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Improving the Vegetative Growth and Chemical Contents of Coriander (*Coriandrum sativum* L.) Plant by Using Moringa Leaf Extract.

Omaima M. Abd-ElKafie[1]; Mahassen M. Sidky[2]; M. M. Kasem[1] and Shaimaa M. Abd-ElBaki[1]
[1]Veget. & Floric. Dept., Fac. Agric., Mansoura Univ.
[2] Hort. Res. Inst. Agric. Res. Center

ABSTRACT

This study was conducted to enhance the vegetative growth, fruits yield and chemical constituents of the coriander plant, in a trial to reducing the residual effects of the chemical fertilizers. Two methods for moringa leaf extract (cold or boiled extract) with different dilutions (25, 50, 75 and 100%) beside the distilled water as the control were used. The results cleared that the superior plant dry weight, N, P and K% in leaves were recorded by using the boiled MLE at 100%. In addition, the heaviest seed index (weight of 1000 fruits) was recorded by using the boiled MLE at 75%. In addition the maximum essential oil percentage was recorded by using 100% from the boiled or the cold MLE and linalool was the main component in the essential oil.
Keywords: moringa leaf extract (MLE), coriander and methods of leaf extract.

INTRODUCTION

Coriander (*Coriandrum sativum* L.) belongs to the family *Apiaceae.* It is an aromatic herb, annual medicinal and spice plant, cultivates in the winter or the summer, depending on the climatic conditions and it is native to Mediterranean regions. Its cultivation is widespread in many countries surround the world. The traditional uses of coriander plants are culinary or medicinal based on the plant green herb or the dry fruits Ramadan and morsel (2002). Coriander fruit considered a usable raw material, in the applied therapeutics such as a stimulant for digestion, and improving the flavor of many dishes. Fruit essential oil is the main bioactive compound of coriander, which being a mixture of many terpenes, from which the greatest significance has linalool and geraniol Smallfield *et al.,* (2001) and valuable raw materials in the perfume industry. It has been recommended for loss of appetite, dyspeptic complaints, convulsion, indigestion, insomnia, 3carminative, diuretic, rheumatism, against worms tonic and stomachic. Moreover, the essential oils possess antioxidant anti-diabetic, anti-bacterial, anti-mutagenic activities and anti-cancerous Melo *et al.,* (2003).

Moringa is a very important plant having miscellaneous allelopathic potential Fuglie (1999). Its water extract could enhance or improve the plant growth, if it applied as a foliar spray with low concentrations Phiri (2010).This promoting effect may be due to its content from various second metabolites or allelochemicals such as ascorbates, phenols Foidle *et al.,* (2001) or it's the content of natural cytokinins (zeatin) Fuglie (2000). Moreover, its leaves had been reported to contain 7 x the Vitamin C of Oranges, 4 x the Calcium of Milk, 4 x the Vitamin A of Carrots, 3 x the Potassium of Bananas, and 2 x the Protein of Yogurt) Fuglie *et al.,* (1999). In addition, it considers a big house store from a lot of minerals like K, Ca and Fe that makes it an excellent crop growth promoter. Also, moringa has quercetin, b-sisterol, caffeoylquinic acid and kaempferol which produced the antibacterial and antifungal activities Anjorin *et al.,* (2010). The main advantage of these natural fertilizers is that they do not pollute the soil and also do not show any negative effect on the environment and human health.

So the aim of this investigation to study the effects of moringa leaf extract as biotic elicitor under different diluted concentrations to enhance the vegetative growth, fruits yield and chemical constituents of the coriander plant, in a trial to reduce the residual effects of the chemical fertilizers.

MATERIALS AND METHODS

This study was carried out at the nursery of ornamental plants Fac. of Agric. Mansoura Univ. during 2013/2014 and 2014/2015 seasons to investigate the response of coriander plant to the foliar application of two water extract types of moringa (*Moringa oleifera* L.) leaf.

1: Plant Material

Coriander seeds were obtained from a local market in El-Mansoura City. The experiment was achieved on rows of 70 cm wide and 10 m length for each treatment. Space between every two hills was 25 cm and uncultured row remained between each two treatments. Each treatment consists of three replicates, each contained five hills. A total nine cultured rows consisted all the experiment treatments. After the full germination, hills were thinned to approximately four plants per hill when seedlings reached approximately 10cm in height. the process of irrigation was performed as usual with adding a basal NPK (20:20:20) after 2 weeks from the full germination.

