How to Cite:
Hamada, J., & Ahmed, M. A. (2022). Effect of spraying with glutamic acid and nano zinc oxide on the active substance and some anatomical characteristics of Lavendula Angustifolia. *International Journal of Health Sciences*, *6*(S6), 2844–2868.
https://doi.org/10.53730/ijhs.v6nS6.9843

Effect of spraying with glutamic acid and nano zinc oxide on the active substance and some anatomical characteristics of Lavendula Angustifolia

Jasim Hamada
Horticulture and Landscape, Department of Agriculture Collage Tikrit University
Email: 120@gmail.com

Mohamed Abdulla Ahmed
Horticulture and Landscape, Department of Agriculture Collage Tikrit University
Email: mohmeed.abdullah@tu.edu.iq

***Abstract*---**The study was conducted in the wooden canopy of the Department of Horticulture and Landscape Engineering / College of Agriculture / Tikrit University during the growing season 2021-2022, to study the effect of spraying with glutamic acid and nano-zinc oxide on some vegetative growth characteristics, mineral content, active substance and some anatomical characteristics of Lavendula Angustifolia Mill. A factorial trial was carried out with two factors, the first factor was glutamic acid at three levels (0, 100, and 200) mg. L-1 and the second factor are zinc oxide nanoparticles at four levels (0, 0.50, 1, and 1.50) g. L-1 According to the RCDB (Randomized Complete Block Design) with three replications, the most important results are summarized as follows:Estimation of some of the active compounds in the volatile oil in lavender leaves: The interaction treatment G2Z3 (spraying with glutamic acid at a concentration of 200 mg. L-1 + nano zinc oxide at a concentration of 1.50 g. L-1) was characterized by giving the highest concentration of phenolic compounds in the volatile oil in lavender leaves in (Linalyl acetate, Linalool, Lavandulyl). acetate) which reached (33.32 - 20.69 - 120.4) respectively, compared to the lowest concentrations of the comparison treatment. Anatomical features: When taking some anatomical sections of the leaves of the lavender plant, it was found that they contain two types of hairs: 1- the adenoid hairs; It is of multicellular type and branched star-shaped, and the shape of the base is circular or triangular, and the leaf with its upper and lower layers is dense with adenoid filaments, 2- and glandular hairs. 4-6 cells) are found on the epidermal layer of the lavender leaf.

***Keywords*---**active substance, anatomy, lavender.

Introduction

Lavender plant (*Lavendula Angustifolia Mill* or *Lavendula Officinalis Chaix* Lavendula, English name: Lavendulae Aetheroleum or Lavender), which belongs to the Lamiaceae family, is an important medicinal and aromatic plant, which is the original home of its important commercial species to the mountainous regions of the Mediterranean countries and is cultivated in southern Europe, Bulgaria, Russia and the United States of America (WHO, 2001 and Bisset, 1994). This genus includes 48 species and more than 100 strains. The plant grows well in light, fertile, well-drained soils. The Lavender plant tolerates frost and moderate drought and is sensitive to high humidity. High temperatures can adversely affect the quality of the oil (Curtis, 2005), and it contains volatile oil at a rate of 6-3%, and the most important compounds of this oil are Linalyl acetate 40% and Linalol 30%, which is due to the distinctive smell of the lavender plant due to these compounds. Therefore, we believe that some agricultural operations can contribute to improving the growth of this plant and increasing its production of volatile oil, including glutamic acid,which is one of the essential amino acids in the manufacture of the protein, which numbered 20 amino acids, performs several structural functions for the growth of higher plants and controls the process of opening and closing stomata (Ewais *et al.*,2005). Glutamic acid is one of the amino acids that contribute to building proteins, and this is done by testing amino acids with the help of specialized enzymes and in the presence of ATP to form the proteins needed by the plant according to its need (Jain and Amentals, 2011). It was found that treating plants with glutamic acid contributes to building carbohydrates and proteins in the plant and improving physiological characteristics (Saburi *et al.*, 2014). Nano-fertilizers have unique features due to their small size and large surface area, which leads to an increase in the absorption surface and thus an increase in the rate of photosynthesis, which in turn increases the production of active substances in the plant (Singh *et al.*, 2016). Zinc is one of the main elements for growth in plants, and its absence or lack of it at the required levels negatively affects the plant, and it is a real key, regulator, and co-factor for a wide range of enzymes such as alcohol-dehydrogenase enzyme in vital processes, especially carbohydrate manufacturing processes in the process of Photosynthesis (Mengel and Kirkby, 2001).

Because of the recent research of nano-fertilizers in Iraq, given the importance of the plant globally and locally, and its multiplicity of coordination, medicinal and aromatic uses, and to test the possibility of its cultivation under the conditions of Salah Al-Din Governorate. Therefore, the current study aimed at knowing the effect of the study factors on growth characteristics and concentrations of some active substances in the volatile oil of lavender leaves. Hendawy *et al.* (2012) confirmed that spraying the black seed plant with a mixture of amino acids, including glutamic acid, led to a significant increase in the vegetative growth indicators of the plant and an increase in the proportion ofoil and the content of fatty acids. A study conducted by Salama and Yousef (2015) showed the significant effect of foliar spraying with amino acids on the sweet basil plant *Ocimum basilicum L.* at different levels (0.5, 1.5, and 2.5) mg. L^{-1}. The results

showed a significant increase in vegetative growth characteristics at the level of 1.5 ml. L^{-1}.

And between Zivile *et al.* (2021) when four cultivars of mint were treated with Phenylalanine, Tryptophan, and Tyrosine, at concentrations (0, 100, 200) mg. L^{-1} for each of them had a significant effect on Benzoic acid, Caffeic acid, and Cinnamic acid. and p-coumaric acid and ferulic acid mg. 100 g.Ahmadreza *et al.* (2020) found when spraying basil with two nanoparticles of zinc oxide at concentrations (0, 1000, 2000, 4000) mg. L^{-1} , and nano-copper in concentrations (0, 1000, 2000, 4000) mg. L^{-1} had a significant effect on most of the vegetative and chemical growth characteristics, and the interaction spraying treatment with a concentration of 4000 Zn + 2000 Cu was characterized by giving the highest values in each of chlorophyll a, chlorophyll b, total chlorophyll, and the highest concentrations of phenols and flavonoids. Zahra *et al.* (2021) found when spraying with chelated zinc and nano-chelated zinc at concentrations of (1,5,1,0.5,0) g. L^{-1} led to a significant increase in menthol, menthone, and menthofuran, which amounted to (237,6%, and 28%) respectively compared to the control treatment.

Materials and Methods

The experiment was carried out in the wooden canopy of the Department of Horticulture and Landscaping / College of Agriculture / Tikrit University during the growing season 2021-2022. The experiment included studying the effect of spraying with glutamic acid and nano-zinc oxide on some characteristics of vegetative growth, the active substance, and some anatomical characteristics of *Lavendula Angustifolia Mill*, seedlings were selected. Lavender plant after was obtained from a private nursery in Dohuk governorate on February 11, 2021, in cork pots. The seedlings were transferred to plastic pots with a diameter (of 22 cm) on February 21, 2021, planted in mixed soil and peat moss at a ratio of 2:1.

Experimental design and parameters used: The study consisted of twofactors

The first factor: spraying with glutamic acid (C5H9NO4), symbolized by A, and at three levels:

- G0: comparison treatment (spray with distilled water only).
- G1: Spraying with glutamic acid at a concentration of 100 mg. L^{-1}. G2: Spraying with glutamic acid at a concentration of 200 mg. L^{-1}.

The second factor: spraying with zinc oxide nano-ZnO NP5, symbolized byZ, and at four levels

- Z0: comparison treatment (spraying with distilled water only)
- Z1: spraying with nano zinc oxide at a concentration of 0.50 g. L^{-1}. Z2: spraying with nano-zinc oxide at a concentration of 1 g. L^{-1}.
- Z3: spraying with nano-zinc at a concentration of 1.50 g. L^{-1}.

