American Journal of Plant Biology
2019; 4(4): 46-56
http://www.sciencepublishinggroup.com/j/ajpb
doi: 10.11648/j.ajpb.20190404.11
ISSN: 2578-8329 (Print); ISSN: 2578-8337 (Online)

Effect of Ascorbic, Folic acids and Hibiscus Extract on Geranium (*Pelargonium graveolens*)

Tamer Farouk Ahmed El-Moghazy*, Esam Abd-Elkareem Abd-Elazeem Al-Azzony

Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt

Email address:
drtamerelmo051@gmail.com (T. F. A. El-Moghazy), esam.karm221@gmail.com (E. A. A. Al-Azzony)

*Corresponding author

To cite this article:
Tamer Farouk Ahmed El-Moghazy, Esam Abd-Elkareem Abd-Elazeem Al-Azzony. Effect of Ascorbic, Folic acids and Hibiscus Extract on Geranium (*Pelargonium graveolens*). *American Journal of Plant Biology*. Vol. 4, No. 4, 2019, pp. 46-56. doi: 10.11648/j.ajpb.20190404.11

Received: September 12, 2019; **Accepted**: September 29, 2019; **Published**: October 12, 2019

Abstract: The present investigation was carried out in Sabahia Horticulture Research Station, Alexandria, Egypt during 2015/2016 - 2016/2017 seasons to study the effect of foliar application with ascorbic acid, folic acid as well as hibiscus extract on quality of Geranium (*Pelargonium graveolens L.)*. Foliar application of ascorbic acid and folic acid as well as extract of hibiscus were sprayed twice in each cut (first spry before cut 60 days and second spray before cut 30 days). Treatments included: control "water only", ascorbic acid at (100 and 200 ppm), folic acid at (50 and 100ppm) and hibiscus extract at (5% and 10%). The essential oil (%) of Geranium was determined by hydro-distillation as well as the main constituents of the volatile oil were determined by (GC). The Results showed that, all treatments (tested) caused a great increase in vegetative growth, the essential oil (%), oil yield (ml/plant and L/Fed.) and active compounds; Citronerlol, Citronelly formate, Iso-menthone, B-caryophyllene and Geranyl formate, while it decreased α-pinene and Geraniol. In addition, ascorbic acid at 200ppm, folic acid at 100ppm and hibiscus extract at (5, 10%) are sharp efficacy on increasing the vegetative growth and volatile oil yield than other treatments. Furthermore, it could be illustrated that natural drying caused pronounced changes (acceptable) in the volatile oil% and main constituents.

Keywords: Geranium, Essential Oil, Ascorbic Acid, Folic Acid, Hibiscus Extract, Natural Drying

1. Introduction

Pelargonium graveolens L. (Geranium, family; Geraniaceae). Major areas of the production (about 5795 fed.) are primarily in mainly Bani Sweif (4057 fed.) followed by Giza (1500 fed.) and Minya (110 fed.) Governorates. Two harvests (cuts) are taken per year; a spring cut from April to June and a summer cut from September to October. Generally, the production averaged by 105581 ton in 2016 year [1]. The volatile oil of Geranium is widely used in the perfumery and cosmetic industries [2-4]. It is an indispensable aromatherapy oil since geranium oil and its major constituents citronellol, geraniol, and linalool [5]. Geranium volatile oil has also become important skin care oil because it is good in opening skin pores and cleaning oily complexions [6, 7]. This oil has also been found to have use in reducing pain due to postherpetic neuralgia, treating dysentery, hemorrhoids, inflammation, heavy menstrual flows, and cancer [6]. The French community is currently treating diabetes as well as diarrhea, gallbladder problems, gastric ulcers, jaundice, liver problems, sterility, and urinary stones with this oil [6, 8, 9]. Moreover furthermore, in Chinese homeopathy, it is thought to open up the liver chakra and promote the expulsion of toxins, helping to achieve a balanced body [10]. Also Geranium essential oil exhibited efficacy on keep the treated peach fruits during cold storage and market life periods [11].

Many biochemical effects of vitamins, one that has factor more recent attention is the improvement of yield and quality of many plants. And especially, enhancing growth and productivity will be of more importance to increase the yield [12-15]. Vitamin Ascorbic acid (C) has a regulatory role in promoting productivity in many plants such as pepper [16]. Balbaa and Talaat (2007) who concluded that with ascorbic acid, phenylalanine and ornithine treatments significantly increased plant height (cm) and number of branches/plant of Rosmary plants [17]. Thymus treated with phenylalanine,

tryptophan or ascorbic acid at different concentrations caused a significantly increment of plant height (cm) and number of branches/plant compared with untreated plants [18]. However, Ascorbic acid (vitamin C) is one Important from vitamins, it is play important roles in plant growth, cell division, cell wall ex-pansion, and other developmental processes [19-21]. And also is synthesized in the higher plants and affects growth of plant and development, it is D-glucose metabolism product which affects some nutritional cycles activity in higher plants and play an important role in the electron transport system [22]. On the other hand, folic acid (vit. B9) has become the most prominent of B complex vitamins despite its essential biochemical function in amino acids metabolism and nucleic acids synthesis [23]. Folic acid (vit. B9) was first isolated from *Spinacia oleracea L*. (1941) and characterized as pteroylmonoglutamic acid, a complex water soluble vitamin B [24, 25]. Foliar treatment of strawberry plants with both concentrations of folic acid, significantly improved agronomic properties of the treated plants including yield, primary and secondary weight of fruits and number of their achenes as compared to the control treatment [26].

Rosella "Karkadeh in Arabic", (*Hibiscus sabdariffa L*., family; Malvaceae), and is mainly cultivated in tropical and subtropical regions of Asia and Africa. The water extract from the calyx is consumed as hot and cold drink. It is also used in the production of Karkadeh jam and as a food colouring agent [27]. Major areas of the production in Egypt (about 12232 fed.) are primarily in mainly Luxor (6058fed.) followed by Aswan (5861 fed.). Generally, the production averaged by 12809 ton in 2016 year [1]. The in vivo pharmacological activities as antipyretic, antioxidant as well as anticholesterol products were screened in rats and rabbits [28]. It was also proved effective in regulating human blood pressure [29, 30].

Hibiscus extract: The physico-chemical analysis of water extract of Roselle calyces, the calcium content was 0.55mg/g, potassium content was 0.46mg/g, sodium 0.33mg/g, iron 0.22mg/g, magnesium 0.21 mg/g, manganese 0.001mg/g and copper content was 0.03 mg/g. Every enzyme needs cofactors to function properly; most of these factors are mineral elements. These results reinforce its uses as a nutrition source for human. The ph of the water extract was found to be 2.35 this indicated that the karkade extract has a reasonable taste for drinking. The moisture content was 10.8g/100g and the ash was 9.7g/100g. [31]. Chemical composition of Roselle: ash 8-12%, protein 5-10%, carbohydrate 60-62%, vitamin C 92.0 mg/100g, organic acids (hibiscic acid 25.5%, citric acid 14.15%, vitamin C 92.7 mg/100g, oxalic acid 0.6%), mineral contents (Ca 0.56%, mg 0.24%, fe 0.08%, na 0.23%, k 0.95%, p 0.19%) and total anthocyanin 0.9 to 1.6% [32]. Flavonoid compounds of hibiscus flower extract (caffeic acid 4.5, Gallic acid 0.9, Homogentisic acid 3.2, pyrogallol 1031.7, 3,4-Dihydroxybenzoic acid 0.7 and 2,5-Dihydroxybenzoic acid 6.7 mg/100ml [33].