2: Moringa leaf extracts (MLE) preparation.

Two methods for moringa leaf extracts were conducted. Since fresh moringa leaves (1 kg) of mature trees were collected, then leaves were washed and mixed with 1 liter distilled water by an electric blender, this extract was diluted with distilled water at a ratio of 1:30 (w/v) Nouman *et al.,* (2012). Half of the previous extract was boiled. On the other side, the other one from the previous extract preparation were used except that it does not boil and kept in the refrigerator at 4°C for 24 h. Then, the two extracted leaves were filtrated through sterilized cheesecloth and their chemical contents were analyzed and shown in Table (2). Finally, four diluted concentrations from each extract (boiled and cold) were prepared with the control one (distilled water), then it sprayed directly on the plants.

3: Experimental Design

A total nine treatments were arranged in a complete randomize block design with 3 replicates, as two water extract type of moringa leaves (boiled and cold extract) were used at four concentrations (25, 50, 75 and 100%), plus the control (distilled water) as a

foliar application which sprayed three times, at 30, 45 and 60 days after sowing.

Table 1. Chemical analysis of moringa leaf extract.

Sample Method	Conc.	mg/l N	P	K
Cold	25%	27.3	4.66	53.4
	50%	48.2	8.95	107.8
	75%	71.4	12.99	153.6
	100%	92.6	17.38	198.2
Boiled	25%	31.8	6.08	60.1
	50%	56.3	11.22	115.9
	75%	56.9	17.05	176.1
	100%	109.7	21.65	227.4

Chemical analysis of MLE was performed for determining its contents (Table1) and the soil sample also was analyzed and presented in Table (2).

Table 2. Chemical and mechanical analysis of the experimental soil.

Items		Value
Mechanical analysis (%)	Coarse sand	3.22
	Fine sand	21.37
	Silt	43.25
	Clay	32.16
	Texture class	Sandy Clay loam
E.C. $dS.m^{-1}$(1:5)		1.05
pH(1:2.5)		7.87
S.P%		48.5
O.M%		1.62
$CaCO_3$%		3.77
Available (mg/kg)	N	48.2
	P	4.35
	K	1.85

4: Data recorded

Vegetative growth characteristics; Plant height (cm), branches number/hill and herb dry weights (g)/hill were determined

Fruit parameters; umbels number/hill, fruits yield (g)/hill and seed index (weight of 1000 fruits).

Chemical determinations; N, P, K %, total carbohydrates in the plant tissues at the start of the flowering stage, beside the total chlorophyll were measured. The Nitrogen was determined according to AOAC (1984), phosphorus was estimated according to Jackson (1973) and potassium was determined according to Peterburgski (1968). Also, the total carbohydrates (%) in leaves were determined according to the method described by Sadasivam and Manickam (1996). Finally, the total chlorophyll in leaves were determined according to Mackinney (1941).

Essential oil determinations: The essential oil percentage was calculated as follows :

$$\text{Oil percentage} = \frac{\text{Volume of oil in graduated tube (ml)}}{\text{Weight of sample}} \times 100.$$

For determining the essential oil% dried fruits were subjected to the hydro distillation by using the modified Clevenger traps in British pharmacopeia (2000)

Essential oil constituents (%)

The volatile oil obtained from the dried fruits of five treatment samples (control, 75% cold, 100% cold, 75% boiled and 100% boiled MLE) in the second season only was analyzed using Ds Chrom6200Gas Chromatograph,

5: Statistical analysis

Data were subjected to analysis of variance (ANOVA) using Genstat v 11.1, 2008. Mean comparisons were performed by using the least significant differences methods (L.S.D), according to Gomez and Gomez (1984). A significant level of 0.05 was adopted for all statistical analysis for both seasons.