The study consisted of (12) factorial treatments from the interactions of factors, so the number of plants in one experimental unit became 4 pots and with three

replications 12 x 4 x 3 = 144 seedlings were used in Experience, the plants were sprayed with glutamic acid in three batches, the first one month after transferring the seedlings on 2/2/2021 and the second 10 days after the first batch, and the third 10 days after the second batch. As for the nano-zinc oxide, it was sprayed five days after each spray the experiment was designed accordingto a randomized complete block design (RCBD).The experiment was carried out according to a Randomized Complete Block Design (RCBD). As a factorial experiment, the results were analyzed using the SAS program and the averages were compared according to Duncan's polynomial test at a probability level of 5%.

Studied Traits

Determination of some active compounds in the volatile oil of lavender leaves using GC-FID device.

Oil extraction

He took (20 g) of the fresh form, put a beaker, added to it (100 ml) of distilled water, and put it in the Clevenger device for 3 hours. Collect the oil andadd to it 20 ml of hexane to separate the oil from the water droplets collected with the oil, Put the oil in sterilized cans and put it in the refrigerator until the analysis process.

Analysis method

The test was carried out in the laboratories of the Ministry of Science and Technology / Department of Environment and Water using a gas chromatograph device, Shimadzu 2010 model, Japanese origin, using the Flame Ionized Detector (FID) and using a capillary column type (DM-5Ms) with lengths (30m* 0.25 um * 0.25 mm), where the temperature was The temperature of the injection area and the detector, respectively: (280, 340 C), while the temperature of the separation column was gradual, starting from (100 - 300) degrees Celsius, at a rate of 10 degrees/min. Use of inert nitrogen gas as a carrier gas at a rate of 100 KPa (Hclnl et al., 2013). The following compounds were analyzed: (% Linalool - Linalyl acetate % - Lavandulyl acetate %) using the following equation: Active ingredient concentration % = concentration of the standard substance x area of the sample/area of the standard substance x dilution factor/weight of the sample x 100. Study of some anatomical characteristics of lavender leaves Epidermis Preparation Fresh samples were prepared as they were used directly and according to the method of (Jonson, 1940 Stace, 1965). We obtained the following anatomical sections.

Results and Discussion

Effect of spraying with glutamic acid and nano zinc oxide on the activesubstances of lavender leaves using GC-FID device. Table (1) shows that the interaction treatment G2Z3 (spraying with glutamicacid at a concentration of 200 $mg.L^{-1}$ + nano-zinc oxide at a concentration of 1.50 $g.L^{-1}$) was superior by giving the highest concentration of the active substances compounds phenols in the volatile oil in lavender leaves in both (Linalyl acetate, Linalool, Lavandulyl acetate)

reached (33.32 - 20.69 - 120.4) respectively, compared to the lowest concentrations of the control treatment, which reached (30.25, 16.88, 17.86), respectively.

Table 1
Effect of spraying with glutamic acid and nano zinc oxide on some active substances of lavender plants using GC-FID device

Parameters	% Linalool	% Linalyl acetate	Lavandulyl acetate %
G0Z0	30.25	16.88	17.86
G0Z1	30.62	17.15	18.05
GOZ2	31.25	17.60	18.50
G0Z3	31.96	19.20	19.30
G1Z0	30.89	17.36	18.23
G1Z1	31.78	18.90	19.02
G1Z2	32.20	19.56	19.58
G1Z3	32.74	20.22	20.08
G2Z0	31.45	17.86	18.79
G2Z1	32.48	19.89	19.78
G2Z2	33.05	20.48	20.20
G2Z3	33.32	20.69	20.41

Effect of spraying with glutamic acid and nano zinc oxide on some anatomical characteristics of lavender buds

Table (2) shows that the stomata on the lower surface of the lavender leaf were 196 µm, while on the upper surface of the leaf it reached 195 µm. We note the convergence of the stomata between the two surfaces of the leaf, and this may be due to the genetic structure and environmental conditions surrounding the plant. As for the stomata evidence, it was on the lower surface is more than the upper surface, as it reached 15, while on the lower surface it reached 13, and it may be attributed to the exposure of the upper surface to environmental stress and environmental conditions more than the lower surface. As for the average length and width of normal epidermal cells, it was wider on the bottom surface of the leaf, which reached 300 micrometers, compared to the top surface of the leaf, and it was narrow, reaching 290 micrometers, despite the absence of a significant difference between them.Table (3), shows that the frequency of stomata per unit area (mm^2) was moreon the lower surface than on the upper surface, as it reached 23 stomata on the lower surface. mm^2 compared to the upper surface, which amounted to 18 holes. mm^2, as the average between the upper and lower surfaces of the gap frequency, was 0.78 mm 2 and there was no significant difference between the two surfaces, which indicates the adaptation of the higher plant to the surrounding environmental conditions.

Table 2
Shows the dimensions of the stomata (stomata space) and the upper and lower epidermis of leaves in lavender plants in micrometers

Adjectives	Stomata in Lower	Stoma	Stomata in Upper	Stoma	Average length x

Samples	Surface		guide on Lower Surface	Surface		guide on Upper Surface	average width of normal cells	
	Length	Width		Length	Width		Lower Surface	Upper Surface
1	13-15 (14)	12-16 (14)	15	11-15 (13)	13-16 (15)	13	12×25	10×29

Table 3
Shows the variation in stomata frequency in the leaves of the lavender plant

Adjectives / Samples	Frequency of leaf stomata			
	Lower Surface	Upper Surface	The ratio between the ratio of the upperand lower surface Ratio U/L	
1	18-26 (23)	12-16 (14)	16-20 (18)	0.78

Table 4
Shows the quantitative characteristics of the leaf cross-sections of lavender, measured in micrometers

Adjectives / Samples	Cuticle thickness		epidermis Leaf thickness rate		Number of rows of Emadi tissue	Emadi tissue thickness rate	Emadi cell aspect rate		Number of rows squishy tissue	squishy tissue thickness rate	squishy cellaspect rate	
	Upper	Lower	Upper	Lower			Length	Width			Length	Width
1	4	2	18	17	3-2	55	20	15	5-4	65	15	11

Table 5
Shows the phenotypic characteristics of the surface covering of leaves andstems in lavender plants

Adjectives / Samples	superficial coating (capillaries)			
	Hairs type	The number of component cells	The number of cells of the filament carrier	filament base shape
Upper and lower epidermal leaf	Glandular	single-celled head two-celled head with a multicellular head	Unicellular	circular
Leaf and stem	no Glandular	multicellular branched triple branched	Unicellular Multicellular	circular and triangular
Leaf	Peltate	head made of one cell	not embroidered	straight

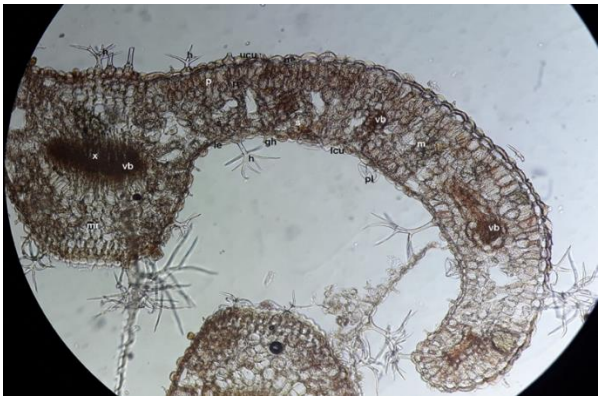


Figure 1. A cross-section of lavender leaves showing their parts. Magnification power10 x

Ue:upper epidermis, le:lower epidermis, h:hair, gh:galand hair, x:xylum, ph:phloem, mr:midrib, vb:vascular bundle, ucu:upper cuticle, lcu: lower cuticle, m:mesophyll, p:palisadetissue,s:spongytissue.