The main target of the present study was to improve the growth and productivity of Germanium by some vitamins and Hibiscus extract and evaluate the effect of natural drying on the content and chemical composition of the essential oil.

2. Materials and Methods

2.1. Plant Material

The research was carried out at the Sabahiya, Horticulture Research Station in, Alexandria, Egypt during two successive seasons of 2015/2016 and 2016/2017, to study the effect of ascorbic, folic acid and hibiscus extract on quality of Geranium (oil%, active compounds and vegetative growth). Seedlings were planted at the end (April/2015) in pots. Foliar application of ascorbic acid and folic acid as well as extract of hibiscus were sprayed twice in each cut (first spry before cut 60 days and second spray before cut 30 days) and taken two cut in each season.

2.2. Preparation of the Hibiscus Extract

Collect the fresh hibiscus (Roselle) calyx and natural drying at room temperature until constant weight. The dry calyx was powder using automatic blender and taken 50g and 100g of dried calyx was placed in 1000 mL water under stirring and then left for 12 hours then filtration and used to spray plants.

2.3. The Treatments Were as Follows

1. Treat. (T1) sprayed with water Control.
2. Treat. (T2) sprayed with ascorbic acid at concentration at 100 ppm.
3. Treat. (T3) sprayed with ascorbic acid at concentration at 200 ppm.
4. Treat. (T4) sprayed with folic acid at concentration at 50 ppm.
5. Treat. (T5) sprayed with folic acid at concentration at 100 ppm.
6. Treat. (T6) sprayed with extract of hibiscus at concentration at 5.0%.
7. Treat. (T7) sprayed with extract of hibiscus at concentration at 10.0%.

2.4 Harvest

The plants were harvested first cut (October) and second cut (May) in both seasons.

2.5. Data Were Recorded

2.5.1. Vegetative Growth

i. Plant height (cm)
a. Number of branches (N/plant)
b. Fresh and dry weights (g/plant)

2.5.2. The Fresh and Dry Herbs Yield (Ton/Fed.)

$$\frac{Fresh\ or\ dry\ weight\ (g/plant)\ x\ number\ plants/fed.(30000)}{1000000}$$

2.5.3. The Essential Oil Percentage (%)

A hundred (g) fresh (after 24 h. from cut) and dry Geranium herb (after 2 weeks from natural drying at room temperature 20 ± 2°C until constant weight) were subjected to three-hours of hydro-distillation using a Clevenger-type apparatus as described by [34].

2.5.4. The Essential Oil Yield (ml/plant)

$$\frac{Essential\ oil\ \%\ x\ \ Fresh\ or\ dry\ plant\ weight\ (g/plant)}{100}$$

2.5.5. The Essential Oil Yield (L/Fed.)

$$\frac{Oil\ yield\ (ml/plant)\ x\ number\ plants/fed.(30000)}{1000}$$

2.5.6. Chemical Composition (Active Compounds) of Essential Oil

The GC analysis of volatile oil samples was carried out using gas chromatography instrument stands at the Medicinal and Aromatic Plants Res. Dept., Hort. Res. Inst. With the following specifications. DsChrom 6200Gas Chromatograph equipped with a flame ionization detector, Column: BPX-5, 5% Phenyl (equiv.) polysillphenylene-siloxane 30m x 0.25mm ID x 0.25 µm film., Sample size: 1 µl, Temperature program ramp increase with a rate of 10°C /min from 70°C to 200°C, Detector temperature (FID): 280°C, Carrier gas: nitrogen, Flow rate: N2 30ml/min; H2 30ml/min; air 300ml/min. Main compounds of the volatile oils were identified by matching their retention times with those of the authentic samples injected under the same conditions. The relative percentage of each compound was calculated from the area of the peak corresponding to each compound.

2.6. Experimental Design and Statistical Analysis

Data of the present study were subjected to the analysis of variance test (ANOVA) as Randomized Complete Block Design. Where the first factor was for seven treatments mentioned before, the second factor was for cuts. The least significant differences (LSD at the 5%) of probability were calculated by a computer program (Costat, version 6.303, 2005) according to the study [35].

3. Results and Discussion

3.1. Vegetative Growth

3.1.1. Plant Height (cm) and Number of Branches (N/plant)

Data of studying the effect of ascorbic acid, folic acid and hibiscus extract on plant height (cm) and number of branches/ plant of Geranium during 2015/2016 – 2016/2017 seasons are reported in (Table 1) and (Figure 1) in two seasons of study, results showed that all treatments caused a significantly increase in plant height (cm) and number of branches/ plant compared with control. In addition, ascorbic acid at 200 ppm, folic acid 100ppm and hibiscus extract at 5% and 10% in both seasons were sharp efficacy on increasing plant height (cm) and number- branches/ plant than other treatments and control.

Regarding the effect of cuts date, statistical analysis show that, plant height (cm) and number of branches/ plant were gradually increase and significantly with the second cut compared with first cut in both seasons.

Table 1. *Effect of ascorbic acid, folic acid and hibiscus extract on plant height (cm) and number of branches/ plant of Geranium during 2015/2016 – 2016/2017 seasons.*

Treatments	First season						Second season					
	Plant height (cm)			Number of branches/plant			Plant height (cm)			Number of branches/plant		
	1st Cut	2nd Cut	Means	1stCut	2ndCut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	50.66	71.33	61	6.33	11.33	8.83	54.93	63	58.96	8.66	8.66	8.66
Ascorbic acid												
100 ppm	54.33	84.25	69.29	7.33	11.66	9.5	68.5	76.66	72.58	8.93	10	9.46
200 ppm	59.36	86.16	72.76	8	12.66	10.33	76.33	85	80.66	9.33	10.33	9.83
Folic acid												
50 ppm	53.5	79	66.25	6.88	11.66	9.27	62.66	68.33	65.5	8.66	9.33	9
100 ppm	57.1	84	70.55	7.33	12	9.66	65.33	78.33	71.83	8.8	9.66	9.26
Extracted-hibiscus												
5%	59.43	87.33	73.38	7.33	11.66	9.5	76.33	86.66	81.5	9.66	10	9.83
10%	62.06	102.76	82.37	7.66	11.66	9.66	82.66	88.33	85.5	10	10.33	10.16
Means cuts	56.63	84.96		7.26	11.8		69.53	78.04		9.16	9.76	
L.S.D. Treatments	3.87			0.85			7.32			0.735		
Cuts	2.07			0.45			3.914			0.393		
Interaction Tre.xcuts	4.53			0.991			8.56			0.859		

The interactions among treatments and cuts dates revealed that significantly decreased plant height (cm) and number of branches/ plant in first cut. Ascorbic acid, folic acid and hibiscus extract treatments were more effective on increasing plant height (cm) and number of branches/ plant than first cut in both seasons.