RESULTS AND DISCUSSION

1: Vegetative growth parameters

Data in Table (3) indicate that applying the foliar spray of the cold moringa leaf extract at concentration of 100% produced the tallest plant height than all of the other treatments, since it recorded 88.67 cm, during the first season, followed by the values of 85.00 and 85.33cm for coriander plants which sprayed with the cold and boiled MLE at 50%. On contrast, the control plants which treated with the distilled water and boiled 100 recorded the shortest plants recorded 71.00 and 71.33cm. Moreover, similar results were obtained in the second season. These findings were in agreement with Abdalla (2013) which considered the increase in plant length in rocket (*Eruca vesicaria* sub sp. *sativa*) plants due to the fertilization with the MLE. In addition, this may be due to its high component from N percentage which has been shown inTable (1).

Regarding the effect of MLE type and concentration on the branches number, data in the same Table (3) clear that all of the cold extracts concentration giving a positive increment in this parameter than the other extraction method (boiled extract) in both seasons, as it was the superior in gaving values ranged from 27.00 to 31.67 branch/hill and the other one ranged from 20.33 to 21.67 branch/hill. Similar results were obtained during the second season, since it was obvious that insignificant differences were shown inside most of the cold extract concentrations (25, 50, and 75%). On contrast, the lowest branches number value recorded using the boiled MLE at 75%.

Similar trends which obtained with the plant height and the branches number were also observed with the herb dry weight, as the data in same Table (3) show 25.20 and 26.88 or 26.34 and 27.95 g/herb dry weight/hill, during the first and the second season by using 100% cold and boiled extract, respectively. It was obvious that the boiled moringa leaf extract was the superior to the other treatments in this parameter. This result matches with Mishra *et al.,* (2013). In addition, the control plants in the two examined season, significantly recorded the lowest values of 17.05 and 18.69 g/hill, respectively when compared with most of the other treatments. In a similar way Balakumbahan and Rajamani (2010), Prabhu *et al.,* (2010) recorded similar results when they applied the MLE at 2 or 4% on senna plants and sacred basil, respectively. As they concluded that spraying 2% of MLE was more effective than 4% and raised all the measured growth parameters above the control plants (plant height, dry weight, branches number). The reason for this acceleration of growth may be due to the high content of moringa leaf

extracts from the crude proteins (43.5%) and the growth promoting hormones like auxins and cytokinins Moyo *et al.,* (2012) and Makkar and Becker (1996). In addition, it was known that the proteins are essential for formation of the protoplasm, while the growth hormones favored rapid cell division, cell multiplication and enlargement

Table 3. Effect of different extraction methods and concentrations of moringa leaf extract on plant height (cm), branches number/hill and herb dry weight (g)/ hill.

Moringa extract		Plant height (cm)		Branches number/ hill		Herb dry weight(g)/ hill	
Method	%	1st	2nd	1st	2nd	1st	2nd
Control	0	71.33	73.33	26.67	25.33	17.05	18.69
Cold	25	78.33	93.67	27.00	29.00	18.14	19.81
	50	85.00	76.67	29.33	31.67	20.56	22.06
	75	84.33	86.67	30.76	28.67	22.83	24.44
	100	88.67	101.33	31.67	21.67	25.20	26.88
Boiled	25	82.33	87.67	20.33	22.67	19.40	22.69
	50	85.33	88.67	21.67	20.33	21.75	23.22
	75	79.67	90.67	20.33	19.00	24.04	25.74
	100	71.00	84.67	21.00	20.67	26.34	27.95
L.S.D at 5%		7.25	6.59	6.59	4.64	0.18	1.65

2. Fruit parameters:

Data in Table (4) clear that 50 and 100% cold extract significantly recorded the highest values (73.33 and 79.17) in the first season and (79.16 and 78.30) in the second season than all treatments. It could be observed that spraying the cold extract at all concentrations used produced the highest values than the boiled extracts

Concerning data in the same Table (4) it was obvious that spraying the cold MLE at 100% produced the heaviest fruits yield g/hill recording 37.51 and 32.51 g /hill followed by the values of the cold MLE at 50 and 75% recording values ranged from 34.04 to 26.56 g /hill with insignificant differences between them. On the other hand, the boiled MLE at 25% recorded the lowest value in the first season and the cold one recorded the lowest in the second season in that characteristic comparing with the others.

Table 4. Effect of different extraction methods and concentrations of moringa leaf extract on umbels number/hill, fruits yield (g)/hill and seed index of coriander plant in the two seasons.