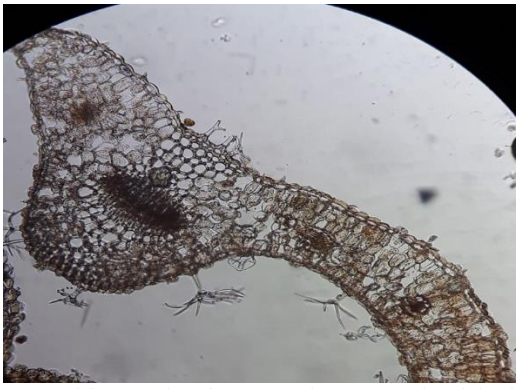


Figure 2. A cross-section of lavender leaves showing the blade and the middle vein

Magnification power 10 x.

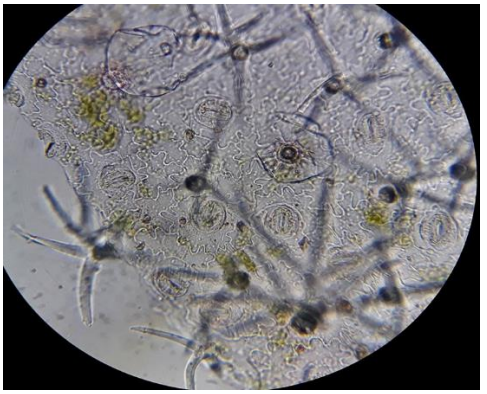


Figure 3. The upper epidermis of lavender leaves shows stomata, normal epidermalcells, and superficial epidermis. Magnification power 40 x

From the study of the external and internal appearance of the leaves of the lavender plant, it was found that the young and mature leaves of this plant had a dense surface covering that included an abundance of glandular hairs and non-glandular hairs, although the glandular hairs were of two types:

Capitate glandular hairs

It is characterized by its short neck (1-2 cells) and a single-celled spherical glandular head.

Peltate glandular hairs

It consists of a very short neck and a multicellular head (4-6 cells). It was noted from the study of the surface covering, whether incomplete or sectional preparations of the leaves, that the glandular hairs of both types on the lower epidermis are denser than the upper surface (Fig. 6). As for the adenoid hairs, they are very dense on the upper and lower surfacesof the leaf (Fig. 6). They are of a multicellular type and branched in star-shaped, and the shape of the base is circular and triangular. Other than that, the leaves of the plant did not show any other secretory structures, which was shown by the study of the cross-sections of the leaves of this plant. Below is a description of the internal structure of lavender leaves.

Dermal tissue system
A- upper (or adaxial) epidermis

It is represented by a single row of cells (uniseriate), 18 µm thick and coveredwith a cuticle 4 µm thick in the upper layer of the leaf, and the lower epidermis2 µm due to adaptation to the environment and exposure of the upper epidermis to heat and light. It is characterized by the density of non-glandular hairs in the upper epidermis, as well as the presence of important glandular and shield hairs.

Lower (or abaxial) epidermis

It is represented by a single row of cells up to 17 µm thick, containing normal cells and an abundance of stomata and glandular capillaries of both important and shielding types. According to this description, the leaf tends to be amphistomatic (meaning the abundance of stomata on the lower epidermis).

Ground tissue system

It is represented by a basic tissue consisting of normal Brinkema that extends from the upper epidermis in the form of arms that cut the mesophyll in lobes giving it a zigzag or wavy shape. The green part of the mesophyll is of a dorsiventral type (bifacial, i.e., distinct into two regions, one for the palisade parenchyma, which is organized by 2-3 rows and up to 55 µm thick, and the other for the spongy parenchyma, which is arranged in rows of 5-4 rows of cells The average thickness of the spongy tissue was 65 micrometers. It was noted in the Midrib region that the mesophyll extends into this region to surround the Midrib.

Vascular tissue system

It is represented by closed collateral vascular bundles closed distributed in the mesophyll (Fig. 2), while the midrib is represented by an arc bundle shaped with cap fibers from its side (i.e., towards the lower epidermis) and surrounded on the lower epidermis by a basic component tissue of Lamellar Collenchyma under the inferior epidermis followed by Ordinary parenchyma (Fig. 2).

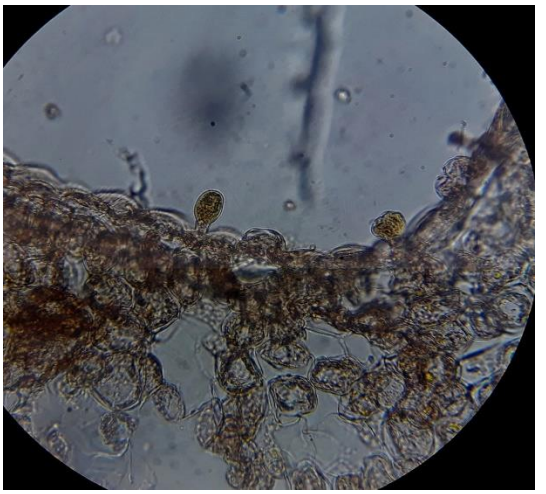


Figure 4. Glandular hairs in the epidermis of lavender leaves and stems showing the single-celled glandular head. The second cell and the multi-cell are mounted on a single-cell holder and the base is circular

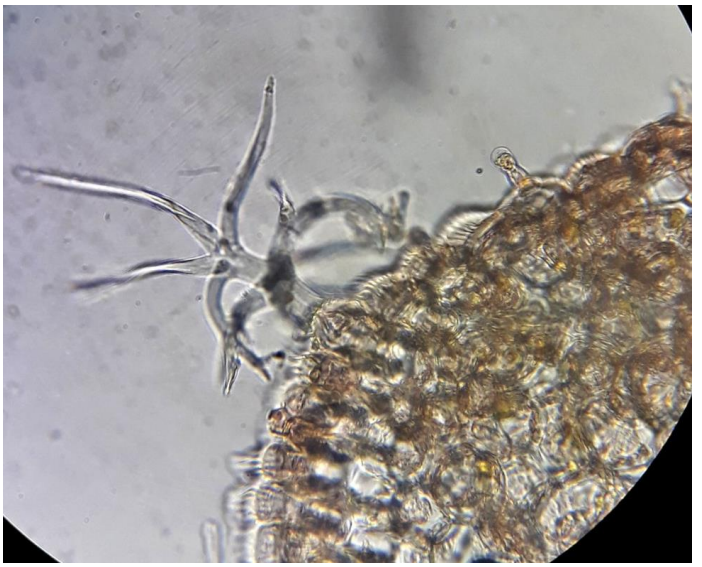


Figure 5. Glandular and adenoid hairs in the epidermis of lavender leaves in the middle vein. A glandular hair with a single glandular head is carried on a single-celledcarrier, while the adenoid hair is a branched, multi-celled hair. Magnification power 40X

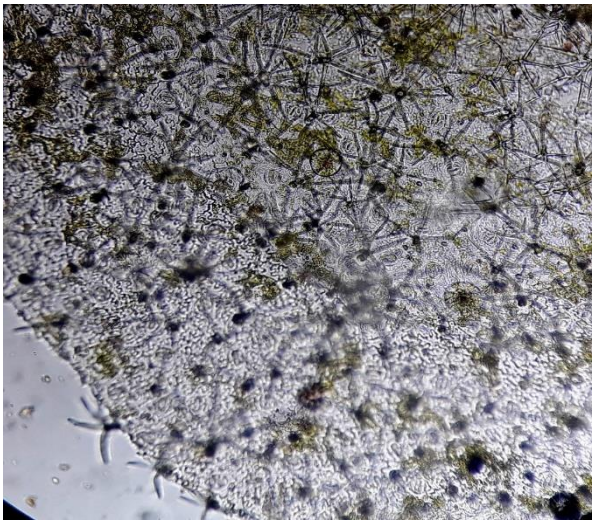


Figure 6. The adenoid hairs in the epidermis of the lavender plant show the density ofhairs on the upper surface of the upper epidermis. 10x

