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Effect of type of organic matter and spraying seaweed extract on growth and active substance of the plant ornamental pepper (*Capsicum annuum* L.).

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ABSTRACT

This study was conducted in one of the greenhouses belonging to the research station of the Department of Horticulture and Landscaping - College of Agriculture , Tikrit University in the period extending from (15/10/2022) until (30/5/2023) , to find out the effect of adding several combinations of organic fertilizers 0 comparison treatment, 42 cm3 of tea residue + 42 cm3 of poultry manure + 42 cm3 of sheep manure, 63 cm3 of poultry manure + 63 cm3 of tea residue, 63 cm3 of sheep manure + 63 cm3 of tea residue and spraying with seaweed extract in three concentrations 0 Comparison treatment, 0.5 g L-1, 1 g L-1) and the interaction between them in the growth and active component of ornamental pepper plant, the results showed that the treatment (42 cm3 of tea residue + 42 cm3 of poultry manure + 42 cm3 of sheep manure) excelled in most vegetative growth traits of ornamental pepper plants (plant length, number of branches, and fruit content of gallic acid, caffeic acid, and the alkaloid capsaicin) compared with the comparison treatment, and the treatment (63 cm3 poultry manure + 63 cm3 tea residue) was significantly superior in leaf area characteristic, while the treatment of spraying Seaweed extract did not record a significant superiority in the vegetative growth traits, and the concentration 1 g L-1 of the Seaweed extract was significantly superior by giving the highest values for the fruits' content of gallic acid, caffeic acid, and the alkaloid compound capsaicin. The interaction treatment between the combination of organic fertilizers (63 cm3 of tea residue + 63 cm3 of poultry manure) in addition to spraying with extract of seaweed at a concentration of 1 g L-1, it excelled in the characteristics of vegetative growth of the plant (number of branches, plant length).

KEYWORDS: Ornamental pepper; *Capsicum annuum* L; Organic fertilizers; Seaweed.

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تأثير نوع المادة العضوية والرش بمستخلص الاعشاب البحرية في نمو والمادة الفعالة لنبات فلفل الزينة (*Capsicum annuum* L.)

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الملخص

أجريت هذه الدراسة في احد البيوت الزجاجية التابعة لمحطة أبحاث قسم البستنة وهندسة الحدائق-كلية الزراعة-جامعة تكريت للمدة الممتدة من 10/15 /2022 حتى 5/30 /2023, لمعرفة تأثير إضافة عدة توليفات من الأسمدة العضوية هي ((Ms 0معاملة المقارنة, Mp)) 42 سم3 مخلفات أغنام +42 سم3 مخلفات دواجن+42 سم3 بقايا الشاي, 63 سم3 مخلفات دواجن+63 سم3 بقايا الشاي) 63 سم3 مخلفات أغنام +63 سم3 بقايا الشاي والرش بمستخلص الأعشاب البحرية بثلاث تراكيز (0 معاملة المقارنة, 0.5 غم لتر-1, 1 غم لتر-1) والتداخل بينهم في نمو والمادة الفعالة لنبات فلفل الزينة, النتائج أظهرت أن المعاملة (42 سم3 مخلفات أغنام+42 سم3 مخلفات دواجن+42 سم3 بقايا الشاي تفوقت في أغلب صفات النمو الخضري لنبات فلفل الزينة (طول النبات, عدد الأفرع, ومحتوى الثمار من حامض الكاليك وحامض الكافيك والمركب القلويدي الكابسيسين) مقارنة مع معاملة المقارنة, وتفوقت معاملة (63 سم3 مخلفات دواجن+63 سم3 بقايا الشاي) معنوياً في صفة المساحة الورقية أما معاملة الرش بمستخلص الأعشاب البحرية لم تسجل تفوق معنوي في صفات النمو الخضري وأن التركيز 1 غم لتر-1 من المستخلص البحري تفوق معنوياً بإعطاء اعلى القيم لمحتوى الثمار من حامض الكاليك وحامض الكافيك والمركب القلويدي الكابسيسين, أما معاملة التداخل بين توليفة الأسمدة العضوية (63 سم3 مخلفات دواجن+63 سم3بقايا الشاي) والرش بمستخلص الأعشاب البحرية بتركيز 1 غم لتر-1 فقد تفوقت في صفات النمو الخضري للنبات (طول النبات, عدد الأفرع).

