

Phytochemical evaluation of the synergistic effect of onion peels and mint extract on improving volatile oils in sunflower plants

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ABSTRACT

Sunflower plant (*Helianthus annuus* L) One of the major oil seed crops of the world because of its high quality oil and high content of unsaturated fatty acids and bioactive antioxidant compounds. This research aimed to evaluate the effect of onion peel waste as a soil conditioner, and mint extract (*Mentha* spp.) As a foliar growth stimulant, both individually and in combination, in improving the growth traits, yield, oil content, and active compounds in sunflower plants. The experiment was conducted using a Randomize Complete Block Design (RCBD) with seven treatments, including a control treatment, two levels of onion peels (2 and 4 tons/ha), two levels of mint extract (5% and 10%), in addition to the combined treatments of both. The results showed a significant superiority of the organic treatments over the control treatment in most growth and yield traits. The treatment combining a high level of onion peels and 10% mint extract achieved the best results in terms of increased seed yield, oil percentage, improved phenol content, and antioxidant activity. This is attributed to the improvement in soil fertility, increased microbial activity, in addition to the stimulating effects of the phenol compounds and essential oils present in mint and onion peels. The study concludes that the integration of organic waste and plant extracts represents an effective and environmentally friendly strategy to improve the productivity and quality of sunflower oil.

Key words: Sunflower, organic fertilization, onion peels, mint extract, stimulation, oil content, sustainable agriculture

INTRODUCTION

Medicinal plants and oil sources are among the most important sources of active secondary metabolites, which include phenols, flavonoids, and terpenes, and play a pivotal role in antioxidant and antimicrobial activity [1]. The sunflower plant one of the most important oil seed crops globally, due to the high nutritional value of its oil, which contains a high percentage of unsaturated fatty acids such as linoleic acid and oleic acid, in addition to containing antioxidant compounds like tocopherols (vitamin E) [2]. Sunflower oil is a strategic crop for global food security since it is one of the most used oils in the food and pharmaceutical industries [3]. Also, the seeds of it are considered to be essential nutrients for the body. They contain minerals and unsaturated fatty acids, which are important medicinal substances in human nutrition. Also it has antioxidants like vitamin E which makes the human immune system stronger [4]. The phytochemical production of medicinal and aromatic plants, due to their ability to activate the metabolic pathways responsible for the production of secondary compounds [5]. Onion peel waste (*Allium cepa* L.) Among the organic sources rich in phenolic compounds, flavonoids, and micro nutrients, which can contribute to improving plant growth through their role as natural bio stimulants [6]. Onion peels also contain organic sulphur compounds that possess antioxidant and antimicrobial properties, which positively reflect on plant health and nutrient absorption efficiency[7]. On the other hand, peppermint extract (*Mentha* spp.) A rich source of volatile oils such as menthol and menthone, in addition to flavonoids and polyphenols, which have shown an important role in enhancing physiological processes within the plant and increasing its resistance to environmental stresses [8]. Studies also indicate that plant extracts can act as growth stimulants by activating enzymes associated with photosynthesis and the formation of secondary metabolites [9]. Based on this, this research aims to study the effect of organic fertilization using onion peels and mint extract, individually and in combination, on improving the growth of sunflower plants and increasing the oil content and active compounds in the seeds, in line with sustainable agriculture trends and reducing reliance on chemical inputs.

MATERIAL AND METHODS**The location of the experiment and its conditions**

The experiment was performed in an agricultural field or greenhouse in a homogeneous sandy clay soil during the 2024-2025 growing season. The soil was plough and leveled well to ensure uniform growth conditions among the experimental units, with regular irrigation provided according to the needs of the sunflower plant (*Helianthus annuus* L.). Uniform seeds of the sunflower variety (local) were used, and they were selected to ensure uniform growth and reduce genetic variation among the plants [10]. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications per treatment. Treatments were randomly assigned within block to reduce environmental variation [11].

