IN VITRO EFFECTS OF *CLITORIA TERNATEA* AQUEOUS EXTRACT ON PHYSICOCHEMICAL COMPONENTS AND GROWTH OF *ACHILLEA FRAGRANTISSIMA* L. CULTIVATED UNDER SALINITY STRESS

EL SHERIF, F.[1,2*] – ALSOBAIE, M. M.[3] – KHATTAB, S.[1,2]

[1]*Department of Biological Sciences, College of Science, King Faisal University, AlAhsa 31982, Saudi Arabia*
(e-mail: skhattab@kfu.edu.sa (Khattab, S.), felsherif@kfu.edu.sa (El Sherif, E.))

[2]*Department of Horticulture, Faculty of Agriculture, Suez Canal University, Ismailia 41522, Egypt*

[3]*King Abdulaziz and His Companions Foundation for Giftedness and Creativity "Mawhiba", Al Ahsa, Saudi Arabia*
(e-mail: mariamalsobaie2008@gmail.com)

[*]*Corresponding author*
e-mail: felsherif@kfu.edu.sa; phone: +966-5355-41288

(Received 29th Oct 2024; accepted 24th Jan 2025)

Abstract. *Clitoria ternatea* flowers aquatic extract (CTFAE) contains a mixture of essential elements, which promote plant growth and yield. *Achillea fragrantissima* is a medicinal plant native in Saudi Arabia. It has antiviral, anti-neuroinflammatory, anticancer and antispasmodic. Salinity is a primary abiotic environmental challenge, disrupting source-sink relationships, senescence, cellular metabolisms, and ultimately hindering plant growth and development. In this study, a novel strategy for enhancing *A. fragrantissima* propagation under salinity stress by applying a natural plant growth enhancer, CTFAE, to in-vitro plantlets were investigated. The experiment was conducted using a split-plot design with salinity levels as the main factor and CTFAE concentrations as the sub-factor. The CTFAE at concentrations of 0.5 g/L or 1.0 g/L and distinct concentrations of seawater were introduced to the MS media to set salinity level (2000 ppm and 4000 ppm). Our results revealed that CTFAE effectively enhanced *A. fragrantissima* seed germination and plant growth during multiplication and rooting stages, as well as increased the phytochemical compounds in *A. fragrantissima* plants as compared to control treatment. Furthermore, for plants that were exposed to 4000 ppm salinity levels, the application of 0.5 g/L CTFAE was able to alleviate the salinity-induced adverse effects on some of the plant growth parameters.
Keywords: *GC-MS, qaysoom, bio-stimulant, abiotic stress, tissue culture*

Introduction

Crop productivity and production are negatively impacted by biotic and abiotic stresses resulting in enormous economic losses globally. One of the primary abiotic environmental challenges is salinity, that is brought on by dissolved salt in soil water. Salinity sterss disrupts source-sink relationships, speeds up senescence, slows down cellular metabolisms, and ultimately hinders plant growth and development (Sarmoum et al., 2019). Studies have been carried out in recent years to identify the mechanisms underlying salinity tolerance and to create plants that can withstand salt (Murtaza et al., 2024). One of the most crucial stages to lessen the effect of salinity on crops and their production is the search for materials and treatments that boost the resistance and tolerance of salt-intolerant plants. Natural substant and plant extracts that contain

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

significant and useful substances that enhance other plants' growth and increase their resistance to the negative effects of salinity are among the most important tools used to lessen the effect of salinity on plant production and growth (Alkuwayti et al., 2020; Noreen et al., 2024). The perennial leguminous herb *Clitoria ternatea*, also known as the butterfly pea, has garnered a lot of attention due to its numerous uses in agriculture and medicine. These include use as a crop for cosmetics, traditional medicine, food coloring, and the production of an environmentally friendly insecticide (Jamil et al., 2018). Butterfly pea flowers contain a variety of phytochemical compounds, including flavonoids, anthocyanins, alkaloids, steroids, tannins, and reducing sugars (Escher et al., 2020), which may function as a biostimulant to promote plant development. It is challenging to select crops for salt tolerance based on yield performance in fields because of the significant spatial variation of the salinity level in fields (Pecetti et al., 2024).