Plant height (cm)

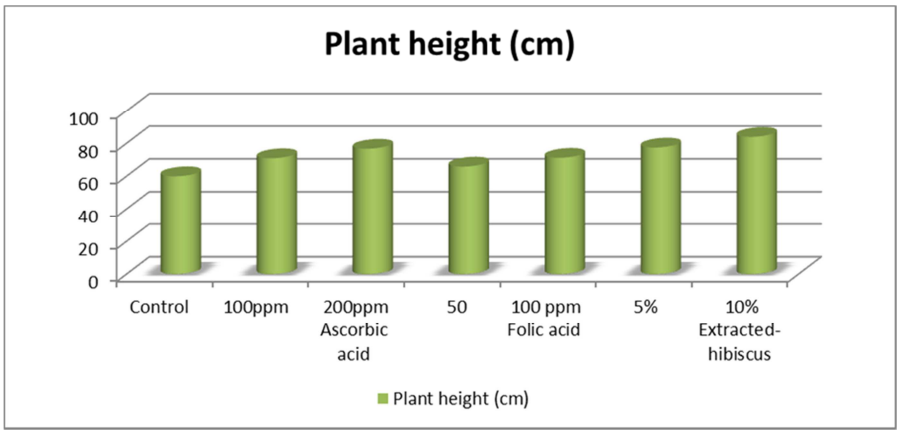

Figure 1. *Effect of ascorbic acid, folic acid and hibiscus extract on plant height (cm) of Geranium in both seasons.*

Many biochemical effects of vitamins, one that has factor more recent attention is the improvement of yield and quality of many plants. And especially, enhancing growth and productivity will be of a more importance to increase the yield [12-15]. The results obtained showed that foliar application of Geranium plants with ascorbic acid, folic acid, hibiscus extract, significantly increase plant high (cm) and number of branches/ plant the experimental period. Similar results were obtained by Balbaa and Talaat (2007) who found that ascorbic acid treatment significantly increased plant height (cm) and number of branches/plant of Rosmary plants [17]. And also Ghazal (2015) reported that plant (*Thymus vulgaris L.*) treated with ascorbic acid at different concentrations caused a great increased of plant height (cm) and number of branches/ plant at (100 and 150ppm) compared with control [18]. However, Ascorbic acid (vitamin C) is one Important from vitamins, it is play important roles in plant growth, cell division, cell wall expansion, and other developmental processes [19-21]. On the other hand, folic acid (vitamin B9) has become the most prominent of B complex vitamins despite its essential biochemical function in amino acids metabolism and nucleic acids synthesis [23]. The present results are in a general harmony with those of Emam *et al.,* (2011) who found that foliar application of flax plants with either folic acid or ascorbic acid significantly stimulated growth and development throughout the experimental [36]. Chemical composition of Roselle: ash 8-12%, protein 5-10%, carbohydrate 60-62%, vitamin C 92.0 mg/100g, organic acids (hibiscic acid 25.5%, citric acid 14.15%, vitamin C 92.7 mg/100g, oxalic acid 0.6%), mineral contents (Ca 0.56%, mg 0.24%, fe 0.08%, na 0.23%, k 0.95%, p 0.19%) and total anthocyanin 0.9 to 1.6% [32]. The effect of hibiscus extract treatment on plant height (cm) and number of branches/plant may be due to its effect on enzyme activity as a (cofactor) and metabolism, as it contains; ascorbic acid, mineral elements and anthocyanin.

3.1.2. Fresh and Dry Weights (g/plant)

Data presented in (Table 2) indicated that when foliar application with ascorbic acid, folic acid and hibiscus extract, they significantly increased of fresh and dry weighs (g/plant) when compared with the control treatment in both seasons. On the other hand ascorbic acid at 200ppm, folic acid 100ppm and hibiscus extract at 5% and 10% in two seasons were more effective on increasing fresh and dry weights (g/plant) than other treatments.

Table 2. *Effect of ascorbic acid, folic acid and hibiscus extract on fresh and dry weights (g./plant) of Geranium during 2015/2016 - 2016/2017 seasons.*

Treatments	First season						Second season					
	Fresh weight (g./plant)			Dry weight (g./plant)			Fresh weight (g./plant)			Dry weight (g./plant)		
	1st Cut	2nd Cut	Means	1stCut	2ndCut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	327.66	413.33	370.5	93.66	122.43	108.05	351	360	355.5	104	101.66	102.83
Ascorbic acid												
100 ppm	350	433	391.5	101.1	137.46	119.28	370.33	383	376.83	116.66	119.66	118.16
200 ppm	356.66	440.33	398.5	106.66	141.66	124.16	372	386.66	379.33	125	129	127
Folic acid												
50 ppm	340	431.66	385.83	98.33	130.76	114.55	360.33	376.66	368.5	102.6	111.66	107.16
100 ppm	355	435.66	395.33	101.66	136.33	119	366	383.33	374.66	105.8	110	107.83
Extracted-hibiscus												
5%	371	450	410.5	115	136	125.5	377.66	401.66	389.66	125	123.39	124.16
10%	380	455.66	417.83	116	140.66	128.33	385	396.66	390.83	125	126.66	125.83
Means cuts	354.33	437.09		104.63	135.04		368.9	384.04		114.85	117.42	
L.S.D. Treatments	13.62			8.27			13.07			6.71		
Cuts	7.28			4.425			6.98			3.59		
Interaction Tre.xcuts	15.93			9.682			15.29			7.85		

Data showed that, fresh and dry weight (g/plant) was sharp increased with the second cut compared with first cut in two seasons. Looking to the interaction effect between the tested treatments and cuts, it is obvious that all treatments had the lowest fresh and dry herb weights (g/plant.) in 1st Cut in both seasons.

The results obtained showed that foliar application of Geranium plants with ascorbic acid, folic acid as well as hibiscus extract, significantly increase fresh and dry weight the experimental period. These results are in agreement with those obtained by Ghazal (2015) who showed that fresh weight of (*Thymus vulgaris L.*) herb, significantly responded to ascorbic acid foliar application at different concentrations compared with untreated plant [18]. Similar results were obtained by Balbaa and Talaat (2007) who observed that ascorbic acid treatments significantly increased fresh and dry herb weights of rosemary plants [17]. Foliar treatment of strawberry plants with both concentrations of folic acid, significantly improved agronomic properties of the treated plants including yield, primary and secondary weight of fruits and number of their achenes as compared to the control treatment [26]. The effect of hibiscus extract treatment on fresh and dry weight (g/plant.) may be due to its effect on enzyme activity (cofactors) and metabolism, as it contains; ascorbic acid, mineral elements and anthocyanin.

3.2. Essential Oil% and Essential Oil Yield (ml/plant) of Fresh Herb

Results of the present investigation, presented in (Table 3) and (Figure 2) showed that effect of spray application of ascorbic acid, folic acid and hibiscus extract, on essential oil% and essential oil yield (ml/plant) of fresh Geranium herb in 2015-2016 and 2016-2017 seasons. Data showed that, oil percentage and oil yield of all treatments significantly increase compared with control in both seasons. Moreover, ascorbic acid at 200 ppm, and hibiscus extract at 5% and 10% in two seasons were more effective on increasing essential oil% and essential oil yield (ml/plant) of Geranium.