الكلمات المفتاحية: أسمدة عضوية، أعشاب بحرية، فلفل الزينة، بقايا الشايز

INTRODUCTION

Ornamental pepper (*Capsicum annuum* L.) belongs to the Solanaceae family, its native home is Central and South America, then its cultivation moved to countries of the world (Thang 2007, Barsari et al., 2018). Scientists had different opinions about dividing pepper according to type, some of them divided it into two types and others divided it into six, the division used in Europe and Asia is the division into two types C.annuum and C.frutescens (Mattalob et al., 1989) and the type *Capsicum annuum* L. is the most widespread and used species as it contains varieties of hot and sweet peppers (Boras et al., 2011). Ornamental pepper has many uses, its fruits can be used fresh, or as an additive to enhance the taste of food, and it is also used in the manufacture of sauces, seasonings, and pickles, and these plants can be grown in small pots, and to decorate gardens. The hot pepper plant also has many medical uses as a result of its fruits containing an effective alkaloid group called Capsaicinoids, which is the substance responsible for the spicy taste, and one of its most famous compounds is Capsaicin (Tiwari, 2009). It also contains several compounds with pharmaceutical properties such as anti-inflammatory, anti-allergic, and antioxidants (Lee et al., 2005). In addition, pepper fruits contain vitamins E, A, and C. Pepper fruits also contain carotenoids, which are components of the non-enzymatic antioxidant system and are important for humans (Rao and Rao, 2007). Agriculturally, the pepper plant needs slightly more fertilizers than plants of the same family as tomato plant, taking into account the type of soil, its fertility, and the environmental conditions surrounding the plant (Mattalob et al., 1986).

There are several types of fertilizers, including chemical and organic. When added, they lead to increased growth and productivity of the plant. One of the problems facing farmers is the large cost of providing chemical fertilizers. On the other hand, the use of chemical fertilizers in quantities more than what the crop needs, leads to soil, water, air and environment pollution (Al-Shaibani, 2005). To reduce the use of chemical fertilizers and reduce pollution, there was a need to find alternatives to these fertilizers, and organic fertilizers are considered good and available alternatives, and when added, they lead to improving the chemical and physical properties of the soil (Saleh et al., 2003, Al-Haddad, 2003). Seaweed is considered as a source of organic fertilizers that are used in agricultural production and it is complementary to fertilizers, and its use leads to an increase and improvement in the effectiveness of fertilizers and does not leave any residues on the soil and plants (Khan et al., 2009), many studies have shown the positive effect of seaweed extract which is used in agriculture to improve agricultural production, and also increases plant resistance to insects and some plant pathogens (Stephenson, 1966, Genesoylu, 2016). The increase in population growth required an increase in agricultural production, which led to an increase in waste to high levels (Ekbic et al., 2022), and among these waste are tea residues that can be used as fertilizer to get rid of them, and

they are also beneficial to plants, as they are characterized by their ability to retain water , and it is an organic material that increases soil quality (Lee et al., 2004). Based on the foregoing, this experiment was conducted to find out the effect of adding a mixture of some different organic materials to the cultivation medium on the growth and the active substance of ornamental pepper fruits, as well as to study the effect of spraying seaweed extract on plant growth and the active substance.

