054			MT=0.108		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Dry matter percentage

As shown in Table 8, significant differences were also observed in dry matter percentage. The interaction treatment T1M6 achieved the highest value, whereas T1M0 gave the lowest. Similarly, soaking duration T2 recorded the highest percentage (0.939 g equivalent), while T3 gave the lowest (0.747 g). Among plant extracts, M3 was superior (0.937 g equivalent), whereas M0 produced the lowest value (0.621 g).

Table 8. Effect of soaking durations of bitter melon seeds in selected plant extracts on dry matter percentage (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	5.65	19.8	21.93	21.83	19.52	20.15	26.17	23.86	22.18	**20.48**
T2	20.16	21.12	21.53	22.14	24.43	21.68	21.49	21.86	19.13	**22.17**
T3	18.5	19.94	18.09	17.21	14.49	15.91	17.77	17.12	18.81	**17.6**
Mean	**15.08**	**20.29**	**20.53**	**21.89**	**19.47**	**19.27**	**21.78**	**20.97**	**20.03**	
L.S.D 5%		T=N.S			M= 0.089			MT=0.150		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Total chlorophyll concentration

The results in Table 9 indicate that the treatments significantly influenced total chlorophyll concentration. The interaction T2M2 produced the highest chlorophyll content, while T1M0 gave the lowest. Across soaking durations, T2 was superior 48.00), in contrast to T3, which gave the lowest value (41.41). Among extracts, M2 recorded the highest value (51.33), while M6 had the lowest (40.47 g).

Table 9. Effect of soaking durations of bitter melon seeds in selected plant extracts on Total chlorophyll content

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	35.22	52.75	43.03	42.83	45.92	49.27	40.33	43.22	45.71	**44.25**
T2	52.21	50.11	70.18	42.16	49.73	46.34	39.29	41.37	40.60	**48.00**
T3	42.09	40.33	40.78	42.11	43.67	41.92	41.78	39.55	40.44	**41.41**
Mean	**43.17**	**47.73**	**51.33**	**42.37**	**46.44**	**45.84**	**40.47**	**41.38**	**42.25**	
L.S.D 5%		T=1.22			M= 1.11			MT=2.03		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa 43Extract4%.

Nitrogen and protein percentages

Tables 10 and 11 show significant differences in nitrogen and protein content. The interaction

treatment T3M2 resulted in the highest nitrogen (3.383%) and protein percentage (21.14%), while T1M0 gave the lowest values (1.100% and 6.875%, respectively). Considering soaking durations, T3 produced the highest nitrogen and protein percentages (2.401% and 15.00%, respectively), compared with T1, which recorded the lowest (1.750% and 10.93%). Regarding plant extracts, M3 was superior with values of 2.360% nitrogen and 14.75% protein, whereas M0 gave the lowest percentages (1.719% and 10.743%).

Table 10. Effect of soaking durations of bitter melon seeds in selected plant extracts on nitrogen (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	1.100	1.113	1.500	1.800	2.100	1.703	1.500	2.300	2.633	**1.750**
T2	2.400	2.700	1.363	2.587	2.093	2.020	2.400	2.743	2.033	**2.260**
T3	1.657	2.650	3.383	2.693	2.383	2.773	2.453	1.447	2.167	**2.401**
Mean	**1.719**	**2.154**	**2.082**	**2.360**	**2.192**	**2.166**	**2.118**	**2.163**	**2.278**	
L.S.D 5%			T=0.042			M= 0.068			MT=0.204	

Table 11. Effect of soaking durations of bitter melon seeds in selected plant extracts on protein (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	6.875	6.956	9.375	11.25	13.12	10.64	9.375	14.37	16.45	**10.93**
T2	15.00	16.87	8.518	16.16	13.08	12.62	15.00	17.14	12.70	**14.12**
T3	10.35	16.56	21.14	16.83	14.89	17.33	15.33	9.043	13.54	**15.00**
Mean	**10.743**	**13.46**	**13.01**	**14.75**	**13.7**	**13.53**	**13.23**	**13.51**	**14.23**	
L.S.D 5%			T=0.048			M= 0.089			MT=0.150	

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Phosphorus (%)

The results presented in Table 12 reveal significant differences in phosphorus percentage. The interaction treatment T3M2 yielded the highest value, reaching 0.720%, compared to treatment T1M0, which produced the lowest value of 0.346%. Regarding seed soaking durations, treatment T3 outperformed others, achieving the highest phosphorus percentage of 0.590%, while treatment T1 resulted in the lowest value of 0.459%. In terms of plant extracts, treatment M7 demonstrated superiority with the highest phosphorus percentage of 0.622%, whereas treatment M0 yielded the lowest value of 0.462%.