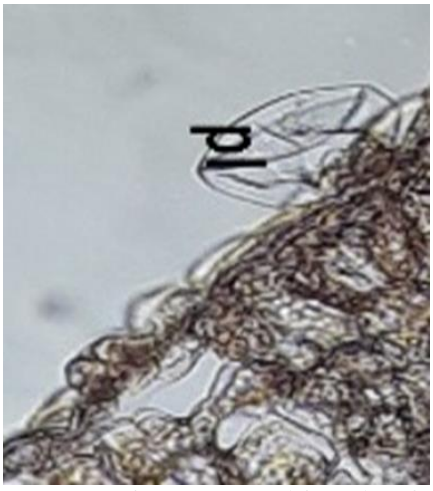


Figure 7. Peltate hair appears on the upper epidermis of the lavender plant leaves without a neck

Discussion

The observed effect of increasing the active substance in lavender leaves by the foliar spray method may be attributed to the rapid arrival of the added nutrients in the foliar spray method and their representation in metabolic sites through stomata in leaves or wounds and scratches in the cuticle layer and through cytoplasmic bridges to reach the cells at a faster time. Which helps in the continuity of the nutritional tide and metabolic processes (Ruttkay-Nedecky *et al.*, 2017), which is positively reflected in the increase in the nutritional substance in the plant. The addition of amino acids to the plant leads to an increase in the number and expansion of cell divisions and contributes to the production and formation of secondary metabolic compounds in medicinal plants, and its

important role inthe formation of plant tissues (Rafiee et al., 2016). The increase in the leaf content of active compounds and total phenols is because nano-fertilizers provide different metabolic reactions in the plant with a larger surface area, which leads to an increase in the rate of photosynthesis, thus preserving the plant from various vital stresses (Singh et al., 2017), which Positively reflected on the increase of most of the active compounds. As for the anatomical characteristics, we note that the plant itself with pre-existing defensive means "against difficult environmental conditions, which is the presence of adenoid hairs in a very large density" on the surfaces of the upper and lower leaves, and their type, which was multicellular and branched in a star shape, as noted in the above figures, which may be one of the reasons Increasing the effective compounds in the plant, since the active compounds are found in the form of oilglands on the epidermis layer, not in the form of grooves inside the leaf.

We conclude the study

The interaction treatment A2Z3 (spraying with glutamic acid at aconcentration of 200 mg. L^{-1} + nano zinc oxide at a concentration of 1.50 g. L^{-1}) was characterized by giving the highest concentrations of the active substance in the leaves of the plant. From taking some anatomical sections of lavender leaves, it was found that they contain two types of hairs:

- adenoid capillaries; It is of multicellular type and branched star-shaped, and the base shape is circular or triangular.
- The glandular hairs are distinguished by two types, including the pedunculated with a spherical glandular head, single-celled, and the shield (seated) with a very short neck and a multicellular head (4-6 cells) found on the epidermal layer Lavender leaf.

From the results obtained, we recommend

Conducting future studies using higher levels of glutamic acid and nano zinc oxide on the same plant and at higher concentrations. And study the date of planting and appropriate environmental conditions. Study some anatomical sections of lavender plant flowers to know the type of glandular hairs.

References

Ahmadreza , A. ; F. Shahrabadi and B. Valizadehkaji.(2022) . Effects of green synthesized Zinc and copper nano- fertilizers on the morphological and biochemical attributes of basil plant . Journal of plant Nutrition . V:43- Issue .8.

Curtis ,B . (2005) . Lavender production and marketing . Washington Atate Univerity (WSU) Cooperative Extension Bulletin . Online : http:// www. Small farms. Wsu.edu/ crops/ Lavender.html . Accessed 19 August 2006.

Ewais Magda, A., Amina, Abd El-Tif, Awtaf , M.A. Mahmud and M.M. Abd El-Ghani , (2005). Integrated effect of organic and inorganic fertilizerson growth, yield and NPK uptake by onion plants gro wn on a sandy soil Egypt. J. Appl. Sci., 20(10A): 702-716.

Bisset , N .G.(1994). Herbal drugs and phyto pharmaceuticals . Boca Raton , FL , CRC Press.

Jain,V. K. ; F. amentals (2011) . of plant physiology,13thed.S. Chand and Company LTD. Romanger. New Delhi, India: 137-140.

Jonson , A.C.(1940) . microscopic preparation in plant tissues . botanical journal of American union .press . usa. P:30-38.

Hendawy , S. F.; EL-Sherbeny , S.E. Hussein , M .S. Khalid, K .A. and Ghazal , G.M .(2012) . Response of Two species of black cumin to foliar spray treatments ' Aust . J.Basic and Appli . Sci .,6(10) 636-642.

Mengel .K . and E. A . Kirkby .(2001) . principles of plant Nutrition , 5th edition. ISBN 0-7973-7150-x.

Rafiee, H; B. H. Naghdi; A. Mehrafarin; A. Qaderi; N.Zarinpanjeh; A. Sekara and E. Zand.)2016.(Application of Plant Biostimulants as New Approach to Improve the Biological Responses of Medicinal Plants- A Critical Review. Journal of Medicinal Plants. 15(59): 1-34.

Ruttkay - Nedecky, B.; Krystofova,O.; Nejdl,L. and Adam,V.(2017). Nanoparticles based on essential metals and their phytotoxicity. J.Nanobiotechnol, 15(33):2-19.

Saburi , M.; Hadi , M.R .H.S. and Darzi , M.T.(2014). Effect of amino acids and nitrogen fixing bacteria on quantitative yield and essential oil content of basil (*Ocimum basilicum*). Agric.Sci. Dev. 3(8) :265-268.

Singh, A; S. Singh and S. M. Prasad.(2016). Scope of nanotechnology in crop science : profit or Loss . Research and Reviews : Journal of Botanical sciences. 5(1):1-4.

Stace , D . J. (1965) . Preparation of epidermis in plants. botanical journal . usa .p14-22.

WHO. (2001) . Monographs on selected medicinal plants . Vol . 3.I .WHO , Consultation on Selected Medicinal Plants . (3rd :2001 : Ottawa,Ont) II.World Health Organization.

Zahra ,N .L. Ali, A.J. pejhman,M and Alireza ,L,M.(2021) .Application of chelate and nanooche late Zinc micronutrient ormorpho- physiological traits and Essential oil compounds of peppermint cmontha piperitalo.journal of medicinal plants and Ry-products; 1:21-28.

Zivile , T . ; A . Velicka and A . Paulauskiene . (2021) . Impact of Foliar Application of amino acids Total Phenols, Phenolic acids Content of Different Mints Varieties under the Field Condition . Plants.10:599.

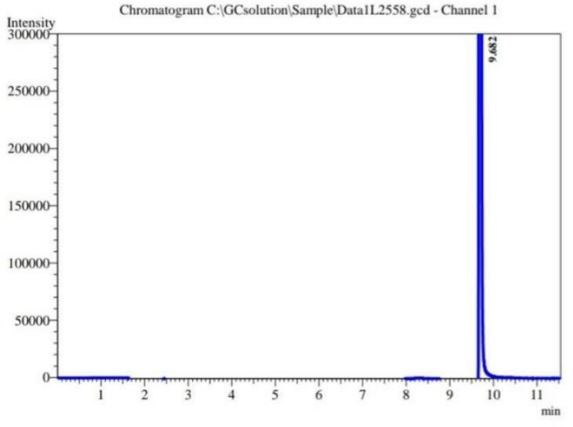
Rinartha, K., & Suryasa, W. (2017). Comparative study for better result on query suggestion of article searching with MySQL pattern matching and Jaccard similarity. In *2017 5th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-4). IEEE.