MATERIALS AND METHODS

This experiment was done in one of the greenhouses of the Research Station in the Department of Horticulture and Landscape College of Agriculture , Tikrit University in the period extending from (15/10/2022) to (30/5/2023). The study included the effect of two factors, the first, combinations of organic fertilizers , (Ms) 0 comparison treatment, (Mp) 42 cm^3 of tea residue + 42 cm^3 of poultry manure + 42cm^3 of sheep manure, (Mc) 63 cm^3 of tea residue + 63 cm^3 of poultry manure, (Ml) 63 cm3 of tea residue + 63 cm^3 of sheep manure , and the second factor spraying with extract of seaweed in three concentrations (F0) 0 Comparison treatment, (F1) 0.5 g L^{-1}, (F2) 1 g L^{-1}) on growth and active substance of ornamental pepper plant (*Capsicum annuum* L.), The seeds of ornamental pepper were planted in plastic dishes, and they were filled with the agricultural medium (peat moss) and sprayed with water and placed in the wooden canopy on 11/9/2022, and after one week, the first germination appeared and the seedlings were planted in the pots after the formation of the fourth and fifth true leaf. The various agricultural media were prepared, which were mixed soil, sheep waste, poultry waste. And tea residue before planting, then samples were taken from them for the purpose of analysis. The pots which have a diameter of 24 cm, a capacity of 7 liters, and a depth of 22 cm were filled with soil, with the addition of the mixture (organic fertilizers) according to the treatments. The seedlings were planted in the pots on 17/10/2022, with 4 plants in each experimental unit. The care operations such as irrigation, weeding, and insect control, in addition to the ventilation of the greenhouse, were carried out continuously and homogeneously in all plants, and then the readings were taken for the following characteristics:

Plant height , number of branches, Leaf area and Phenolic compounds (gallic acid and caffeic acid) and the alkaloid compound capsaicin The extract of capsaicin:- The column method was used to extract capsaicin from the sample, where 5 g of the sample (ornamental pepper powder) was taken and placed in a 50 ml volumetric vial, adding 25 ml of methanol and 10 ml of distilled water with the addition of some drops of orthodoxy phosphoric acid to make the medium acid.

Phenolic compounds extracted by use 3g of ornamental pepper fruits powder mixed with 60 ml of methanol and distilled water at a ratio of 40-60 ml for 24 hours, then the mixture was filtered and concentrated at a low pressure to 5 ml. This solution was decomposed by adding 5 ml of 2N

NaOH for 30 minutes, then the pH of the mixture was adjusted to 7 using 2N HCl, then the phenolic acids were extracted by using ethyl acetate 20ml and the extracts were combined and the ethyl acetate removed by evaporation, and the residue was dissolved in 7 ml of methanol.

The analysis was done using a high-performance liquid chromatography HPLC device, model SYKAM HPLC, Germany, equipped with an C18-ODS separation column (250 × 4.6 mm, 5 micrometers). The Phenolic compounds (galic acid and caffeic acid) were detected using the UV visible detector at 278 nm, as for the capsaicin alkaloid compound, the UV detector was used at a wavelength of 220 nm. The data was also recorded by the calculator that draws the chromatographic diagram, as the standard model of the studied phenolic and alkaloid compounds was injected, and the area of the standard model bundle and the detention time were separated, and then the research models were injected, the bundles obtained from the research models were compared with the standard solution model and the concentrations were calculated according to the following equation:

$$\textbf{substance concentration} = \frac{Sample\ area\ x\ Standard\ compound\ concentration}{Standard\ compound\ area} \times \frac{Dilution\ coefficient}{Sample\ weight}$$

After collecting the data for the aforementioned characteristics, they have been analyzed using the complete randomized design, and the means were compared according to Dunkin's multiple range test under the probability level of 0.05.

RESULT AND DISCUSSION

The results of Table (1) show that the treatment Mp organic fertilizer combination (Mp) was significantly superior in number of branches, plant height, gallic acid, caffeic acid and capsaicin, reaching 16.750 cm, 8.833 branch Plant^{-1}, 106.006 mg g^{-1}, 53.117 mg g^{-1}, 638.811 mg g^{-1}, respectively, compared to the lowest value when the comparison treatment Ms (soil only) which amounted to 12.237 cm,5.806 mg g^{-1}, 96.341 mg g^{-1} ,45.636 mg g^{-1} 482.167 mg g^{-1}, respectively, the reason may be attributed to the nutrients contained in organic fertilizers that increase plant growth, for example the element nitrogen is included in the composition of both chlorophyll and cytochromes, which have an effective role in the processes of photosynthesis and respiration as well as its role in the formation of vitamins , proteins, nucleic acids, cellular membranes and energy compounds. This led to an increase in indicators of vegetative growth (number of branches, plant length) (Mengel and Kirkby 2001), (Hopkins and Huner, 2009). The cause may be due to the fact that organic fertilizers contain phosphorus, which is important in building DNA, RNA, amino acids and enzymatic accompaniments NAD and NADP, These compounds are important in the process of oxidation and reduction during the chain of respiration and photosynthesis processes, as well as its importance in building the compound with high energy ATP which is important for the vital processes of the plant, leading to an increase in the activity of the photosynthesis process and thus increases the