Plant biotechnology techniques such as tissue culture have been effectively employed to enhance plant features and efforts to develop stress tolerance to plants (Goda et al., 2017; Khalifa et al., 2023). Because there is greater control over plant growth than in the outside environment and because evaluations are typically favorable to good outcomes in a limited space, *in vitro* cultivation techniques can greatly aid in the study and selection of plant species (Трушкин et al., 2013). Secondary metabolites, which are frequently good sources of bioactive chemicals employed in the pharmaceutical and medical industries, are found in medicinal plants. Asteraceae family: *Achillea fragrantissima* (Forssk.), a fragrant perennial wild herb also known as lavender cotton in English and Qaysoom in Arabic (El-Ashmawy et al., 2016), is considered a fundamental part of Middle Eastern folk medicine. It has been used historically in the Arabian Peninsula to treat a wide range of ailments, including fever, rheumatism, and diabetes (El Fattah et al., 2018; Goda et al., 2023a). *A. fragrantissima* is useful in treating a wide range of ailments, including headaches, exhaustion, smallpox, ophthalmic issues, menstrual difficulties, and lung impacts (Farouk et al., 2019). The essential oil of *A. fragrantissima* has demonstrated efficacy against a variety of drug-resistant bacteria (Zeedan, 2014). According to the literature, no research has been done on the impact of CTFAE as a biostimulant on plant growth. The objective of this investigation is to detailed the specific method of using an aqueous extract of *C. ternatea* flowers (CTFAE) to enhance the growth, yield, and salinity tolerance of *A. fragrantissima* under *in vitro* condition.

Materials and methods

Sources of A. fragrantissima seeds and C. ternatea flower powder

C. ternatea powdered flower was purchased from Earth Circle Organics (USA). Seeds of *A. fragrantissima* were collected at Wadi Harqan, Alqareenah, Riyadh, Saudi Arabia.

Analysis of C. ternatea flower powder compositions

Analyses of macro- and micro-nutrients composition of *C. ternatea* flower powder were performed according to Ryan et al. (2001). Extraction and identification of vitamins were performed as Shindy and Smith (1975); and Qian and Sheng (1998) methods. Fat and total protein were measured according to Chen (2019). The compositions from the above analysis were documented in *Table 2.*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Preparation of aquatic extracts from C. ternatea flower powder

C. ternatea flower powder Aqueous extract was prepared according to Escher et al. (2020) method.

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on seed germination percentage of A. fragrantissima

A. fragrantissima seeds were first soaked in a 70% ethanol solution for 30 seconds, then submerged in a 5% (v/v) sodium hypochlorite solution for 5 minutes, and lastly washed three times with sterile tap water while being exposed to laminar airflow. In 60 ml capacity tubes containing 15 ml of half-strength (1 /2X) Murashige and Skoog (MS) basic salts and vitamins (Caison Labs, Smithfield, UT, USA), supplemented with 30 g/L sucrose (Sigma Aldrich, Saint Louis, MO, USA), and, 7 g/L agar (Caison Lab, Smithfield, UT, USA)., distinct concentrations of seawater (35000 ppm) from the he Arabian Gulf (Uqair, 26.0786 N, 50.0393 E) (*Sup Table 1*) were introduced to the media to produce salinity level (2000 ppm and 4000 ppm) the control treatments containing (1 /2X) MS medium only without adding seawater and/or aquatic extract of CTFAE (0.5 g/L and 1.0 g/L). Split-plot design was used for the experiment, with two components, the concentration of the CTFAE (0.0, 0.5 g/L and 1.0 g/L) as a sub-factor and salinity (control, 2000 ppm and 4000 ppm) as the major factor. Disinfested seeds were cultured then, the culture vessels were maintained in a growth chamber (Phillips TLM 40 W/33RS) at 24±2˚C with a 16-hour photoperiod and 4000 Lux light intensity. The germination rate was measured after four weeks.

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on multiple shoots induction of A. fragrantissima plants

Shoot tips, measuring between 0.5 and 1.0 cm in length, were obtained from *in vitro* germinated seeds and sub cultured (at the same salinity and CTFAE levels with the germination medium, which the shoot tip was obtained from) on 30 ml of MS medium containing 30 g/L sucrose, 7 g/L agar, and 0.2 mg/L benzyl aminopurine (BAP) (Goda et al., 2023a) in a 200 mL container. Split-plot design was used for the experiment, with two components, the concentration of the CTFAE (0.0, 0.5 g/L and 1.0 g/L) as a sub-factor and salinity (control, 2000 ppm and 4000 ppm) as the major factor. Each treatment consists of ten culture vessels. The longest shoot's height, the explant's fresh weight, the number of shoots, and the callus % were measured after four weeks of culture. To prepare for methanol extraction and phytochemical analysis by GC-MS, a portion of the duplicate explants from each treatment were allowed to air dry at room temperature.

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on rooting induction of A. fragrantissima plants

The shoot tips (0.5–1.0 cm in length) of the 4-week plantlets were separated and cultivated on the same MS medium as previously mentioned, using the same seawater concentrations and CTFAE that were used in the media from which the shoot tips were derived, in addition to 0.4 mg/L 1-naphthaleneacetic (NAA) (Sigma Aldrich) (Goda et al., 2023a) to facilitate roots. Plant fresh weight, root length, number of roots, and plant height were measured after 4 weeks. Some of the rooted plantlets were moved to a plant growth chamber where they were allowed to acclimate in pots filled with a moist mixture

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

of sand and perlite (1:1). For three weeks, a fine mist was used to irrigate the plants. After four weeks, the proportion of plants that survived was calculated.