Moringa extract		Umbels number /hill		fruits yield (g)/hill		Seed index	
Method	%	1st	2nd	1st	2nd	1st	2nd
Control	0	61.67	63.33	23.11	20.95	7.64	7.64
Cold	25	67.50	72.50	21.89	20.23	8.74	8.72
	50	73.33	79.16	34.04	26.56	10.19	9.44
	75	67.67	71.66	33.09	30.51	9.76	10.12
	100	79.17	78.30	37.51	32.51	9.93	10.63
Boiled	25	50.83	56.66	21.51	26.00	8.11	8.05
	50	54.16	50.83	30.64	24.21	8.77	8.70
	75	50.83	47.50	30.30	28.11	11.44	11.83
	100	52.50	51.66	27.30	27.05	8.82	8.56
L.S.D at 5%		9.16	11.92	7.71	8.05	2.66	2.75

Concerning 1000 fruits weight, data in Table (4), clear that spraying the boiled MLE at 75% produced the highest values of 11.44, 11.83 during the first and the second season, respectively followed by the values of the cold MLE at 50, 75, 100% with no significant difference between them. Similar results were obtained during the second season. In general, it could be observed that most of the other extract concentrations had an insignificant difference between them in this parameter. While the control plant produced the lowest values during the two seasons in this character. The fruits weight increase in plants sprayed with a foliar application of MLE was probably due to the presence of high endogenous levels of cytokinins like zeatin, kinetin, etc. resulting in the increase of the fruit size and the number of the umbel. MLE contains major and minor nutrients, amino acids, vitamins, and also cytokinins, auxins, and abscisic acid (ABA) like growth substances Foidle *et al*., (2001). This finding may be due to the potential promoting process of the moringa on the vegetative growth and the fruit yield Mohamed *et al*., (2013) and Azra *et al*., (2013).

3: Chemical constituents:

Data in Table (5) indicate that applying the foliar spray of the boiled MLE at a concentration of 100% significantly produced the highest values of nitrogen percentage 4.33, 4.24 on the first and the second seasons, followed by the values of 4.23, 4.15 with using the cold MLE at 100%. On contrast, the lowest value of N% was recorded by using the control in the both seasons. It could be observed an ascending increase in the nitrogen percentage by increasing the concentrations of the moringa extract in the two extraction methods.

Concerning data in the same Table (5) indicate that applying the foliar spray of the boiled or the cold MLE at a concentration of 100% significantly produced the highest values of phosphors 0.52 on the first season. On the other side, the lowest P percentage recorded by the control in both seasons (0.46 and 0.43). This may be a result of moringa high content from the essential minerals such as Ca, Mg, K, Fe, Zn, P, S, Cu, Mn, Se and Na which can be valorized for a balanced nutrition of plants Moyo *et al*., (2011) and Yameogo *et al*., (2011).

Table 5. Effect of different extraction methods and concentrations of moringa leaf extract on N P K% of Coriander plant in the two seasons.

Moringa extract		N%		P%		K%	
Method	%	1st	2nd	1st	2nd	1st	2nd
Control	0	3.70	3.55	0.46	0.43	4.40	4.61
Cold	25	3.76	3.66	0.46	0.44	4.52	4.75
	50	3.93	3.81	0.49	0.46	4.68	4.95
	75	4.04	3.96	0.50	0.47	4.83	5.08
	100	4.23	4.15	0.52	0.49	4.97	5.26
Boiled	25	3.86	3.74	0.47	0.45	4.58	4.86
	50	3.99	3.90	0.49	0.47	4.72	5.00
	75	4.16	4.08	0.51	0.48	4.92	5.18
	100	4.33	4.24	0.52	0.50	5.07	5.26
L. S.D at 5%		0.08	0.07	0.01	0.01	0.07	0.07

Regarding the effect of MLE type and concentration on K percentage, data in Table (5), show that the increase in K percentage values was combined with the increase in the concentration of the moringa extract in the two extraction methods. So the highest percentage of 5.07 and 4.97% were recorded by using the boiled MLE and the cold MLE at 100% in the first season, respectively and the same results were shown in the second season since the highest percentage of 5.26 was recorded by using the boiled and cold MLE at 100%. Several comparable studies confirmed the current data. For instance, Schuphan (2005), Noori *et al*., (2010), Sivakumar and Ponnusami (2011) and Abdalla and El-Khoshiban (2012) realized the increment uptake and accumulations of some nutritive elements as N, P, K, Ca, Mg as well as Fe in roots and shoots of several plants under investigation as a consequence of organic fertilization from different sources (plant and animal source) including MLE.