nutrients manufactured in the leaf and its transmission to the different parts of the plant and an increase in the number and size of the cells , and this leads to an increase in vegetative growth (plant length, number of branches) (Hopkins and Huner, 2009 and Mia, 2015) These results are consistent with what Hammoud and Zughair (2013) concluded in a study of adding organic fertilizers (poultry waste) at level (0 without addition, 7 tons ha^{-1}, 14 tons ha^{-1}) for pepper plants, the results showed that the treatment of poultry 7 tons ha^{-1} was superior in vegetative growth characteristics (plant length, number of branches).

On the Other hand, the reason may be attributed to organic fertilizers and their role in improving the soil's biological, chemical and physical properties when added due to the organic matter it contains, as they increase soil fertility and work to improve the soil's pH, and these fertilizers are rich in nutrients ready for absorption by the roots, especially nitrogen , phosphorous and potassium, and these fertilizers are characterized by their ability to retain water, and all these characteristics lead to an increase in vegetative growth (Akanbi *et al*., 2005, Shaheen *et al*., 2007, Abdel-Mouty *et al*., 2011), or the reason for this increase may be due to the high content of important nutrients for the plant in tea residue, and among these nutrients is potassium, which is important in the formation of carbohydrates and proteins and in strengthening plant tissues. Also, tea residue contains nitrogen, which is involved in the growth of buds and the formation of proteins, which leads to an increase in the vegetative growth of the plant (Harline, 2003 , El- Etr *et al*., 2004 and Siti Maryam *et al*., 2006) and this is consistent with what was reached by Abdel-Rasoul *et al*. (2013) in an experiment on maize plant when tea residues were added at levels (0%, 1%, 2%), which led to a significant increase in plant length with increased levels of tea residue, as well as consistent with what was found by Aziez *et al*. (2022) in a study on pepper plants when tea residue was added at levels (0, 10, 20, 30, 40) ton ha^{-1}, which led to an increase in the number of branches when treating 40 ton ha^{-1} compared to the control treatment. The superiority of Mp treatment in the fruit content of phenolic compounds (caffeic acid and gallic acid) and the alkaloid capsaicin to the role of organic fertilizers (animal and plant waste) in lowering soil pH and increasing the effectiveness of microorganisms, which led to an increase in the nutrients needed by the plant, and their ease of absorption by the roots, including potassium, which has an effective role in the transpiration process through its control of opening and closing of the stomata which increases the gaseous exchange and preserves the water balance, thus activating the photosynthesis process, thus increasing the different metabolites and their transfer to the parts of the plant, which leads to an increase in the proportion of phenolic compounds and the alkaloid capsaicin in the fruits of ornamental pepper (Sahaf *et al*., 2011, Tejada *et al*., 2016). Mp treatment increases some of vegetative growth characteristics, which led to an increase in the activity of vital processes, especially the process of photosynthesis as a result of the increase in ready-made nutrients absorbed by the plant, and thus an increase in nutrients processed in the leaves and

transferred to the parts of the plant, which leads to an increase in the chemical content in the fruits (Barker and Pilbeam, 2015). The Mc treatment, combination of organic fertilizers (63 cm^3 tea residue + 63 cm^3 poultry manure) also excelled in characteristic of leaf area compared to the comparison treatment Ms (soil only). The reason may be due to the role of poultry manure that regulates the effectiveness of plant hormones controlling the growth and division of main cells, this increased the leaf area (Table 1), and this was confirmed by Al-Nasirawi (2015) in his study on the pepper plant when poultry manure was added at the level of (0%, 3%, 5%) of the soil volume, which resulted in an increase in the leafy area at treatment 5%.