Regarding the effect of first and second cuts date, results recorded in second cut of the two seasons gave significantly higher essential oil% and essential oil yield (ml/plant) than first cut.

Evaluating the interaction effect between treatments and tested cuts, data show that the interactions registered the lowest values of oil percentage and oil yield with first cut in both seasons.

Table 3. *Effect of ascorbic acid, folic acid and hibiscus extract on essential oil% and essential oil yield (ml/plant) from fresh herb of Geranium during 2015/2016-2016/2017 seasons.*

Treatments	First season						Second season					
	Essential oil%			Essential oil yield (ml/plant)			Essential oil%			Essential oil yield (ml/plant)		
	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	0.11	0.119	0.114	0.35	0.48	0.42	0.12	0.131	0.125	0.42	0.46	0.43
Ascorbic acid												
100 ppm	0.12	0.13	0.125	0.41	0.56	0.49	0.134	0.136	0.135	0.49	0.52	0.5
200 ppm	0.131	0.149	0.14	0.46	0.65	0.55	0.143	0.146	0.145	0.53	0.56	0.54
Folic acid												
50 ppm	0.11	0.134	0.122	0.36	0.57	0.47	0.125	0.129	0.127	0.46	0.49	0.47
100 ppm	0.12	0.139	0.129	0.42	0.6	0.51	0.13	0.143	0.137	0.47	0.54	0.5
Extracted- hibiscus												
5%	0.139	0.147	0.143	0.51	0.66	0.58	0.146	0.147	0.145	0.54	0.59	0.56
10%	0.143	0.151	0.147	0.53	0.68	0.61	0.155	0.158	0.156	0.59	0.62	0.6
Means cuts	0.124	0.139		0.439	0.608		0.136	0.147		0.5	0.54	
L.S.D. Treatments	0.008			0.035			0.007			0.03		
Cuts	0.004			0.019			0.003			0.016		
Interaction Tre.xcuts	0.031			0.132			0.025			0.114		

Essential oil%

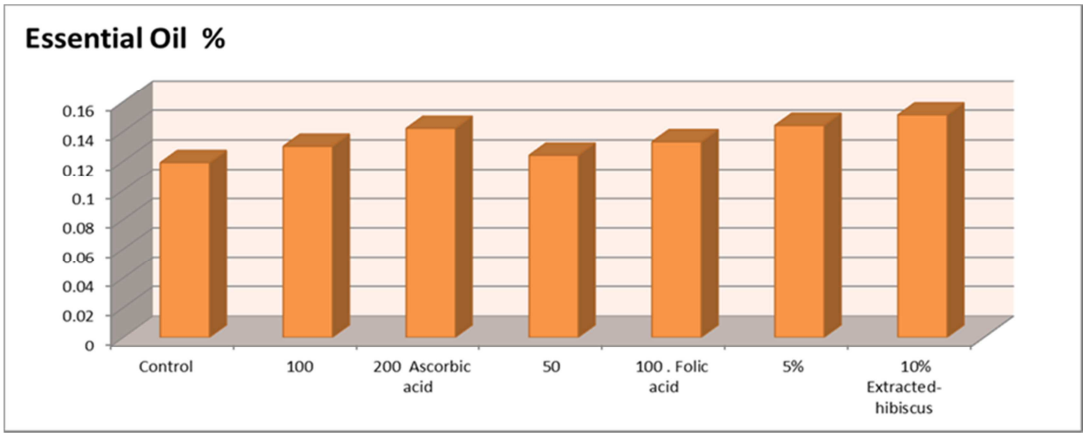

Figure 2. *Effect of ascorbic acid, folic acid and hibiscus extract on essential oil% from fresh herb of Geranium in both seasons.*

These results are consistent with Youssef and Talaat (2003) on rosemary [37], Eid *et al.,* (2010) on *Jasminum grandiflorm* [38], Taraf *et al.,* (1999) on lemongrass [39] as well as El-Lethy *et al.,* (2011) [40] on geranium reported that foliar application of ascorbic acid caused significantly increased in the essential oil% and oil yield. Ascorbic acid treatment significantly increased oil percentage during the 1st season where ascorbic acid at 150 mg / l gave the maximum mean values of volatile oil% in the 1st and 2nd cuts on *Thymus vulgaris L* plant [18]. The effect of hibiscus extract treatment on essential oil% and essential oil yield (ml/plant) may be due to its positively affected on enzyme activity and metabolism, as it contains; ascorbic acid, mineral elements and anthocyanin.

3.3. Essential Oil% and Essential Oil Yield (ml/plant) of Dry Herb

Table 4 indicated that effect of ascorbic acid, folic acid as well as hibiscus extract on essential oil% and essential oil yield (ml/plant) from dry herb of Geranium during 2015/2016 - 2016/2017 seasons. Different treatments increased the% and yield of essential oil (ml/plant) of dry herb in two seasons than treatment control. For essential oil% and essential oil yield (ml/plant), the higher value from spray ascorbic acid at 100, 200ppm, and hibiscus extract at 5% and 10% in first seasons. And also ascorbic acid at 100, 200ppm, folic acid at 100ppm and hibiscus extract at 5% and 10% gave increased% and yield of volatile oil (ml/plant) of dry herb in second season.

Regarding the effect of first and second cuts date, Data show that, essential oil% and essential oil yield (ml/plant) of dry herb in first season were significantly increased with the second cut compared with first cut. In Second season not significantly increase between first and second cut. The interaction effect between the treatments and cuts date, it is obvious that all treatments had the lowest essential oil% and essential oil yield (ml/plant) at first cut in two seasons.

Table 4. *Effect of aascorbic acid, folic acid and hibiscus extract on essential oil% and essential oil yield (ml/plant) from dry herb of Geranium during 2015/2016 - 2016/2017 seasons.*

Treatments	First season						Second season					
	Essential oil%			Essential oil yield (ml/plant)			Essential oil%			Essential oil yield (ml/plant)		
	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	0.291	0.303	0.297	0.27	0.371	0.32	0.298	0.31	0.304	0.309	0.314	0.312
Ascorbic acid												
100 ppm	0.321	0.38	0.35	0.323	0.521	0.422	0.335	0.34	0.337	0.393	0.397	0.395
200 ppm	0.362	0.365	0.363	0.387	0.517	0.452	0.406	0.39	0.398	0.505	0.486	0.496
Folic acid												
50 ppm	0.303	0.35	0.326	0.298	0.461	0.38	0.355	0.325	0.34	0.364	0.36	0.362
100 ppm	0.31	0.346	0.328	0.315	0.473	0.394	0.387	0.35	0.368	0.409	0.383	0.396
Extracted- hibiscus												
5%	0.353	0.366	0.36	0.405	0.497	0.451	0.425	0.42	0.422	0.531	0.516	0.524
10%	0.36	0.424	0.392	0.417	0.595	0.506	0.437	0.426	0.431	0.545	0.541	0.543
Means cuts	0.328	0.362		0.345	0.49		0.377	0.366		0.436	0.428	
L.S.D. Treatments	0.053			0.067			0.053			0.063		
Cuts	0.028			0.036			0.028			0.034		
Interaction Tre.xcuts	0.062			0.079			0.062			0.073		

3.4. Fresh and Dry Herbs Yield (ton/fed.)

Data in (Table 5); generally revealed that when spray application of ascorbic acid, folic acid and hibiscus extract, on fresh and dry herbs yield (ton/fed.) of Geranium in 2015-2016 and 2016-2017 seasons. Data showed that all treatments increased fresh and dry herbs yield (ton/fed.) than control. And also in the first season ascorbic acid at 200ppm, folic acid 100 ppm and hibiscus extract 5, 10% achieved significantly the highest yield [fresh and dry (ton/fed.)] expressed as weight. Besides, the highest yield in second season with ascorbic acid at 100, 200ppm, folic acid 100 ppm and hibiscus extract 5, 10%.