Table 12. Effect of soaking durations of bitter melon seeds in selected plant extracts on phosphorus (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	0.346	0.445	0.427	0.438	0.373	0.472	0.510	0.514	0.611	**0.459**
T2	0.510	0.582	0.463	0.382	0.474	0.532	0.438	0.700	0.570	**0.517**
T3	0.530	0.528	0.720	0.710	0.646	0.446	0.473	0.652	0.603	**0.590**
Mean	**0.462**	**0.518**	**0.536**	**0.510**	**0.498**	**0.483**	**0.474**	**0.622**	**0.594**	
L.S.D 5%		T=0.0077			M= 0.0219			MT=0.0362		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Potassium (%)

The data in Table 13 show that neither soaking durations (T), nor plant extracts (M), nor their interaction (T × M) exerted significant effects on potassium percentage, as indicated by the non-significant (N.S.) results. Across the treatments, potassium percentages ranged between 1.7% (T1M0) and 3.4% (T3M1). The mean values for soaking durations were 2.40% for T1, 2.84% for T2, and 2.91% for T3, while the overall mean across all treatments was 2.80%.

With respect to plant extracts, the mean potassium percentages varied slightly, with the highest mean of 3.13% observed in M8 and the lowest of 2.30% in M0. However, these differences were not statistically significant. These results indicate that potassium concentration in seeds was not affected by soaking duration, plant extracts, or their interaction.

Table 13. Effect of soaking durations of bitter melon seeds in selected plant extracts on Potassium (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	1.7	2.0	2.3	2.9	2.4	2.6	2.0	2.9	3.1	**2.4**
T2	2.9	3.1	2.6	2.3	2.9	2.3	3.0	3.2	3.3	**2.84**
T3	2.3	3.2	3.4	2.7	3.11	2.7	3.1	2.7	3.0	**2.912**
Mean	**2.3**	**2.8**	**2.8**	**2.6**	**2.80**	**2.5**	**2.7**	**2.9**	**3.13**	
L.S.D 5%			L.S.D T=N.S		L.S.D.M= N.S		L.S.DMT= N.S			

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

Phenols

The results presented in Table 14 show that soaking durations of bitter melon seeds, the type of plant extract, and their interaction had significant effects on phenol percentage. The mean values of soaking durations indicated that treatment T2 recorded the highest phenol content (5.184%), followed

by T3 (3.992%), while T1 gave the lowest value (2.710%). Across plant extracts, phenol percentages varied widely, with the highest overall mean observed for M8 (6.827%) and the lowest for M6 (2.174%). In general, M5, and M8 showed relatively higher phenolic content compared with the other extracts. The interaction (T × M) revealed that the highest phenol content was obtained from T2M8 (13.880%), whereas the lowest value was recorded in T1M0 (1.263%) .

Table 14. Effect of soaking durations of bitter melon seeds in selected plant extracts on phenols (%)

Treatments	M0	M1	M2	M3	M4	M5	M6	M7	M8	Mean
T1	1.263	3.641	3.453	3.244	3.060	2.977	2.389	1.724	2.640	2.710
T2	2.171	4.560	2.723	2.90	2.591	12.373	1.919	3.541	13.880	5.184
T3	2.640	3.617	4.880	4.187	3.907	6.867	2.215	3.657	3.960	3.992
Mean	2.024	3.940	3.685	3.444	3.186	7.406	2.174	2.974	6.827	3.962
L.S.D 5%			T=0.373		M= 0.208			MT=0.409		

T1= Soak the seeds for 3hours, T2=Soak the seeds for6 hours, T3=Soak the seeds for 9 hours, M0= Distilled water, M1= sweet Fennel extract 1% , M2= sweet Fennel extract 2%,M3= sweet Fennel extract3% ,M4= sweet Fennel extract 4%,M5= Moringa Extract 1% ,M6= Moringa Extract 2%,M7= Moringa Extract3%,M8= Moringa Extract4%.

DISCUSSION

Germination percentage and germination speed are important variables for evaluating seed viability as it correlates positively with seedling vigor. The enhancement of photosynthesis via improvement of seedlings growth and assimilates' transportation to sink organs by plant extracts may be considered as a possible cause of increase. Furthermore, cytokinins present in Moringa extract were helpful in decreasing the respiration rate. Low respiration indicates low absorption of soluble solids in the sap of the plant decreases such as sugar, organic acids and amino acids) leading to an increase in the total soluble solids in the plant tissues (Al-Asady and AlKikhani, 2019). This suppression of respiration also may contribute to the protection of vitamin C from oxidation.

Furthermore, hydrolysis of complex Carbohydrates into simple sugars increased germination. The present of added auxins induced the development of new tissues by loosening the cell wall due to increased protein digestion and thus enhanced plant growth. These effects are primarily due to the presence of contains plant hormones that enhance seed germination (Rehman et al., 2014). The present findings are consistent with those of Ismail and Ganzour (2021), El-Nour and Ewais (2017) for Pepper seeds and Ahmed and El-Mahdy (2022) for maize. Similar findings were reported by Ghanim et al. (2024) with foliar application of Moringa extract on Chrysanthemum.