Rinartha, K., Suryasa, W., & Kartika, L. G. S. (2018). Comparative Analysis of String Similarity on Dynamic Query Suggestions. In *2018 Electrical Power, Electronics, Communications, Controls and Informatics Seminar (EECCIS)* (pp. 399-404). IEEE.

Gandamayu, I. B. M., Antari, N. W. S., & Strisanti, I. A. S. (2022). The level of community compliance in implementing health protocols to prevent the spread of COVID-19. International Journal of Health & Medical Sciences, 5(2), 177-182. https://doi.org/10.21744/ijhms.v5n2.1897

Estimation of some active compounds in the volatile oil of lavender leaves

Sample Information
Sample Name = linalool 0.2 %
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa

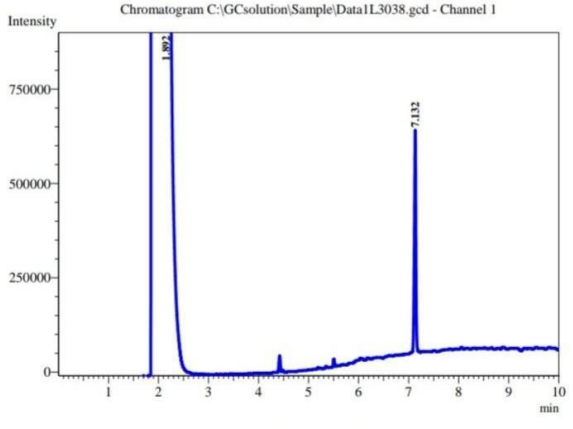


Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	9.682	26987820	100.0000	13953566	
Total		26987820	100.0000	13953566	

Appendix (1) Linalool Standard Curve

Sample Information
Sample Name = linalyl acetat l 0.2 %
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa

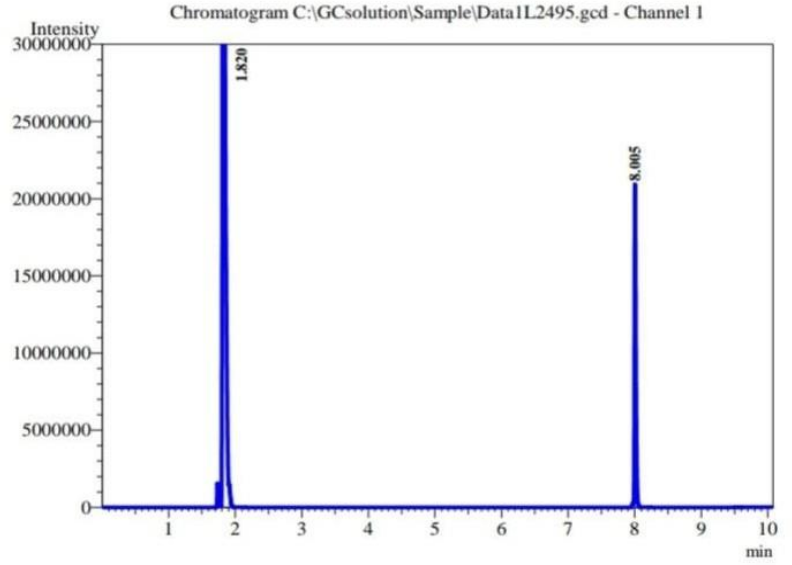


Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	1.892	912294428	99.9308	95261853	
2	7.132	632042	0.0692	395384	
Total		912926470	100.0000	95657237	

Appendix (2) Standard curve for Linalyl acetate

Sample Information
Sample Name = lavandulyl acetat l 0.2 %
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



Peak Table - Channel 1

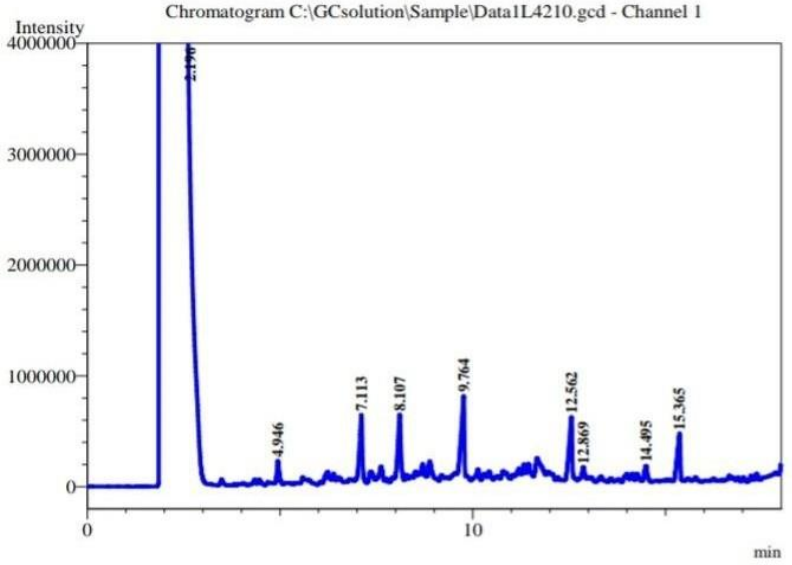
Peak#	Ret.Time	Area	Area%	Height	Name
1	1.820	215581535	87.8005	92594090	
2	8.005	29954054	12.1995	20378662	
Total		245535589	100.0000	12972752	

2858

Appendix (3) Standard curve for Lavandulyl acetate

Sample Information

Sample Name = 1
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



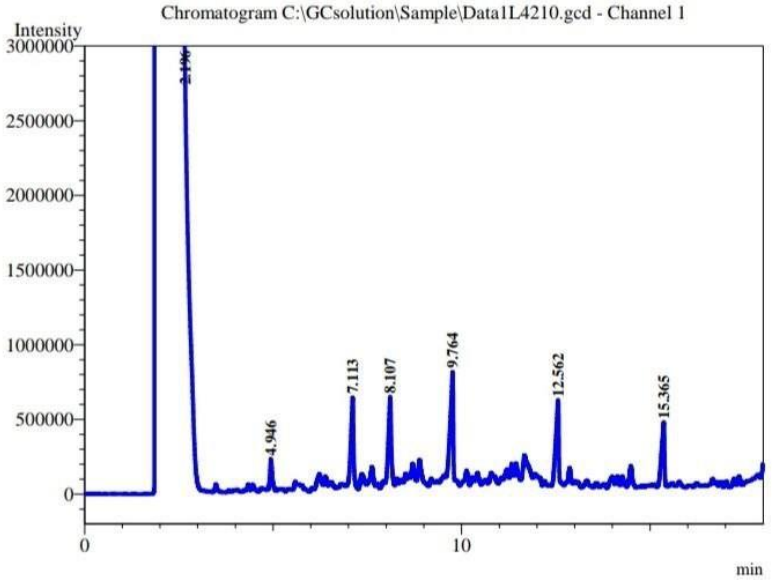
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2692007033	99.3689	39382846	
2	4.946	879097	0.0324	208559	
3	7.113	2932543	0.1082	595181	
4	8.107	3033691	0.1120	584153	
5	9.764	3868995	0.1428	719176	
6	12.562	3015824	0.1113	557889	
7	12.869	388982	0.0144	101196	
8	14.495	714211	0.0264	138236	
9	15.365	2264635	0.0836	427931	
Total		2709105011	100.0000	42715167	