Regarding the effect of first and second cuts date, results recorded in second cut of the first season gave significantly higher fresh and dry herbs yield (ton/fed.) than first cut. On the other side, in the 2nd season no significant differences were observed between first and second cut.

The interaction effect between the treatments x cuts date, it is obvious that all treatments had the lowest fresh and dry yields (ton /fed.) at 1st Cut in two seasons.

Table 5. *Effect of ascorbic acid, folic acid and hibiscus extract on fresh and dry herbs yield (ton/fed.) of Geranium during 2015/2016 - 2016/2017 seasons.*

Treatments	First season						Second season					
	Fresh yield (Ton/Fed.)			Dry yield (Ton/Fed.)			Fresh yield (Ton/Fed.)			Dry yield (Ton/Fed.)		
	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	9.8	12.4	11.16	2.8	3.6	3.2	11.1	10.8	10.96	3.1	3	3.05
Ascorbic acid												
100 ppm	10.4	12.9	11.7	3.1	4.12	3.55	11	11.5	11.28	3.5	3.5	3.48
200 ppm	10.7	13.2	11.95	3.2	4.2	3.7	11.13	11.6	11.35	3.7	3.7	3.73
Folic acid												

Treatments	First season						Second season					
	Fresh yield (Ton/Fed.)			Dry yield (Ton/Fed.)			Fresh yield (Ton/Fed.)			Dry yield (Ton/Fed.)		
	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
50 ppm	10.2	12.9	11.56	2.9	3.9	3.4	10.76	11.3	11.03	3	3.3	3.18
100 ppm	10.6	13	11.85	3	4	3.53	10.9	11.5	11.23	3.1	3.3	3.2
Extracted- hibiscus												
5%	11.1	13.5	12.3	3.4	4	3.73	11.3	12	11.66	3.7	3.7	3.71
10%	11.4	13.6	12.53	3.4	4.2	3.81	11.5	11.9	11.71	3.7	3.8	3.76
Means cuts	10.63	13.09		3.11	4		11.12	11.51		3.41	3.48	
L.S.D. Treatments	0.43			0.269			0.496			0.207		
Cuts	0.23			0.143			0.265			0.11		
Interaction Tre.xcuts	0.5			0.313			0.578			0.242		

The results obtained showed that foliar application of Geranium plants with ascorbic acid, folic acid, hibiscus extract; a great increase fresh and dry weight (ton/fed.) the experimental period. These results are in agreement with those obtained by Ghazal (2015) showed that fresh weight herb, significantly responded to ascorbic acid at different concentrations compared with untreated plants (*Thymus vulgaris L.*) [18]. Similar results were obtained by Balbaa and Talaat (2007) who showed that ascorbic acid treatment significantly fresh and dry herb weights of rosemary plants [17]. Foliar treatment of strawberry plants with both concentrations of folic acid significantly improved agronomic properties of the treated plants including yield, primary and secondary weight of fruits and number of their achene's as compared to the control treatment and also found that folic acid enhances fruit quality and yield of strawberry [26]. The effect of hibiscus extract treatment on fresh and dry weight (g/plant.) may be due to its positively affected on enzyme activity and metabolism, as it contains; ascorbic acid, mineral elements and anthocyanin.

3.5. Essential Oil Yield (L/fed.) from Fresh and Dry Herbs

Table 6 indicated that effect of ascorbic acid, folic acid as well as hibiscus extract on essential oil yield (L/fed.) from fresh and dry herbs of Geranium during 2015/2016-2016/2017 seasons. Different treatments increased the essential oil yield (L/fed.) in first and second seasons than control treatment. For essential oil yield (L/fed.) from fresh herb, the higher value from spray ascorbic acid at 200 ppm and hibiscus extract at 5% and 10% in two seasons. And also ascorbic acid at 200ppm, folic acid at 100 ppm and hibiscus extract at 5% and 10% gave increased essential oil yield (L/fed.) from dry herb in in both seasons.

Table 6. *Effect of ascorbic acid, folic acid and hibiscus extract on essential oil yield (L/fed.) from fresh and dry herbs of Geranium during 2015/2016 - 2016/2017 seasons.*

Treatments	First season						Second season					
	Essential oil yield (L/fed.) from fresh herb			Essential oil yield (L/fed.) from dry herb			Essential oil yield (L/fed.) from fresh herb			Essential oil yield (L/fed.) from dry herb		
	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means	1st Cut	2nd Cut	Means
Control	10.7	14.6	12.65	8.07	11.13	9.6	12.5	13.8	13.16	9.28	10.24	9.76
Ascorbic acid												
100 ppm	12.5	17	14.75	9.61	15.64	12.62	14.8	15.5	15.15	11.79	11.91	11.85
200 ppm	13.9	19.6	16.75	11.61	15.52	13.56	15.9	16.9	16.4	15.17	14.6	14.88
Folic acid												
50 ppm	10.9	17.3	14.1	8.95	13.85	11.4	13.7	14.8	14.25	10.93	10.81	10.87
100 ppm	12.7	17.8	15.25	9.46	14.19	11.82	13.3	16.3	14.8	12.28	11.51	11.89
Extracted-hibiscus												
5%	15.5	19.8	17.65	12.16	14.92	13.54	16.3	17.6	16.95	15.94	15.5	15.72
10%	16.1	20.5	18.35	12.51	17.85	15.18	17.8	18.7	18.26	16.36	16.25	16.3
Means cuts	13.18	18.1		10.33	14.72		14.9	16.22		13.1	12.97	
L.S.D. Treatments	1.09			2.029			0.723			1.97		
Cuts	0.582			1.08			0.386			1.054		
Interaction Tre.xcuts	1.272			2.371			0.845			2.305		

Regarding the effect of first and second cuts date, results recorded in second cut of the first season gave significantly higher essential oil yield (L/fed.) from fresh and dry herbs than first cut. On the other hand in the second season no significant differences were observed between first and second cut of essential oil yield (L/fed.) from dry herb. But essential oil yield (L/fed.) from fresh herb showed that significant differences between first and second cut in two seasons.