As for effect of the moringa leaf extraction methods and their concentrations on total carbohydrates and chlorophyll, data in Table (6) showed that using the boiled method at 100% produced the highest value of total carbohydrates of 48.65 % followed by the cold extract at 100% recording 48.39% in the first season. On contrast, the lowest total carbohydrates percentage of 46.74 % recorded by using the control (distilled water) treatment. Moreover, a similar result with much-closed values was obtained in the second seasons.

Table 6. Effect of different extraction methods and concentrations of moringa leaf on Total carbohydrates and total chlorophyll of coriander plant in the two seasons.

Moringa Extract Method	%	Total carbohydrates% 1st	Total carbohydrates% 2nd	Total chlorophyll (mg/g. f.w) 1st	Total chlorophyll (mg/g. f.w) 2nd
Control	0	46.74	47.97	2.53	2.64
	25	47.28	48.35	2.42	2.06
	50	47.35	48.76	2.95	3.42
Cold	75	47.93	49.18	2.77	2.17
	100	48.39	49.74	2.55	2.72
	25	47.28	48.42	2.61	2.51
	50	47.66	49.02	3.36	3.50
Boiled	75	48.15	49.47	1.39	1.48
	100	48.65	49.95	1.80	1.32
L.S.D 5%		0.35	0.18	0.46	0.51

It was obvious from data in Table (6) that using the boiled MLE at 50% produced the highest total chlorophyll of 3.36 and 3.50 mg/g. f.w., followed by 2.95 and 3.42 with no significant difference when the cold MLE was used at 50% in both seasons, respectively. On the other hand, the lowest total chlorophyll content of 1.39 was recorded by using the boiled MLE at 75%, followed by 1.80 mg/g.f.w. in the first season. On contrary, Abou-Zeid and El-Darier (2014) proved that there was an inverse proportional relationship between increasing the severity of different percentages of M. oleifera extract on one hand, and leaves content from chlorophyll a and b, and total chlorophyll on the other hand and this may differ from plant to other. Some reports mentioned that moringa leaf possesses plant nutrients and antioxidants in considerable amounts Yang *et al*., (2006) and improve the leaf chlorophyll contents under salinity by modulating enzymatic and non-enzymatic antioxidants, total soluble proteins, increased leaf K contents with decreased Na and Cl Azra *et al*., (2013). Moreover, the foliar application of moringa extracts prevents the premature leaf senescence and resulting in more leaf area with higher photosynthetic pigments Rehman and Basra (2010).

Data presented in Table (7), show the effect of the two methods of moringa leaf extract on essential oil percentage. Such data clearly indicate that the percentage of the essential oil had significantly affected by increasing the concentration in the two methods of extraction, since the superior values was obtained by using cold and boiled extract at 75% and 100% with insignificant differences between them during the two seasons. The increment in essential oil yield might be due to the increase in vegetative growth, nutrients uptake or changes in the size of vittae in fruits and monoterpenes biosynthesis. In accordance, essential oil yield of *Coriandrum sativum* increased with increasing rates of N and P application Tiwari and Banafar (1995).

Table 7. Effect of different extraction methods and concentrations of moringa leaf on the essential oil (%)/100(g) dry seeds of coriander plant in the two seasons.