Appendix (4) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G0Z0

Sample Information

Sample Name = 2
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



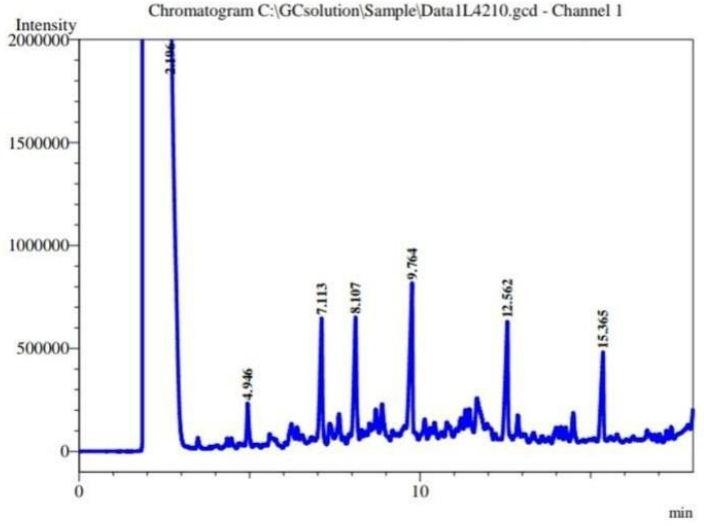
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2671561868	99.6582	39169117	
2	4.946	524581	0.0196	166786	
3	7.113	776474	0.0290	230356	
4	8.107	1383377	0.0516	401699	
5	9.764	2811853	0.1049	661476	
6	12.562	1871016	0.0698	479540	
7	15.365	1796216	0.0670	375646	
Total		2680725385	100.0000	41484620	

Appendix (5) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G0Z1

Sample Information

Sample Name = 3
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



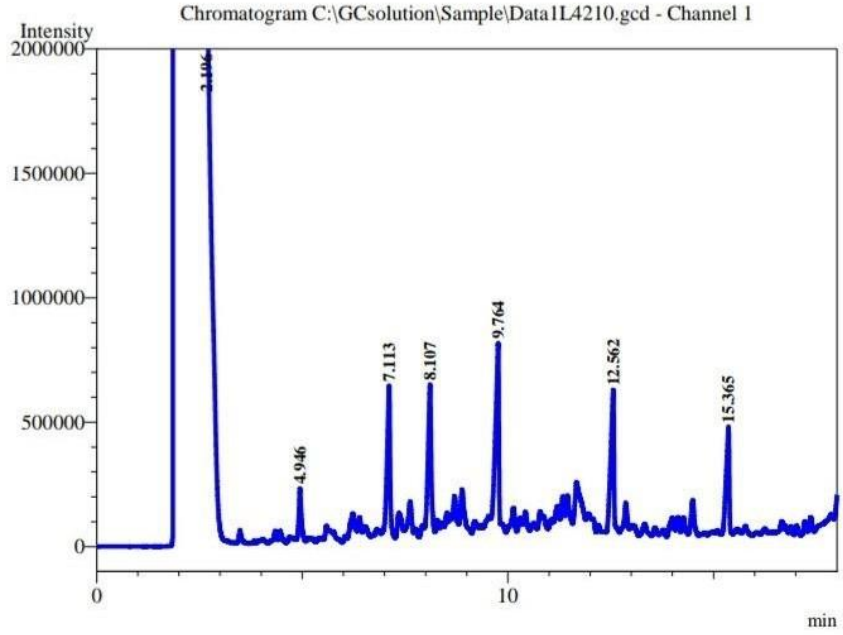
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2466640803	99.6540	35045709	
2	4.946	524581	0.0212	166786	
3	7.113	1103387	0.0446	357951	
4	8.107	1933146	0.0781	478009	
5	9.764	2137421	0.0864	605522	
6	12.562	1208985	0.0488	286221	
7	15.365	1657653	0.0670	368840	
Total		2475205976	100.0000	37309038	

Appendix (6) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G0Z2

Sample Information

Sample Name = 4
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



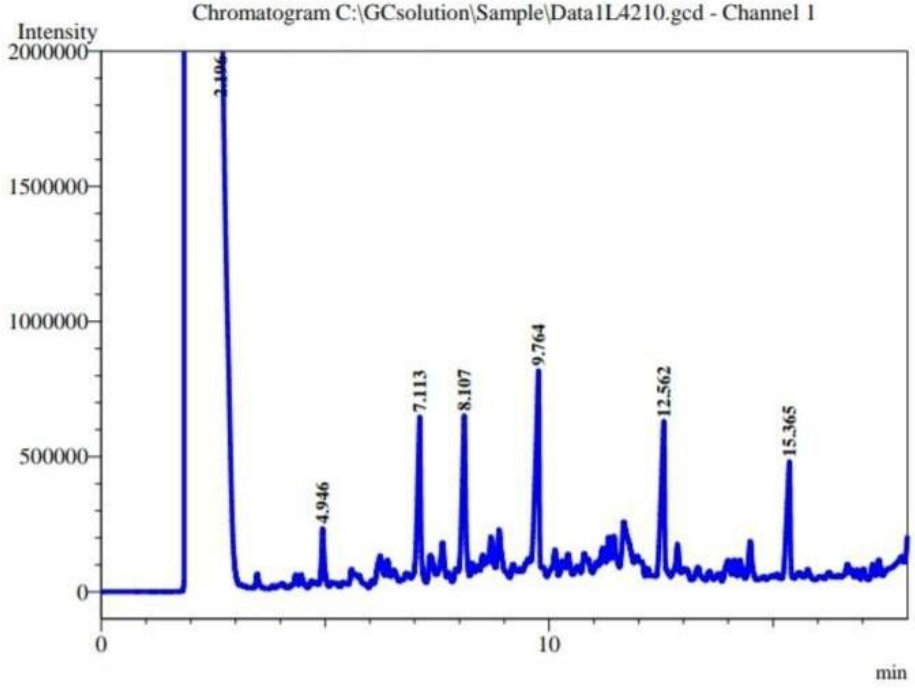
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2665804262	99.7333	39104969	
2	4.946	212617	0.0080	99852	
3	7.113	1490945	0.0558	449001	
4	8.107	1383377	0.0518	401699	
5	9.764	1763322	0.0660	567398	
6	12.562	1091738	0.0408	281516	
7	15.365	1186548	0.0444	344913	
Total		2672932809	100.0000	41249348	

Appendix 7 Behavior of the active compounds in the volatile oil oflavender leaves when treated with G0Z3

Sample Information

Sample Name = 5
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



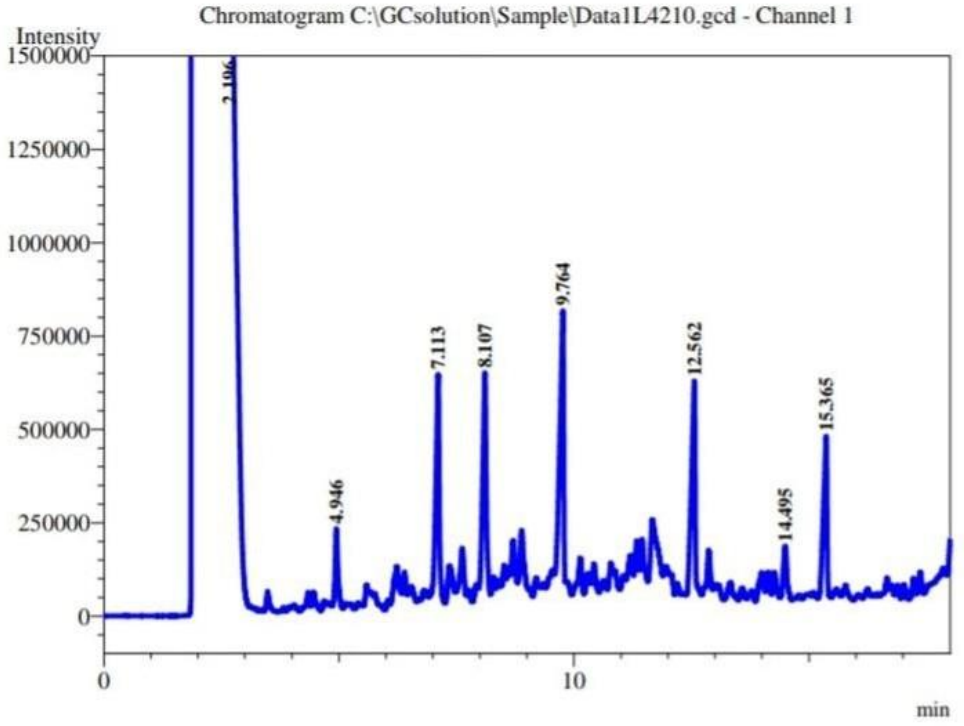
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2654833675	99.6620	38970192	
2	4.946	305614	0.0115	119018	
3	7.113	2131910	0.0800	525496	
4	8.107	1392251	0.0523	364555	
5	9.764	2504050	0.0940	635112	
6	12.562	1906538	0.0716	464874	
7	15.365	764709	0.0287	214005	
Total		2663838747	100.0000	41293252	