CONCLUSION

Soaking of Bitter melon seeds in Moringa and Sweet fennel extracts for varying time

increased germination, seedling growth and biochemical parameters. It may be concluded that natural plant extract particularly Moringa and Sweet fennel treatment showed promising increase in seed germination and seedling growth. These extracts might be suggested as eco-friendly and bio-safe replacement to synthetic treatments, because they have prospect for promoting germination and development. However, more studies are required to assess the impact of Moringa and Sweet fennel extracts on other seed varieties.

REFERENCES

Abou El-Nour, H. H., and Ewais , N. A. (2017). Effect of *Moringa oleifera* Leaf Extract (MLE) on Pepper seed Germination, seedling improvement, Growth, Fruit Yield, and Quality. *Middle East Journal of Agriculture Research, 6*(2), 448–463. ISSN 2077-4605.

Ahmed, A. A., and El-Mahdy, A. A. (2022). Improving seed germination and seedling growth of maize (*Zea mays* L.) seed by soaking in water and *Moringa oleifera* leaf extract. *Current Chemistry Letters, 11*, 147–151.

Ahmed, S. M., Jaber, H. Y., Zamel, K. M., Suhail, A. K., & Lafta, H. A. (2017). Effect of some botanical extracts on growth and yield of pepper (*Capsicum annuum*) under field conditions. *Iraqi Journal of Agricultural Research, 22*(1), 128–136.

Al-Asady, M. H. S., and AlKikhani, H. J. A. (2019). *Plant hormones & their physiological effects*. Al-Qasim Green University, Agriculture College, House of National Books and Documents in Baghdad.

Ayoub, A. A. (2018). Study of the active ingredient of licorice plant and applications. *Engineering and Technology Journal, 36*(3C), 8. https://doi.org/10.30684/etj.36.3C.8

Chekka, S. V., and Mantipelly, N. K. (2020). *Momordica charantia*: A natural medicinal plant. *GSC Biological and Pharmaceutical Sciences, 12*(2), 129–135.

Dennis, M., Gilbero, A. C. E., Tabaranza, E. C., Aranico, E. C., & Amparado, R. F. (2014). Bioefficacy of *Moringa oleifera* leaf extract: Seed germination and growth of seedlings of falcata (*Paraserianthes falcataria*). *AES Bioflux, 6*(2).

EeShian, T., Aminah, A., Nur Kartinee, K., & Hisham, S. (2015). Antioxidant and hypoglycaemic effects of local bitter melon fruit (*Momordica charantia*). *International Journal of PharmTech Research, 8*(1), 46–52.

Fayad, M. H. (2005). *The effect of spraying some growth regulators and plant extracts on the growth and yield of the two plant species: Cucumis melo var. flexuosus Noud. and Cucumis sativus L.* (Ph.D. thesis). College of Agriculture, University of Basrah, Iraq.

Gayathry, K. S. and John, J. A. (2022). A comprehensive review on bitter melon (*Momordica charantia* L.) as a gold mine of functional bioactive components for therapeutic foods. *Food*

Production, Processing and Nutrition, 4(10). https://doi.org/10.1186/s43014-022-00096-2

Gedik, O. and Uslu, Ö. S. (2021). Effects of fennel and cumin extracts on flax seed germination parameters and mitotic activity in the root tip cells. *BEU Journal of Science, 10*(1), 197–206. https://doi.org/10.17798/bitlisfen.806250

Ghanim, S. H., Abdelaziz, M. H., Ahmed, N., Abdul Hamid, M., El-Shamy, M. A., & Sabry, R. M. (2024). Growth and essential oil quantity of pot marigold (*Calendula officinalis*) in response to foliar application of moringa extract and pink-pigmented facultative methylotrophic bacteria (*Methylobacterium populi*). *Journal of Environmental Sciences, 53*(1).

Ibrahim, I. R. and Ameen, S. K. M. (2017). In vitro propagation of *Moringa oleifera*. *Iraqi Journal of Agricultural Sciences, 48*(4), 1089.

Ismail, S. A. A. and Ganzour, S. K. (2021). Efficiency of foliar spraying with moringa leaves extract and potassium nitrate on yield and quality of strawberry in sandy soil. *International Journal of Agricultural and Statistical Sciences, 17*(1), 383–398.

Janagal, B., Singh, C., Purvia, R. P., & Adlakha, M. (2018). A review of hypoglycemic effect of *Momordica charantia* with special reference to madhumeh. *International Journal of Ayurveda and Pharma Research, 6*(1), 50–54.