Fertilization transactions

Onion peel fertilizer was prepared by collecting the peels resulting from household use, then washing them thoroughly to remove impurities and dirt. After that, the peels were dried outdoors under suitable laboratory conditions until they reached a stable weight. The resulting organic fertilizer was added to the soil and mixed well to ensure its even distribution before planting the experimental crop seeds, with the aim of allowing sufficient time for the organic matter to decompose and integrate with the soil components, thereby improving its physical and chemical properties. Onion peels were mixed with the soil two weeks before planting to ensure their partial decomposition and the plant's initial benefit from the nutrients. As for the mint extract, it was sprayed foliar using a manual sprayer during the vegetative growth stages, and the spraying was repeated every 10–14 days until the flowering stage. The planting was done in regular rows, maintaining fixed distances between the plants (30–40 cm) and between the rows (60–70 cm). Irrigation operations were carried out regularly according to the plant's needs without exposing it to water stress. The bushes were also removed manually when necessary to ensure there was no competition for food resources [12].

Table 1. The information of experiments for seven treatments .

Information of experiments	Treatments
Control	treatment without addition.
O 1	onion peels at a low rate (2 tons/hectare)
O 2	Adding onion peels at a high rate (4 tons/hectare).
M 1	Spraying mint extract at a concentration of 5%.
M 2	Spray mint extract at a concentration of 10%.
O 1 +M1	Mixing onion peels (2 tons/hectare) + mint extract 5%.
O2 + M2	Mixing onion peels (4 tons/hectare) + mint extract 10%.

Preparation of mint extract

In the second phase of the study, a mint leaf extract used in the spraying process was prepared. Fresh mint leaves were used and thoroughly washed to remove impurities, then chopped using an electric blender to ensure the homogeneity of the plant material and increase the extraction efficiency. The cold extraction method (Maceration) was adopted in preparing the extract, by soaking the ground leaves in a suitable solvent and leaving them for a specified period at room temperature with gentle stirring occasionally. This is one of the common methods for extracting active plant compounds as it preserves heat-sensitive materials. As for the spraying process, it was carried out at a specific time of the day to ensure stable environmental conditions. The spraying was conducted early in the morning at 8:00 AM to avoid high temperatures and reduce evaporation rates, ensuring higher efficiency in the absorption of the extract by the plant. The extract was prepared in two concentrations (5% and 10%) and used directly for foliar spraying [13].

Extraction and analysis of active compounds from sunflower seeds. The dry sunflower seeds were ground. The organic solvent extraction method was used to obtain the active compounds and oils, where the seed powder was soaked in hexane solvent at an appropriate ratio, and then the mixture was left for 24–48 hours with continuous stirring at room temperature. After that, the extract was filtered using filter paper, and then the solvent was evaporated using a rotary evaporator to obtain the crude oil. The active compounds including oleic acid ,Tocopherols, linoleic acid ,Palmitic acid and thymol % Samples were analyzed by a high-performance liquid chromatography (HPLC) device. The separation was carried out on a C18 column with the appropriate mobile phase at a specific flow rate. The obtained retention times and peaks were compared with standard substances in order to identify the compounds and to estimate their concentration [14].

Statistical analysis

The data were analyzed using Analysis of Variance (ANOVA) according to the RCBD design, and the means were compared using the Least Significant Difference (LSD) test at a significance level of 0.05. The analysis was conducted using SPSS[15].

RESULTS AND DISCUSSION

According to table 2 results, which showed a significant influence among the investigated treatments. The O2 + M2 therapy worked better than the others, yielding the lowest average of 3.13% and the highest average of 7.28% for the control therapy. With the control treatment

having the lowest average of 3.19% and the highest average of 6.65%, the data in the same table also demonstrated that O1 + M1 had a significant effect on thymol. The control treatment had the lowest average of 1.65% and the highest average of 9.76%, despite the two-way interaction demonstrating a substantial difference between the treatments O1 + M1 and O2 + M2.

Table 2. Effect of onion peels and mint extract on thymol.

mint extract	onion peels				Mean
	0	O1	O2	O1 + M1	
0	1.65	2.65	3.67	4.56	3.13
M1	2.65	3.76	4.76	5.84	4.25
M2	3.65	4.76	5.74	6.45	5.15
O2 + M2	4.76	6.84	7.76	9.76	7.28
Mean	3.18	4.50	5.48	6.65	
LSD mint extract= 1.86					
LSD onion peels=0.54					
LSD interaction= 2.76					

Based on Table 3 findings, which demonstrate a substantial impact across the examined therapies. The data from the same table also demonstrated that O1 + M1 had a significant effect on linoleic acid percentage, with the control treatment having the lowest average of 24.23% and the highest average of 28.71%. The O2 + M2 therapy performed better than the others, producing the highest average of 28.26%, while the control treatment produced the lowest average of 24.15%. The control treatment had the lowest average of 22.65% and the highest average of 31.76%, despite the two-way interaction demonstrating a substantial difference between the treatments O1 + M1 and O2 + M2.