Table (1) Effect of added organic fertilizers on the growth characteristics and active ingredient of ornamental pepper plant

organic fertilizers blend	Plant length cm	Number of branches branch $plant^{-1}$	Leaf area cm^2	Gallic acid mg g^{-1}	Caffeic acid mg g^{-1}	Capsaicin mg g^{-1}
Ms	12.237c	5.806b	3.4233c	96.341d	45.636d	482.167d
Mp	16.750a	8.833a	6.0822ab	106.006a	53.117a	638.811a
Mc	15.879ab	8.579a	6.9478a	104.367b	51.861b	620.500b
Ml	13.834bc	8.706a	5.0511b	102.205c	49.570c	582.300c

Numbers with the same letters of the alphabet are not significantly different according to Duncan's multiple range test at the probability level of 0.05.

(Table 2) shows that there are no significant differences when spraying seaweed extract in the characteristics of vegetative growth (leaf area , plant length, number of branches), while spraying extract of seaweed at a concentration of 1 g L^{-1} was significantly superior in the fruit content of phenolic compounds (Caffeic acid and gallic acid) and the alkaloid compound capsaicin, The reason may be due to what the seaweed extract contains of natural hormones such as auxins, gibberellins, and cytokinins, which have an effective role in stimulating physiological and vital processes, thus increasing the products of metabolic processes, including secondary metabolites, which increases their accumulation inside the fruits (phenolic compounds and alkaloids) (Thirumaran *et al*., 2007), and these results were consistent with the findings of Ashour *et al*. (2021) in a study to determine the effect of spraying with marine extract at a concentration of 0%, 0.25%, 0.5%, 1% on sweet pepper plants, Where thay found that spraying seaweed extract at a concentration of 1% led to a significant increase in phenolic compounds compared to the control treatment, and agrees with Zamljen *et al*. (2021) in an experiment on pepper plants that led to an increase in phenolic compounds and capsaicin when sprayed with seaweed extract at a concentration of 0.2%.

Table (2) Effect of spraying seaweed extract on the growth and active ingredient of ornamental pepper plant

Seaweed	Plant length cm	Number of branches branch plant^{-1}	Leaf area cm^2	Gallic acid mg g^{-1}	Caffeic acid mg g^{-1}	Capsaicin mg g^{-1}
F0	14.7700a	8.451a	5.3575a	99.008c	47.564c	529.700c
F1	14.0750a	6.942a	5.2967a	103.133b	50.617b	592.808b
F2	15.1800a	8.550a	5.4742a	104.549a	52.092a	620.325a

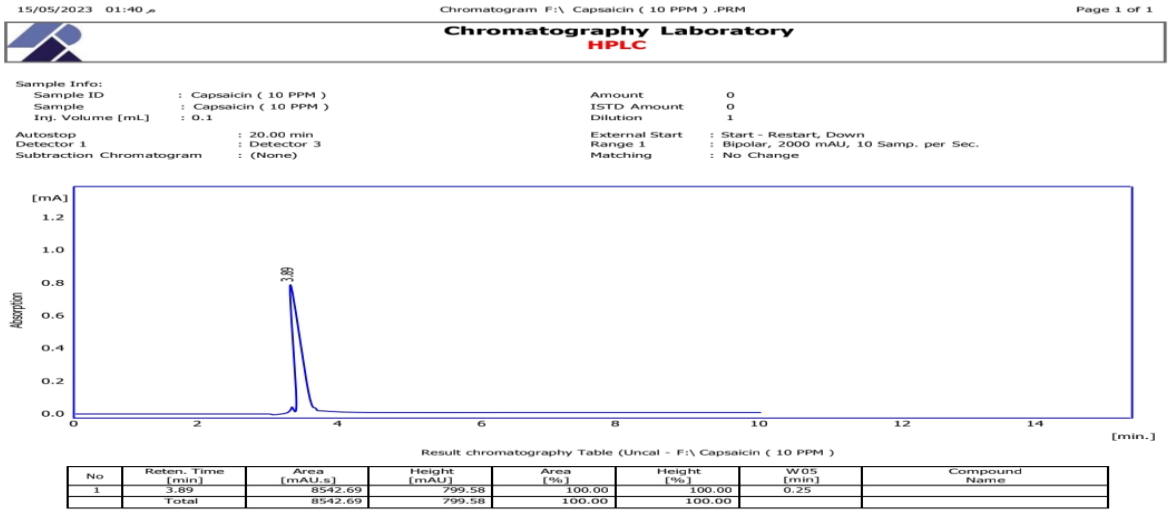
Numbers with the same letters of the alphabet are not significantly different according to Duncan's multiple range test at the probability level of 0.05.