Appendix (8) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G1Z0

Sample Information

Sample Name = 6
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



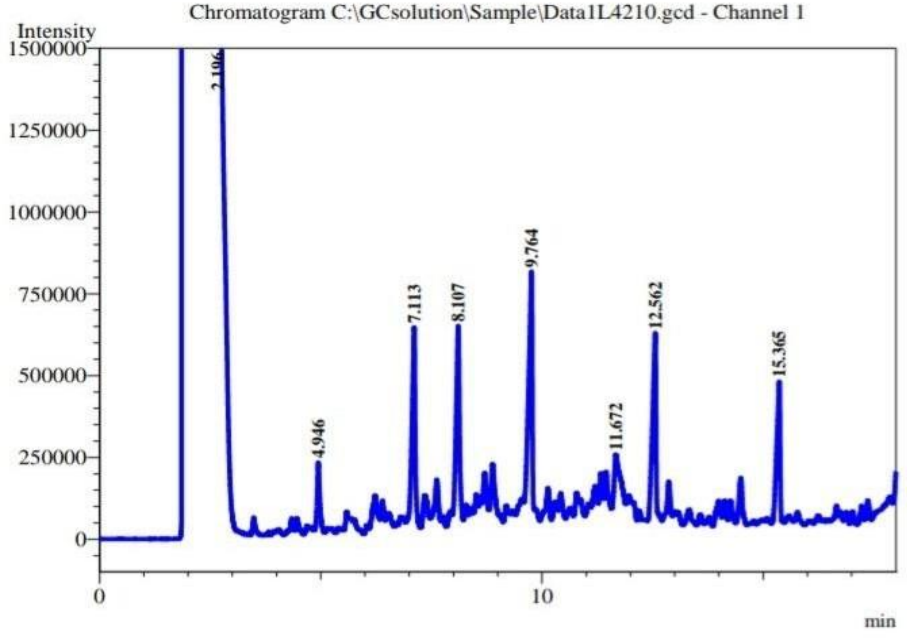
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2651070148	99.6601	38921069	
2	4.946	270147	0.0102	110017	
3	7.113	1292369	0.0486	374313	
4	8.107	1635716	0.0615	427042	
5	9.764	2539453	0.0955	641510	
6	12.562	2140572	0.0805	478289	
7	14.495	287783	0.0108	87567	
8	15.365	876790	0.0330	219630	
Total		2660112978	100.0000	41259437	

Appendix (9) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G1Z1

Sample Information

Sample Name = 7
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



Peak Table - Channel 1

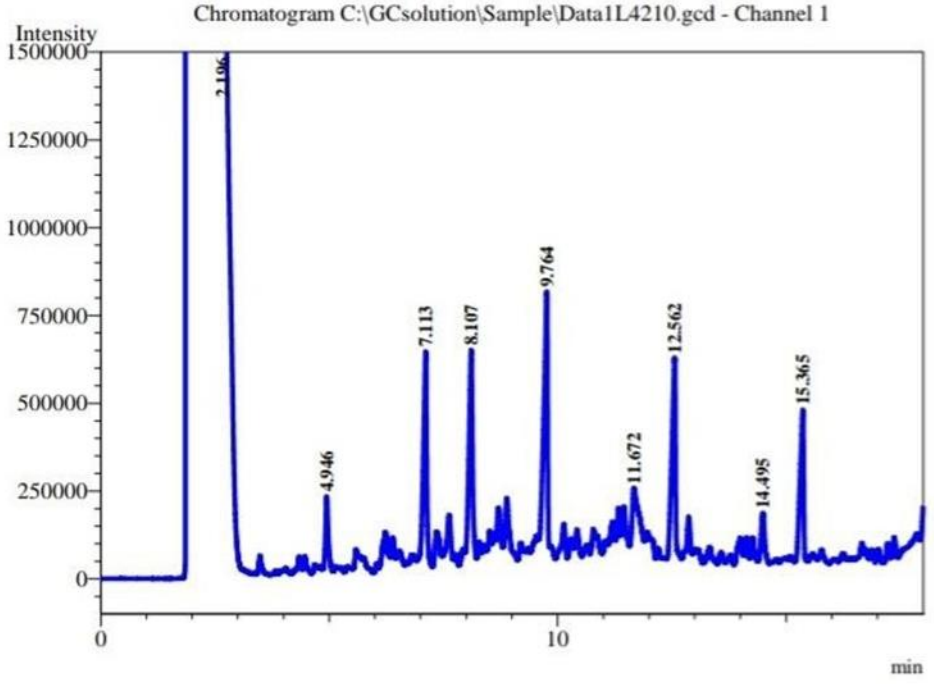
Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2665715247	99.6387	39103099	
2	4.946	397443	0.0149	141755	
3	7.113	1293778	0.0484	424020	
4	8.107	1383377	0.0517	401699	
5	9.764	2755860	0.1030	654224	
6	11.672	676537	0.0253	116631	
7	12.562	2040027	0.0763	491726	
8	15.365	1119143	0.0418	329503	
Total		2675381412	100.0000	41662657	

Appendix (10) Behavior of the active compounds in the volatile oil oflavender leaves when treated with G1Z2

Appendix (11) Behavior of the active compounds in the volatile oil of lavender leaves when treated with G1Z3