Evaluating the interaction effect between treatments x tested cuts, data show that the interactions registered the lowest values of essential oil yield (L/fed.) from fresh and dry herbs with 1st Cut in both seasons. The results obtained showed that foliar application of Geranium plants with ascorbic acid, folic acid, hibiscus extract; a great increase volatile oil yield (L/fed.) from fresh and dry herbs. These results are in agreement with those obtained by Taraf *et al.,* (1999) on lemongrass [39], Youssef and Talaat (2003) on rosemary [37], Eid *et al.,* (2010) on *Jasminum grandiflorm* [38] as well as El-Lethy *et al.,* (2011) [40] on geranium

reported that foliar application of ascorbic acid caused pronounced increased in the yield of essential oil. Ascorbic acid treatment significantly increased oil percentage during the 1st season where ascorbic acid at 150 mg / l gave the maximum mean values of volatile oil% in the 1st and 2nd cuts on Thyme plant [18]. Pronounced increases in the growth characters of *Ammi visnaga L.* plants were obtained as a result of ascorbic acid treatments [41]. This synergistic effect of ascorbic acid might be due to its involvement in the main metabolic processes, especially with energy coenzymes [42]. Foliar of strawberry plants with both concentrations of folic acid, significantly improved agronomic characteristics of the treated plants including yield, primary and secondary weight of fruits and number of their achenes as compared to the control treatment [26]. The effect of hibiscus extract treatment on yield of essential oil may be due to its positively affected on enzyme activity and metabolism, as it contains; ascorbic acid, mineral elements and anthocyanin.

3.6. Effect of Ascorbic Acid, Folic Acid, Hibiscus Extract and Natural Drying (NA) on Oil Yield Production (L/fed.)

From data in (Table 7) and (Figure 3) show that NA (natural drying) increased oil loss from dry herb (L/fed.) compared to fresh herb during 2015/2016-2016/2017 seasons. On the other hand the oil loss by NA 5.00- 6.00 (L/fed.) and weight loss of herb to 70% from fresh herb Table 5 reducing transport and distillation costs percentage 70%. The Geranium product should compare oil lost (5-6) L/fed. to reducing costs (distillation and transportation). The herb may be left to wilt in the field for 72 hours (3 days) to allow for better vaporization of moisture and greater packing of biomass in the distillation vessel [43]. Extending the drying time over 3-4 days caused reduction in oil yield, which may be attributed to volatile oil loses caused by wind, temperature and plant part loses [44].

Table 7. *Effect of ascorbic acid, folic acid, hibiscus extract and natural drying on oil yield Production (L/fed.) from fresh and dry herbs of Geranium during 2015/2016-2016/2017 seasons.*

Treatments	First season			Second season		
	Oil yield from fresh herb (L/fed.)	Oil yield from dry herb (L/fed.)	Oil loss from NA (L/fed.)	Oil yield from fresh herb (L/fed.)	Oil yield from dry herb (L/fed.)	Oil loss from NA (L/fed.)
Control	25.3	19.2	6.1	26.3	19.52	6.7
Ascorbic acid						
100 ppm	29.5	25.2	4.3	30.3	23.7	6.6
200 ppm	33.5	27.1	6.4	32.8	29.7	3
Folic acid						
50 ppm	28.2	22.8	5.4	28.4	21.7	6.7
100 ppm	30.4	23.6	6.8	29.6	23.7	5.9
Extracted- hibiscus						
5%	35.3	27	8.3	33.9	31.4	2.5
10%	36.6	30.3	6.3	36.5	32.6	3.9
Means	31.2	25	6.22	31.11	26.04	5

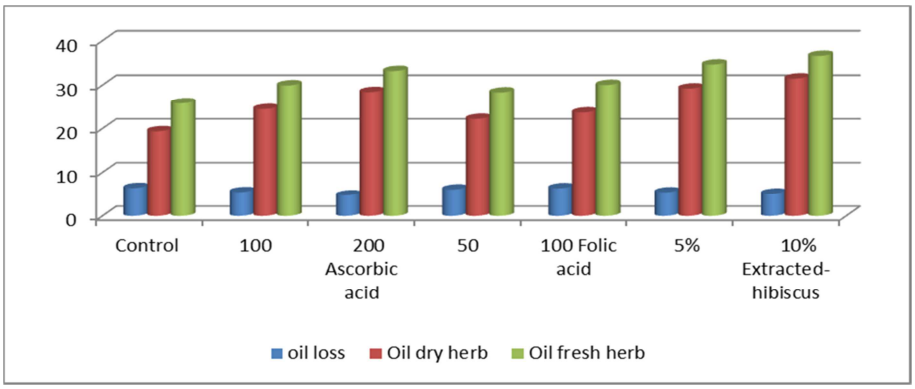

Figure 3. *Effect of ascorbic acid, folic acid, hibiscus extract and natural drying on oil yield (L/fed.) from fresh and dry herbs of Geranium in both seasons.*

3.7. Effect of Natural Drying on Active Compounds

Data were presented in (Table 8) and (Figure 4): effect of NA (natural drying) on active compounds of Geranium during 2016/2017 season. The percentages of components showed that, the Citronellol represented the main compound, followed by Geraniol, Eugenol, Geranyl formate, Citronelly formate, Iso-menthone, B-caryophyllene, Linalool and, α-pinene ordered from high to low. Moreover observed that natural drying caused pronounced increasing in the main constituents (Citronellol, Eugenol, Geranyl formate, Citronelly formate and Iso-menthone) on the other beside caused pronounced decreasing of Geraniol, B-caryophyllene, Linalool and, α-pinene.

Drying herbal yield of geranium up to 3 to 4 days does not affect the physicochemeical traits of the volatile oil, rather

increases slightly the yield and quality, reduces the staking volume and thus the transportation and distillation costs; consequently encourage geranium plantations to extend in new areas far from distillation factories [44].

Table 8. *Effect of natural drying (20 ± 2°C) on active compounds of Geranium essential oil during 2nd Cut, 2016/2017 season.*

Active compounds (%)		Oil-fresh herb	Oil-dry herb
1	α-pinene	0.53	0.6
2	Iso-menthone	4.55	5.29
3	Linalool	3.88	2.74
4	Citronelly formate	5.62	6.63
5	Geranyl formate	5.65	5.45
6	Citronerlol	33.81	37.43
7	Geraniol	26.52	22.86
8	Eugenol	8.3	8.74
9	B-caryophyllene	4.32	3.3
10	Total identified compounds	93.18%	93.04%
11	Other compounds	6.82%	6.96%
12	total compounds	100%	100%