Moringa extract Method	Conc.	Essential oil% 1st	Essential oil% 2nd
Control	0	0.10	0.08
	25	0.10	0.10
	50	0.10	0.10
Cold	75	0.20	0.18
	100	0.30	0.27
	25	0.10	0.10
	50	0.10	0.10
Boiled	75	0.19	0.07
	100	0.28	0.30
L.S.D 5%		0.14	0.12

GLC analysis of the fruits volatile oils was illustrated in Table (8), Figures (1 to 5) which indicated that α –pinene, β-pinene, p-cymene, linalool, geranial, borneol, linalyl acetate, and geranyl acetate were identified in all treatments. Linalool was the main component in all the tested treatments as it showed the highest values in relation to the other components. The highest percentage of linalool was obtained from the boiled MLE at 75 or 100%. α –pinene was higher when the cold MLE at 100% was used. Although, the clod MLE at 75% recorded the superior values in some components like β-pinene, p-cymene, and geranial even the components of borneol recorded 4.94 in a case of using the cold method at 100% and the same recorded the highest in Linalyl acetate followed by the boiled MLE at 75%. Geranyl acetate is known in all of the cold and the boiled treatments except the cold or the boiled 100%.

Table 8. Effect of different extraction methods and concentrations of moringa leaf on the essential oil components in dry seeds of coriander plant.

MLE methods	Control	cold		Boiled	
Components	(D.W)	75%	100%	75%	100%
α –pinene	٣.٤٢	٣.٢٦	٣.٤٤	١.٤٩	2.33
β-pinene	١.٥٦	٣.٦٠	١.٥٧	١.٤٢	1.51
p-cymene	١.٣٢	٣.٦٦	١.٣٢	١.٢٠	1.30
Linalool	٧٨.٣٧	٧١.٧٦	٧٨.٦٣	٨٠.٣٥	83.61
Geranial	٢.٩٨	٣.٠٨	٢.١٠	٢.٩٨	2.97
Borneol	٢.٠٩	٢.١٧	٤.٩٤	٢.١٦	2.20
Linalyl acetate	٤.٩٠	٤.٧٦	٦.٦٣	٥.٠٢	4.99
Gernyl acetate	٣.٦٠	٣.٢٠	-	٣.٧٠	-
Known	٩٨.٢٤	٩٥.٤٩	٩٨.٦٣	٩٨.٣٢	98.91

Generally, the active reaction of moringa leaf extract on the vegetative growth, fruit parameters and the chemical components of the coriander plant may be due to its nutrients content. As a medicinal plant, the leaves extracts of M. *oleifera* provides a rich and rare combination of zeatin Anjorin *et al*., (2010)

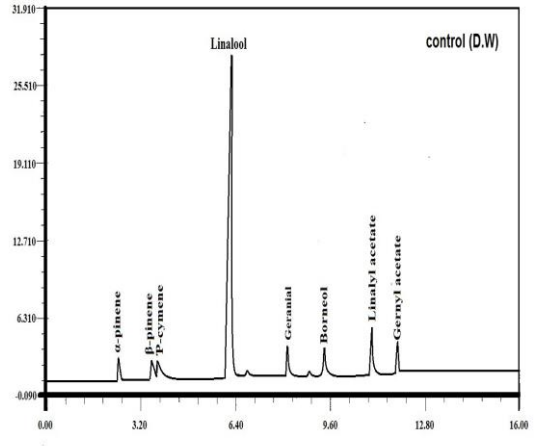

Figure 1. G.L.C. chromatogram analysis of coriander oil constituents (%) on the control (D.W).

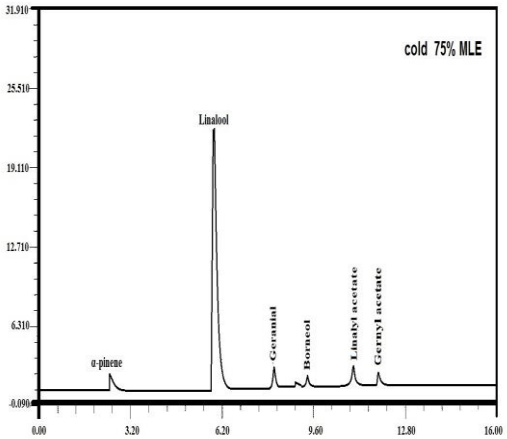

Figure 2. G.L.C chromatogram analysis of coriander oil constituents on the cold MLE extract 75%.