Sample Information

Sample Name = 8
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



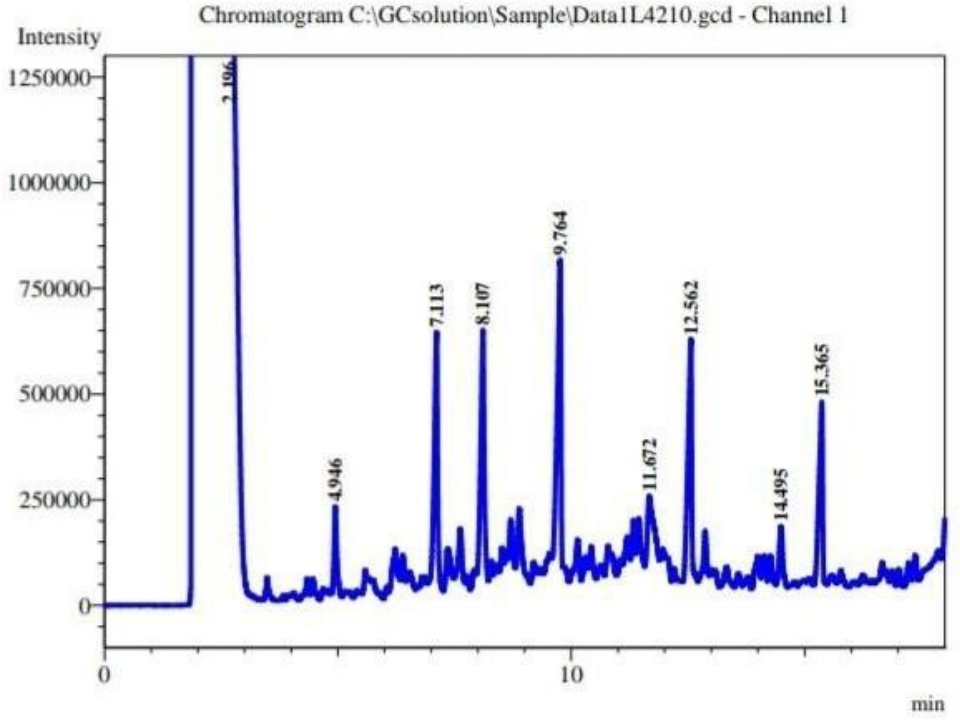
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2683914063	99.6024	39304250	
2	4.946	524581	0.0195	166786	
3	7.113	2329009	0.0864	540990	
4	8.107	2100782	0.0780	493160	
5	9.764	3083592	0.1144	671192	
6	11.672	829115	0.0308	132716	
7	12.562	1208985	0.0449	286221	
8	14.495	351488	0.0130	95055	
9	15.365	285580	0.0106	71610	
Total		2694627195	100.0000	41761980	

Appendix (12) Behavior of the active compounds in the volatile oil of lavender leaves when treated with G2Z0

Sample Information

Sample Name = 10
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



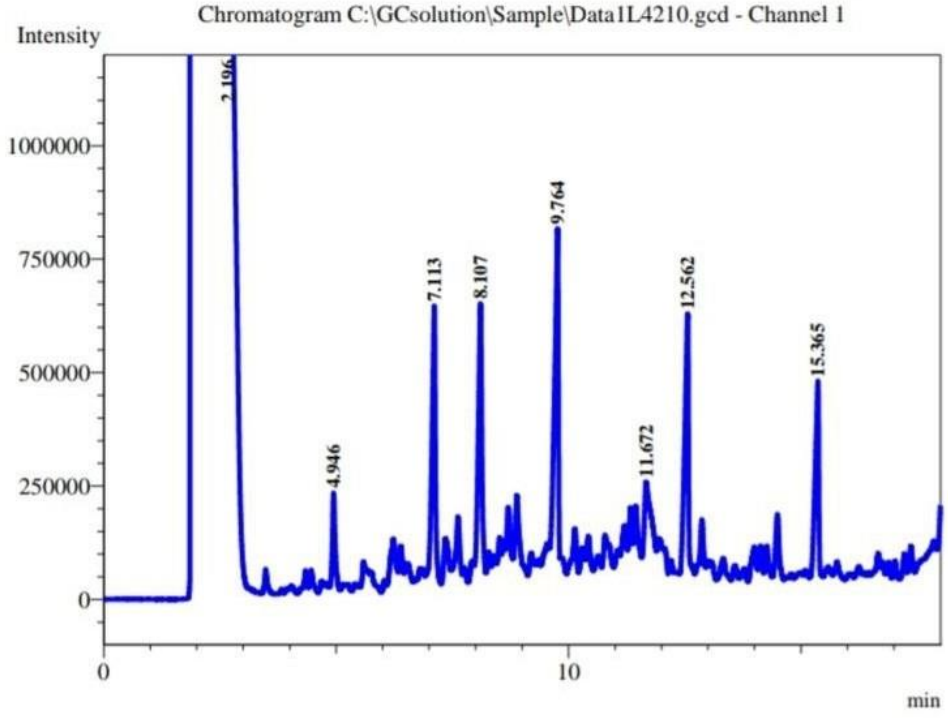
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2675431095	99.6198	39213695	
2	4.946	433933	0.0162	145832	
3	7.113	2412052	0.0898	546598	
4	8.107	1383377	0.0515	401699	
5	9.764	3083592	0.1148	671192	
6	11.672	472556	0.0176	93726	
7	12.562	1091738	0.0407	281516	
8	14.495	457050	0.0170	112980	
9	15.365	876790	0.0326	219630	
Total		2685642183	100.0000	41686868	

Appendix (13) Behavior of the active compounds in the volatile oil of lavender leaves when treated with G2Z1

Sample Information

Sample Name = 11
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



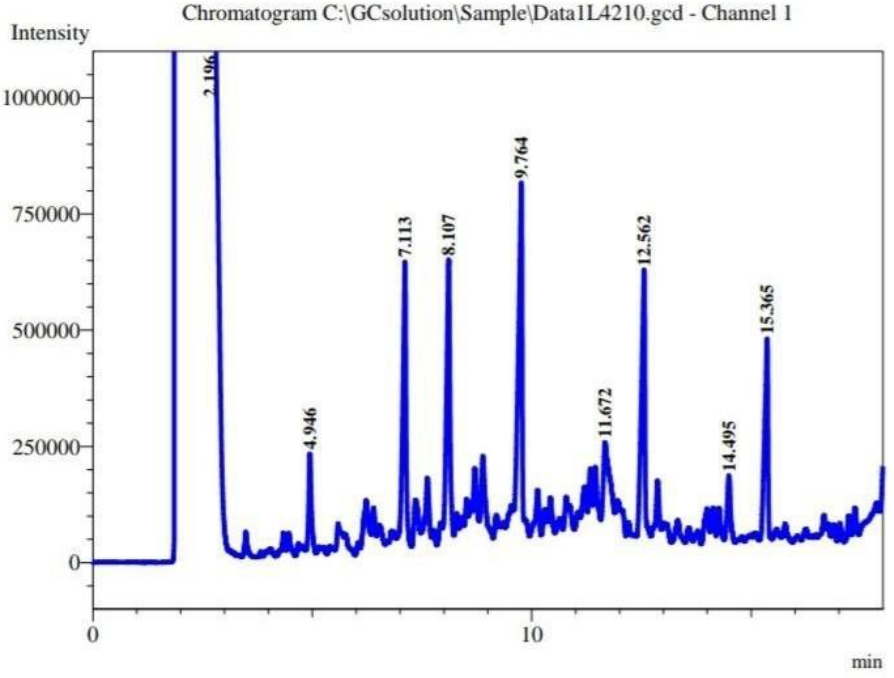
Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2470753703	99.6328	35075515	
2	4.946	425748	0.0172	146540	
3	7.113	1292369	0.0521	374313	
4	8.107	1383377	0.0558	401699	
5	9.764	1003979	0.0405	318292	
6	11.672	857949	0.0346	131433	
7	12.562	2272799	0.0917	484713	
8	15.365	1870801	0.0754	404279	
Total		2479860725	100.0000	37336784	

Appendix (14) Behavior of the active compounds in the volatile oil of lavender leaves when treated with G2Z2

Sample Information

Sample Name = 12
Injection Volume = 1 uL
Tem Injector = 295 C
Tem Detector (FID) = 330 C
Column Oven (ZB- 1) = 100 - 250 c (8 c / min)
pressure= 100kpa



Peak Table - Channel 1

Peak#	Ret.Time	Area	Area%	Height	Name
1	2.196	2690593120	99.6235	39364296	
2	4.946	366670	0.0136	137224	
3	7.113	1621575	0.0600	472864	
4	8.107	646483	0.0239	275551	
5	9.764	3165103	0.1172	683846	
6	11.672	739719	0.0274	104769	
7	12.562	1471090	0.0545	431243	
8	14.495	287783	0.0107	87567	
9	15.365	1870801	0.0693	404279	
Total		2700762344	100.0000	41961639	

Annex (15) Behavior of the active compounds in the volatile oil of lavender leaves when treated with G2Z3