Active compounds%

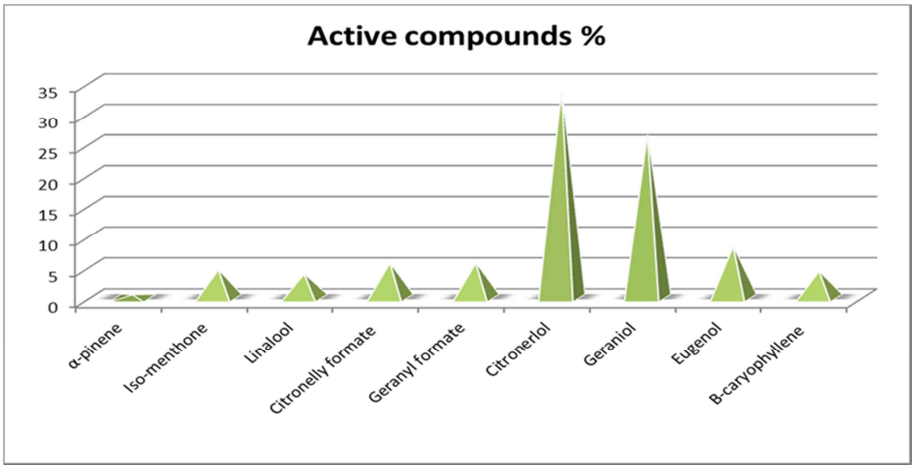

Figure 4. *Active compounds of Geranium essential oil from fresh herb.*

3.8. Effect of Ascorbic Acid, Folic Acid and Hibiscus Extract on Active Compounds

Data concerning the effect of ascorbic acid, folic acid and hibiscus extract on active compounds of Geranium essential oil during 2nd Cut, 2016/2017 season are reported in (Table 9). Results showed that active compounds were 9 compounds representing about 88.11% - 97.09% as a result of different treatments during 2016-2017 season. Citronerlol was identified as the major compound in the different treatments ranging from 31.55% to 40.99%. Geraniol the second main component, ranged 19.29% - 27.11% in the essential oil followed with Eugenol which was identified as the third compounds in the volatile oil and its relative percentage accounted for 8.30% - 10.18%. And results indicated that all treatments caused increase main constituents; Citronerlol, Citronelly formate, Iso-menthone, B-caryophyllene and Geranyl formate. On the other beside all treatments caused a reduction in Geraniol and α-pinene. The effect of ascorbic acid on volatile oil constituents may be due to its effect on enzyme activity and metabolism of essential oil production [18]. Folic acid (vitamin B9) has become the most prominent of Bcomplex vitamins despite its essential biochemical function in amino acids metabolism and nucleic acids synthesis [23]. The effect of hibiscus extract treatment on essential oil and its constituents may be due to its positively affected on enzyme activity and metabolism of essential oil production, as it contains; Ascorbic acid, mineral elements and anthocyanin.

Table 9. *Effect of ascorbic acid, folic acid and hibiscus extract on active compounds of Geranium essential oil during 2nd Cut, 2016/2017 season*

Treatments / Compounds%	Control	Ascorbic acid		Folic acid		Extracted- hibiscus	
		100 ppm	200 ppm	50 ppm	100 ppm	5%	10%
α-pinene	2.37	0.33	0.35	0.24	0.45	0.53	0.29
Iso-menthone	4.61	4.88	4.99	6.99	4.63	4.55	4.74
linalool	2.45	1.64	4.99	1.65	2.95	3.88	2.54
Citronelly formate	4.75	5.95	6.66	7.17	7.85	5.62	4.74
Geranyl formate	2.09	3.97	6.42	6.44	4.97	5.65	5.04
Citronerlol	31.55	40.99	33.7	36.57	36.08	33.81	35.97

Treatments / Compounds%	Control	Ascorbic acid		Folic acid		Extracted- hibiscus	
		100 ppm	200 ppm	50 ppm	100 ppm	5%	10%
Geraniol	28.3	20.16	25.81	23.2	19.29	26.52	27.11
Eugenol	9.49	10.17	8.27	10.18	9.26	8.3	8.54
B-caryophyllene	2.5	5.49	2.1	4.65	4.65	4.32	5.36
Total identified compounds	88.11	93.58	93.29	97.09%	90.13	93.18%	94.33
Other compounds	11.89	6.42	6.71	2.91%	9.87	6.82%	5.67
total compounds	100%	100%	100%	100%	100%	100%	100%

4. Conclusion

In the present study, it could be concluded that using ascorbic acid at 200 ppm, folic acid at 100 ppm and extract-hibiscus 5 and 10% were better treatments in increasing vegetative growth, higher volatile oil content and active compounds than other treatments. Effect of natural drying; it increased oil loss from dry herb (L/fed.) Compared to fresh herb. On the other hand the oil loss by natural drying/ fed. 5.00- 6.00 (L/fed.) and weight loss of herb to 70% from fresh herb reducing transport and distillation costs by 70%. The Geranium product should compare the lost oil (5-6, L/fed.) to reducing costs (distillation and transportation).

References

[1] Bulletin of the Agricultural Statistics. part (1): 2017, part (2) 2018.

[2] Misra A, Srivastava NK. Value addition of essential monoterpene oil (s) in Geranium (Pelargonium graveolens) on leaf positions for commercial exploitation. African J. of Agr. Res. 5 (15), 2010, 2077-2079.

[3] Rao BRR, Kaul PN, Syamasundar KV, Ramesh S. Water soluble fractions of rose-scented geranium (Pelargonium species) essential oil. Bioresource Technology. 84 (3), 2002, 243-246.

[4] Rao BRR. Biomass yield, essential oil yield and essential oil composition of rose-scented geranium (Pelargonium species) as influenced by row spacings and intercropping with cornmint (*Mentha arvensis* L. f. piperascens Malinv. ex Holmes). Industrial Crops and Products. 16 (2), 2002, 133-144.

[5] Lis-Balchin M, Patel J, Hart S. Studies on the mode of action of essential oils of scented-leaf Pelargonium (Geraniaceae). Phytotherapy Research. 12 (3) 1998, 215- 217.

[6] Peterson A, Machmudah S, Roy BC, Goto M, Sasaki M, Hirose T. Extraction of essential oil from geranium (*Pelargonium graveolens*) with supercritical carbon dioxide. Journal of Chemical Technology and Biotechnology. 81 (2) 2006, 167-172.

[7] Fayed SA. Antioxidant and anticancer activities of Citrus reticulate (*petitgrain mandarin*) and *Pelargonium graveolens* (geranium) essential oils. Res. J. Agr. and Biol. Sci. 5 (5), 2009, 740-747.

[8] Weiss EA. Essential Oil Crops. Centre for Agriculture and Biosciences (CAB) International, New York, 1997.

[9] Miller DM. The taxonomy of Pelargonium species and cultivars, their origins and growth in the wild. Geranium and Pelargoniums: The genera Geranium and Pelargonium. In: Medicinal and Aromatic PlantsIndustrial Profiles. Lis-Balchin M (Ed.). Taylor and Francis, London, 2002, 49-79.

[10] Higley C, Higley A. Reference Guide for Essential Oils. Abundant Health, London, 2001.

[11] Abd El-Gawad, M. G., El-Moghazy T. F. A. Extracting some Essential Oils and Studying their Effects on Extending Storage Life and Improving Quality of "Florida Prince" Peach Fruits. Middle East J. Agric. Res., 7 (4), 2018, 1545-1560, ISSN: 2077-4605.

[12] Khan MG, Srivastava HS. Changes in growth and nitrogen assimilation in maize plants induced by NaCl and growth regulators. Biol. Plant., 41, 1998, 93-99.

[13] Al-Hakimi AMA, Hamada AM. Counteraction of salinity stress on wheat plants by grain soaking in ascorbic acid, thiamin or sodium salicylate. Biol. Plant., 44, 2001, 253-261.

[14] El-Tohamy W. A, El-Abugy H. M, El-Gready N. H. M. Studies on the effect putrescine, yeast and vitamin C on growth, yield and physiological responses of eggplant (*Solanum melongena* L.) under sandy soil conditions. Aust. J. Basic Appl. Sci., 2 (2), 2008, 296-300.