Jia, S., Shen, M., Zhang, F. and Xie, J. (2017). Recent advances in *Momordica charantia*: Functional components and biological activities. *International Journal of Molecular Sciences, 18*(12), 2555. https://doi.org/10.3390/ijms18122555

Joseph, B., and Jini, D. (2013). Antidiabetic effects of *Momordica charantia* (bitter melon) and its medicinal potency. *Asian Pacific Journal of Tropical Disease, 3*(1), 93–102. https://doi.org/10.1016/S2222-1808(13)60052-3

Khalil, N., Ashour, M., Fikry, S., Singab, A. N., & Salama, O. (2018). Chemical composition and antimicrobial activity of the essential oils of selected Apiaceous fruits. *Future Journal of Pharmaceutical Sciences, 4*(1), 88–92. https://doi.org/10.1016/j.fjps.2017.10.004

Kole, C., Matsumura, H. and Behera, T. K. (2020). *The bitter melon genome*. Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-030-20037-9

Mohamed, A. A., Gouda, F. E. M., Saleh, F. E. M. and Omran, Y. A. M. (2022). Efficiency of extracts of three medicinal plants to improve growth, yield and quality of red Roomy grapevine. *Assiut Journal of Agricultural Science, 53*(1), 45–59.

Mohammed, R. R. and Majeed, B. H. (2024). Response of strawberry growth, yield and marketable fruit quality to spraying with moringa leaf extract, calcium and potassium silicate. *Iraqi Journal of Agricultural Sciences, 55*(1), 440–452.

Núñez-Gastélum, J. A., Arguijo-Sustaita, A. A., López-Díaz, J. A., Díaz-Sánchez, Á. G., Hernández-Peña, C. C. and Cota-Ruiz, K. (2023). Seed germination and sprouts production of *Moringa*

oleifera: A potential functional food? *Journal of the Saudi Society of Agricultural Sciences, 22*, 223–230. https://doi.org/10.1016/j.jssas.2021.11.002

Rehman, H., Nawaz, M. Q., Basra, S. M. A., Afzal, I., Yasmeen, A., & Hassan, F. U. (2014). Seed priming influence on early crop growth, phenological development and yield performance of linola (*Linum usitatissimum* L.). *Journal of Integrative Agriculture, 13*(5), 990–996. https://doi.org/10.1016/S2095-3119(13)60476-9

Sardar, H., Nisar, A., Anjum, M. A., Naz, S., Ejaz, S., Ali, S., and Ahmad, R. (2021). Foliar spray of Moringa leaf extract improves growth and concentration of pigment, minerals and stevioside in stevia (*Stevia rebaudiana* Bertoni). *Industrial Crops and Products, 166*, 113485. https://doi.org/10.1016/j.indcrop.2021.113485

Satya, V. C. and Mantipelly, N. K. (2020). *Momordica charantia*: A natural medicinal plant. *GSC Biological and Pharmaceutical Sciences, 12*(2), 129–135. https://doi.org/10.30574/gscbps.2020.12.2.0251

Shakir, M. A. and Al-Rawi, W. A. A. (2017). Effect of garlic and licorice root extract on leaf mineral and hormonal content of pear transplants. *Iraqi Journal of Agricultural Sciences, 48*(Special Issue), 131–143.

Shubha, A. S., Devaraju, Sharavati, M. B., Srinivasa, V., Kantharaj, Y., Ravi, C. S., Angadi, A., Kumar, Y. H. and Ahmed, S. (2018). National conference on "Conservation, cultivation and utilization of medicinal and aromatic plants" (College of Horticulture, Mudigere Karnataka, 2018). *Journal of Pharmacognosy and Phytochemistry, SP3*, 297–300.

Sultan, F. I., Al-Farha, A. A. and Shaaban, I. (2020). Separation and identification of some fatty acids and phenolic compounds from *Portulaca oleracea* L. and their biological effect on two types of pathogenic bacteria. *Asian Journal of Agriculture and Biology, 8*(3), 1–11. https://doi.org/10.35495/ajab.2020.02.11

Sultan, I. F., Hayawi, J. A. and Ibrahim, M. A. (2023). Effect of soaking time with cumin extract on the growth and yield of Rehan barley (*Hordeum vulgare* L.). *Journal of Medicinal and Industrial Plant Sciences*. Advance online publication. https://doi.org/10.13140/RG.2.2.36603.12320

Szopa, A., Klimek-Szczykutowicz, M., Jafernik, K., Koc, K. and Ekiert, H. (2020). Pot marigold (*Calendula officinalis* L.): A position in classical phytotherapy and newly documented activities. *Acta Scientiarum Polonorum Hortorum Cultus, 19*(3), 97–109. https://doi.org/10.24326/asphc.2020.3.9