Table 3. Effect of onion peels and mint extract on linoleic acid %.

mint extract	onion peels				Mean
	0	O1	O2	O1 + M1	
0	22.65	23.74	24.45	25.76	24.15
M1	23.76	24.76	25.76	27.87	25.54
M2	24.76	25.76	26.87	29.45	26.71
O2 + M2	25.76	26.74	28.76	31.76	28.26
Mean	24.23	25.25	26.46	28.71	
LSD mint extract=0.65 LSD onion peels= 1.87 LSD interaction = 2.76					

Table 4 results show a significant influence among the investigated treatments. The O2 + M2 therapy worked better than the others, producing the greatest average of 7.68%, At 3.29%, the control therapy yielded the lowest average. With the control treatment having the lowest average of 3.48% and the highest average of 7.65%, the same table's results also demonstrated that O1 + M1 had a significant effect on oleic acid percentage. The control treatment had the lowest average of 1.65% and the highest average of 10.65%, despite the two-way interaction demonstrating a substantial difference between the treatments O1 + M1 and O2 + M2.

Table 4. Effect of onion peels and mint extract on Oleic acid %.

mint extract	onion peels				Mean
	0	O1	O2	O1 + M1	
0	1.65	2.76	3.98	4.75	3.29
M1	2.76	3.78	4.97	6.76	4.57
M2	3.75	4.87	5.87	8.45	5.74
O2 + M2	5.76	6.76	7.56	10.65	7.68
Mean	3.48	4.54	5.60	7.65	
LSD mint extract =1.46 LSD onion peels = 0.75 LSD interaction = 2.76					

According to Table 5 results, which demonstrate a substantial influence among the examined treatments, the O2 + M2 therapy performed better than the others, yielding the greatest average of 12.31% while the control treatment produced the lowest average of 7.63%. The data from the same table also demonstrated that O1 + M1 significantly affected tocopherols, with the control treatment having the highest average of 12.62% and the lowest average of 7.53%. The control treatment had the lowest average of 5.65% and the highest average of 15.75%, despite the two-way interaction demonstrating a substantial difference between the treatments O1 + M1 and O2 + M2.

Table 5. Effect of onion peels and mint extract on Tocopherols.

mint extract	Onion peels				Mean
	0	O1	O2	O1 + M1	
0	5.65	6.76	8.76	9.34	7.63
M1	6.87	7.87	9.76	11.64	9.04
M2	7.85	8.45	10.87	13.76	10.23
O2 + M2	9.76	10.87	12.87	15.75	12.31
Mean	7.53	8.49	10.57	12.62	
LSD mint extract= 0.76					
LSD onion peels= 1.87					
LSD interaction =2.87					

The O2 + M2 therapy performed better than the others, producing the greatest average of 1.14%, while the control treatment produced the lowest average of 0.68%, according to the results in Table 6. The same table's results also showed that O1 + M1 had a substantial impact on palmitic acid percentage, with the control treatment having the lowest average of 0.94% and the highest average of 1.12%. Although the two-way interaction shows a significant difference between the treatments O1 + M1 and O2 + M2, the control treatment had the lowest average of 0.92% and the highest average of 1.137%.

Table 6. Effect of onion peels and mint extract on Palmitic acid %

mint extract	Onion peels				Mean
	0	O1	O2	O1 + M1	
0	0.77	0.87	0.96	1.10	0.92
M1	0.88	0.95	1.10	1.11	1.01
M2	0.99	1.11	1.12	1.13	1.09
O2 + M2	1.12	1.13	1.14	1.15	1.137
Mean	0.94	1.02	1.08	1.12	
LSD mint extract = 1.65					
LSD onion peels=0.54					
LSD interaction =2.76					

Conclusion

The study concludes that the integration of organic waste and plant extracts represents an effective and environmentally friendly strategy to improve the productivity and quality of sunflower oil, supporting sustainable agriculture and reducing reliance on chemical fertilizers.

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