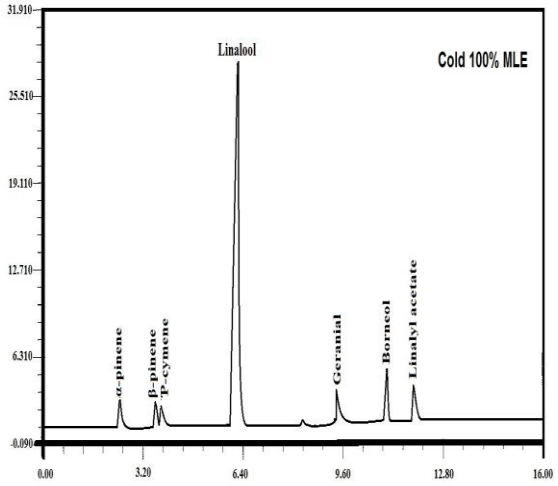

Figure 3. G. L.C. chromatogram analysis of coriander oil constituents on the cold MLE extract 100%.

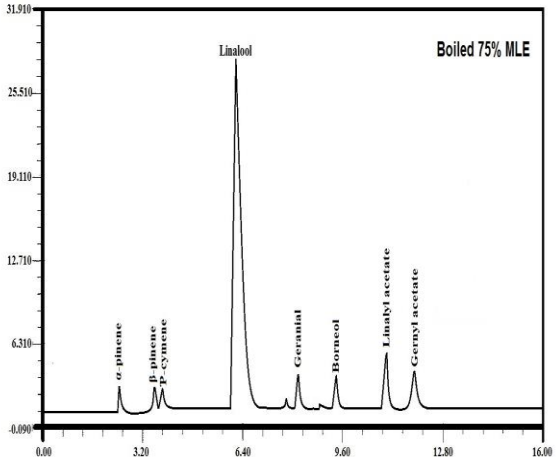

Figure 4. G.L.C chromatogram analysis of coriander oil constituents on the boiled MLE extract 75%.

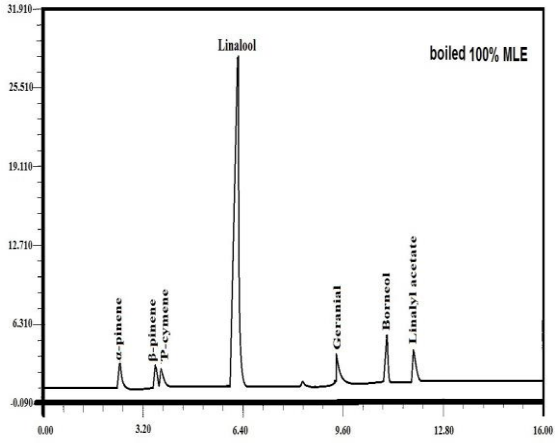

Figure 5. G.L.C. chromatogram analysis of coriander oil constituents on the boiled MLE extract 100%.

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تحسين النمو الخضري والمحتوي الكيماوي لنبات الكزبره باستخدام مستخلص المورينجا.

اميمه محمد عبد الكافي[١], محاسن عبد الغنى صدقى[٢] , محمود مكرم قاسم[١] و شيماء مجدي عبدالباقي[١]

[١] قسم الخضر والزينه _كليه الزراعه.

[٢] معهد بحوث البساتين –قسم النباتات الطبيه والعطريه –الدقي.

تمت هذه الدراسه بهدف حث وتحسين النمو الخضري ومحصول الثمار والمحتوي الكيماوي لنبات الكزبره كمحاوله لتقليل الاثر المتبقي من استخدام الاسمده الكيماويه. تم استخدام طريقتين للاستخلاص المائي لاوراق المورينجا (علي البارد والساخن) مع تخفيفات مختلفه (٢٥ , ٥٠ , ٧٥ , ١٠٠) بالاضافه للماء المقطر كمعامله الكنترول اوضحت النتائج ان افضل وزن جاف للعشب واعلي نسبه مئويه للنيتروجين والفسفور والبوتاسيوم تم تسجيلها عند استخدام مستخلص اوراق المورينجا المغلي بتركيز ١٠٠% بالاضافه لذلك فان اثقل وزن ١٠٠٠ بذره تم الحصول عليه عند استخدام المستخلص المغلي بتركيز ٧٥% كما ان اعلي نسبه مئويه للزيت تم الحصول عليها عند استخدام المستخلص المغلي او البارد لاوراق المورينجا بتركيز ١٠٠% وكان مركب اللينالول هو المركب الرئيسي بالزيت.