As for the interference effect, the combination of organic fertilizers (Mc) and F2 spraying extract of sea weed at a concentration of 1 g L^{-1} (Table 3) gave a significant superiority in the characteristics of plant height, the leaf area and number of branches of the plant, as it reached 18.083 cm, 12.083 branch Plant^{-1}, 7.610 cm^2, respectively compared with the treatment of interaction between soil only and spraying with seaweed at a concentration of 0.5 g L^{-1}, which gave the lowest values in the aforementioned traits, reaching 11.267 cm, 4.583 branch plant^{-1}, 2.693 cm2, respectively. The interaction treatment between (Mp) and F2 spraying with extract of seaweed at a concentration of 1 g L^{-1} excelled in the fruit content of phenolic compounds (caffeic acid and gallic acid) and the alkaloid capsaicin, as it reached 108.563 mg g^{-1}, 55.883 mg g^{-1}, 687.967 mg g^{-1} respectively, compared with the interaction treatment between Ms soil only and F0 (spraying with water only) which gave the lowest value (95.353 mg g^{-1}, 44.336 mg g^{-1}, 453.067 mg g^{-1}), respectively.

Table (3) The effect of the interaction between the combination of organic fertilizers and spraying with sea extract on the growth and active ingredient of ornamental pepper plant

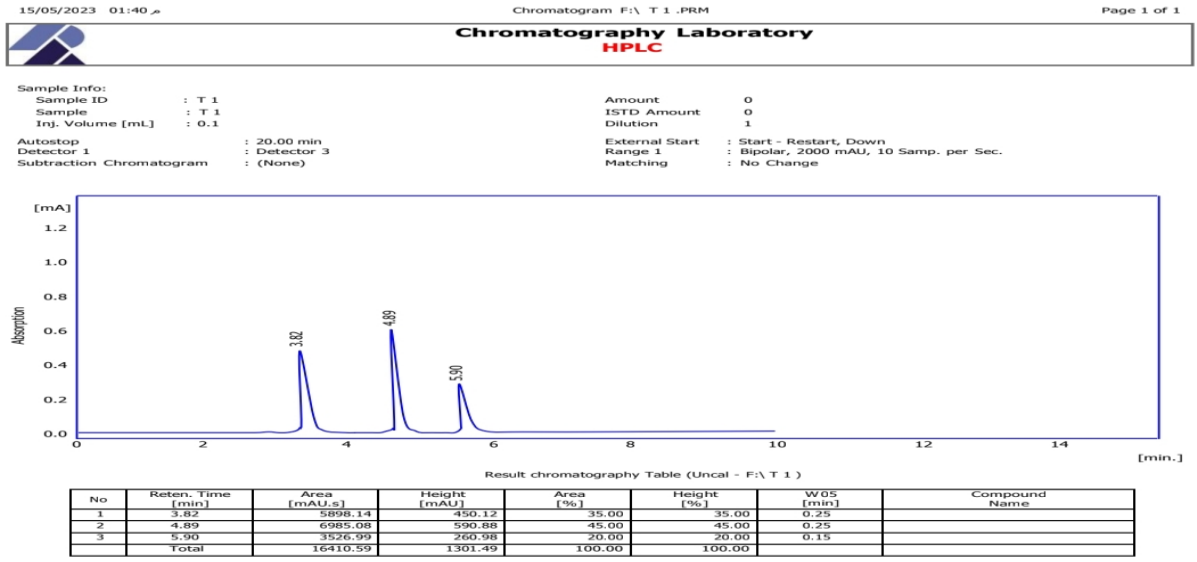
Fertilizers and extract interaction	Plant length Cm	Number of branches branch plant^{-1}	Leaf area cm^2	Gallic acid mg g^{-1}	Caffeic acid mg g^{-1}	Capsaicin mg g^{-1}
F0 Ms	12.027cd	7.250abc	3.173de	95.353l	44.336l	453.067l
F1 Ms	11.267cd	4.583c	2.693e	96.186k	45.813k	489.300k
F2 Ms	13.417abcd	5.583c	4.403bcde	97.483j	46.760j	504.133g
F0 Mp	17.333ab	10.750ab	5.723abcd	102.550g	49.806g	570.967c
F1 Mp	16.833ab	7.750abc	7.130ab	106.906c	53.663c	657.500c
F2 Mp	16.083abc	8.000abc	5.393abcd	108.563a	55.883a	687.967a
F0 Mc	15.637abcd	7.470abc	6.173abc	99.660h	48.670h	553.967h
F1 Mc	13.917abcd	6.183bc	7.060ab	105.873d	52.653d	633.333d
F2 Mc	18.083a	12.083a	7.610a	107.570b	54.260b	679.200b
F0 Ml	14.083abcd	8.333abc	6.360ab	98.470i	47.443i	540.800j
F1 Ml	14.283abcd	9.250abc	4.303cde	103.566f	50.340f	591.100f
F2 Ml	13.137cd	8.533abc	4.490bcde	104.580e	51.466e	615.000e