[15] El-Tohamy WA, El-Gready NHM. Physiological responses, growth, yield and quality of snap beans in response to foliar application of yeast, vitamin E and zinc under sandy soil conditions. Aust. J. Basic Appl. Sci., 1 (3), 2007, 294-299.

[16] Shehata SM, Helmy YI, El-Tohamy WA. Pepper plants as affected by foliar application with some chemical treatments under later summer conditions. Egypt J. Appl. Sci., 17 (7), 2002, 236-248.

[17] Balbaa L. K., Talaat I. M. Physiological response of rosemary plants (*Rosmarinus officinalis L.*) to ascorbic acid, phenylalanine and ornithine. Egypt. J. Appl. Sci. 22 (11B) 2007, 375–385.

[18] Ghazal G. M. Growth and oil yield of *thymus vulgaris* plant as influenced by some amino acids and ascorbic acid, World J Pharm Sci, 3 (10) 2015, 1957-1966.

[19] Asada, K. The water–water cycle in chloroplasts, scavenging of active oxygens and dissipation of excess photons. Annu Rev of Plant Physiol and Plant Mol. Biol. 50, 1999, 601–639.

[20] Conklin, P. Recent advances in the role and biosynthesis of ascorbic acid in plants. Plant, Cell and Environ. 24: 2001, 383-394.

[21] Pignocchi, C. and C. Foyer. Apoplastic ascorbate metabolism and its role in the regulation of cell signaling. Curr. Opin. Plant Biol. 6, 2003, 379–389.

[22] El-Kobisy, D. S.; Kady K. A.; Hedani, R. A. and Agamy, R. A. Response of pea plant (*pisum sativum L.*) to treatment with ascorbic acid. Egypt. J. Appl. Sci., 20, 2005, 36-50.

[23] Andrew WJ, Youngkoo C, Chen X, Pandalai SG. Vicissitudes of a vitamin. Recent Res. Dev. Phytochem., 4, 2000, 89-98.

[24] Cossins E. The fascinating word of folate and one-crbon metabolism. J. of Bot. 78, 2000, 691-708.

[25] Wang Z, Li S and Malhi S. Effects of fertilization and other agronomic measures on nutritional quality of crops. Review. J. of the Sci. of Food and Agr. 88, 2008, 7-23.

[26] Raeisi, J., Pakkish, Z., Saffari, V. R. Efficiency of Folic Acid in Improving Yield and Fruit Quality of Strawberry. J. of Plant Physiology & Breeding, *7* (1), 2017, 15-25.

[27] Nman, N. M., Onyeke, N. G. Chemical composition of two varieties of Sorrel (Hibiscus sabdarifa L.), calyces and the drink made from them. Plant Foods for Human Nutrition, 2003, 58, 1-7.

[28] Ali, B. H., Al Wabel, N., Blunden, G. Phytochemical, pharmacological and toxicological aspects of *Hibiscus sabdariffa* L. Phytotherapy Research, 19, 2005, 369-375.

[29] Haji-Faraji, M., Haji-Tarkhani, A. The effect of sour tea (Hibiscus sabdariffa) on essential hypertension. Journal of Ethnopharmacology, 65, 1999, 231-236.

[30] Herrera-Arellano, A., Flores-Romero, S., Chavez-Soto, M. A., Tortoriello, J. Effectiveness and tolerability of a standardized extract from *Hibiscus sabdariffa* in patients with mild to moderate hypertension: a control and randomized clinical trial. Phytomedicine, 11, 2004, 375-382.

[31] Eltayeib A. A., Hamade H. Phytochemical and Chemical Composition of Water Extract of Hibiscus Sabdariffa (Red Karkade Calyces) in North Kordofan State-Sudan Int, J. of Adv. Res. in Chem. Sci. (IJARCS) Vol. 1, Is. 6, Aug., 2014, PP 10-13 ISSN 2349-039X (Print), ISSN 2349-0403 (Online) www.arcjournals.org

[32] Alshoash W. G. A. Chetnical Composition of Some Roselle (*Hibiscus sabdariffa* Genotypes., (M.SC.) Fac. of Agr., Uni. of Khartoum 1997.

[33] Gingasu, D., Mindru, I., Patron, L., Calderon-Moreno, J. M., Mocioiu, O. C., Preda, S., Stanica, N., Nita, S., Dobre, N., Popa, M. and Gradisteanu, G. Green synthesis methods of $CoFe_2O_4$ and Ag-$CoFe_2O_4$ nanoparticles using hibiscus extracts and their antimicrobial potential. *Journal of Nanomaterials*, Vol. 2016, Article ID 2106756, 12 pages http://dx.doi.org/10.1155/2016/2106756

[34] British Pharmacopoeia The pharmaceutical press 17 Bloomsburg, square. W. C. I. London. 1963.

[35] Gomez, K. A., A. A. Gomez, Statistical procedure for agricultural research. 2nd Edition. 1984, pp. 8-22.

[36] Emam, M. M., El-Sweify, A. H., & Helal, N. M. Efficiencies of some vitamins in improving yield and quality of flax plant. African Journal of Agricultural Research, 6 (18), 2011, 4362-4369.

[37] Youssef, AA. and Talaat I M,. Physiological response of rosemary plants to some vitamins. Egypt. Pharm. J., 1: 2003, 81-93.

[38] Eid, R. A., S. T. Lobna, M. M. Soad. "Physiological properties studies on essential oil of Jasminum grandiflorum L. as affected by some vitamins." Ozean J. of Appl. Sci. 3, no. 1, 2010, 87-96.

[39] Taraf, S. A., Gamal El-Din, K. M., Balbaa, L. K. The response of vegetative growth and essential oil of lemongrass (Cymbopogon citrates Hort) to foliar application of ascorbic acid, nicotinamid and some micronutrients. Arab Univ. of Agric. Sci., 7, 1999, 247-259.

[40] El-Lethy, S. R., Ayad, H. S. and Reda, F. Effect of riboflavin, ascorbic acid and dry yeast on vegetative growth, essential oil pattern and antioxidant activity of geranium (*Pelargonium graveolens L.*). American-Eurasian J. of Agr, and Environmental Sci., 10, 2011, pp. 781-786.

[41] Reda, F.; Fadl, M.; Abdel-All, R. S. and El-Moursi, A. Physiological studies on Ammi visnaga L. The effect of thiamine and ascorbic acid on growth and chromone yield. Egypt. J. Pharm. Sci., 18, 1977, 19-27. Aberg, B. (1961): Vitamins as growth factors in higher plants. Encyclopedia of Plant Physiol. XIV. 418-449.

[42] Aberg, B. Vitamins as growth factors in higher plants. Encyclopedia of Plant Physiol. XIV. 1961, 418-449.

[43] ADC Commercialization Bulletin No. 14 Geranium oil. IDEA/ Geranium oil /March 12, 1998.

[44] Hamouda A. M. A. Effect of Drying Geranium Fresh Herb Before Distillation on Essential Oil Yield and Composition, Egypt. J. Hort. Vol. 40, No. 1, 2013, pp. 113-120.