Numbers with the same letters of the alphabet are not significantly different according to Duncan's multiple range test at the probability level of 0.05.



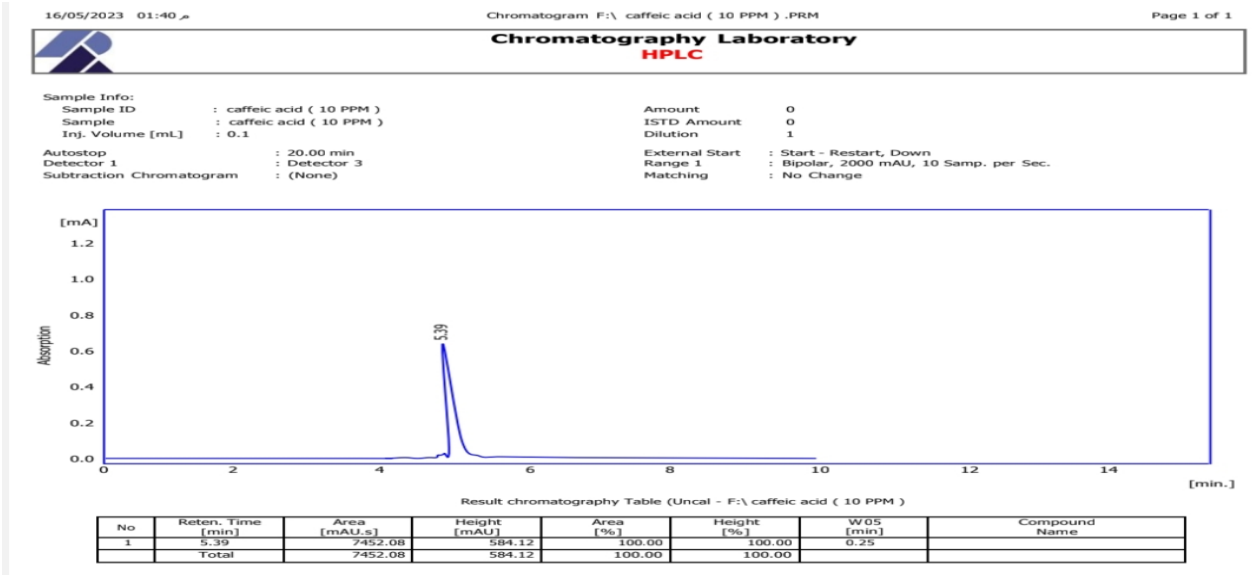
No	Reten. Time [min]	Area [mAU.s]	Height [mAU]	Area [%]	Height [%]	W05 [min]	Compound Name
1	3.89	8542.69	799.58	100.00	100.00	0.25	
	Total	8542.69	799.58	100.00	100.00		

Fig 1. Fluid behavior, retention time and peak area of the Standard model



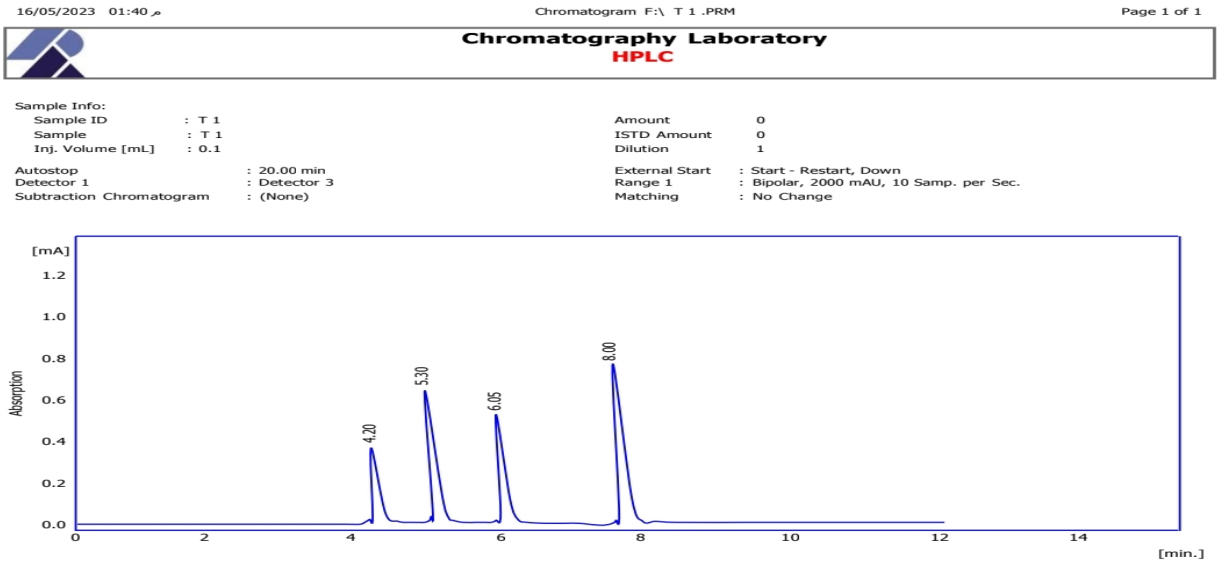
No	Reten. Time [min]	Area [mAU.s]	Height [mAU]	Area [%]	Height [%]	W05 [min]	Compound Name
1	3.82	5898.14	450.12	35.00	35.00	0.25	
2	4.89	6985.08	590.88	45.00	45.00	0.25	
3	5.90	3526.99	260.98	20.00	20.00	0.15	
	Total	16410.59	1301.49	100.00	100.00		

Fig 2. Capsaicin behavior, retention time, and treatment peak area (MsF0)



No	Reten. Time [min]	Area [mAU.s]	Height [mAU]	Area [%]	Height [%]	W05 [min]	Compound Name
1	5.39	7452.08	584.12	100.00	100.00	0.25	
	Total	7452.08	584.12	100.00	100.00		

Fig 3. Behavior of gallic acid, retention time and peak area of the Standard model



Result chromatography Table (Uncal - F:\ T 1)

No	Reten. Time [min]	Area [mAU.s]	Height [mAU]	Area [%]	Height [%]	W 05 [min]	Compound Name
1	4.20	5985.08	360.14	15.00	15.00	0.15	
2	5.30	13698.00	590.41	25.00	25.00	0.20	
3	6.05	11258.98	560.44	22.00	22.00	0.20	
4	8.00	18985.36	730.55	38.00	38.00	0.25	
	Total	49927.15	2241.59	100.00	100.00		

Fig 4. Gallic and Coffee acid block, retention time, and cycle area of the treatment (MsF0)

CONCLUSION

It is concluded from this experiment that the addition of a combination of organic fertilizers (tea residue, sheep waste, poultry waste) had a significant effect on the vegetative growth characteristics, and spraying with seaweed extract had no significant effect on the vegetative growth characteristics, while the addition of a combination of organic fertilizers (poultry waste, residue tea, sheep waste) and spraying with extract of sea weed, either alone or in combination, had a significant effect on the qualitative characteristics of ornamental pepper fruits

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