Chlorophyll pigment determinations

Using acetone (80%), the chlorophyll a (Chl-a), chlorophyll b (Chl-b), and carotenoids were extracted from the leaves of *A. fragrantissima* plantlets that had developed from the root stage. Following spectrophotometric determination in accordance with A.O.A.C. (1984), the pigments were computed as mg/100 g based on fresh weight.

Mineral composition

Plant samples of *A. fragrantissima* from the rooting stage (4 weeks after culturing on rooting media) were dried at 70°C for 24 h then ground and digested according to Cottenie et al. (1979) method. The modified micro-Kjedahl method was used to determine the amount of nitrogen (N^+), as explained by Jackson (1967). Phosphorus (P^+) was calculated using a calorimetric approach using the technique of Murphy and Riley (1962). Using an Atomic Absorption Flame Photometry model Shimadzu-AA7000, the following elements were measured: sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), zinc (Zn^{2+}), iron (Fe^{2+}) and calcium (Ca^{2+}) (Mazumdar and Majumder, 2003).

Determination of carbohydrate

The estimate of carbohydrates (ppm) was determined by DuBois et al. (1956) method.

GC-MS Analysis of C. ternatea flower and A. fragrantissima explants

The GC/MS analyses of *C. ternatea* flower and *A. fragrantissima* dry air samples were performed at the Department of chemistry, collage of Science, King Faisal University. *C. ternatea* flower powder and *A. fragrantissima* samples were extracted with methanol, according to El-Ashmawy et al. (2016). The methanol extracts were analysed by gas chromatography coupled with mass spectrometry (GC/MS-QP 2010 Plus), equipped with an auto-sampler AOC-20i, (Shimadzu, Kyoto, Japan). Separation was performed with a 30 m × 0.25 mm × 0.1 μm RTX®-5SilMS capillary column (Restek, Bellefonte, PA, USA). The stationary phase was composed of 5 % diphenyl and 95 % dimethyl-polysiloxane and high purity helium gas (99.9999 %) used as a carrier gas. The computation of composition was according to Lee et al. (2018) with slight modification.

Statistical analysis

The concentration of the *C. ternatea* flower aquatic extract as a sub-factor and salinity as the major factor with 10 repetitions made up the split-plot design of the experiment. ANOVA/MANOVA of Statistica 6 software was used to statistically analyse. The significance of differences among means was performed using the Duncan test at $p = 0.05$.

Results

Analysis of C. ternatea flower powder compositions

Data in *Table 1* showed the GC-MS analysis of the methanol extract of *C. ternatea* flower powder. The analysis identified a wide variety of compounds, including fatty

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

acids, esters, alcohols, aldehydes, terpenoids, and nitrogen-containing compounds, in the methanol extracts in *C. ternatea* flowers. The most abundant compounds included methyl oleate (22.62%), methyl palmitate (14.33%), palmitic acid (9.67%), and alpha-linoleic acid (10.66%) and ethyl oleate (13.31%) (*Table 1*). Data in *Table 2* showed the phytochemical composition of *C. ternatea* flower includes various maco and micro nutrients and vitamins, such as calcium (340 mg), iron (0.9 mg), vitamin C (200 mg), and small amounts of fats (1.70 g).

Table 1. *Phytochemical composition of methanol extracts from C. ternatea flower by GC MS*

Peak	Compound Name	RT, min	Area %	Molecular Weight (g·mol^{-1})	Molecular formula
1	Thymine	9.338	0.02	126.11	C5H6N2O2
4	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	11.077	0.05	144.12	C6H8O4
5	Hydrouracil, 1-methyl-	12.02	0.03	128.13	C5H8N2O2
6	Capric acid	14.362	0.02	172.268	C10H20O2
8	DL-Pyroglutamic acid	17.992	0.3	129.11	C5H7NO3
9	Methyl dodecanoate	19.485	0.78	214.34	C13H26O2
10	Lauric Acid	20.179	0.92	200.32	C12H24O2
11	Nonanedioic acid, dimethyl ester	20.605	0.2	216.2741	C11H20O4
12	Ethyl dodecanoate	20.774	0.49	228.37	C14H28O2
13	Thiophene, tetrahydro-2-methyl-	21.931	2.87	102.198	C5H10S
14	Methyl tetradecanoate	23.894	0.8	242.40	C15H30O2
15	Myristic Acid	25.023	0.49	228.37	C14H28O2
16	Ethyl palmitate	26.282	0.32	284.484	C18H36O2
17	Undecanone, 6,10-dimethyl	28.301	0.07	98.3449	C13H26O
18	Methyl palmitate	33.205	14.33	270.5	C17H34O2
19	2-Undecanone, 6,10-dimethyl- (Hexahydropseudoionone)	34.667	0.1	149.19	C9H11NO
20	Palmitic acid	36.005	9.67	256.42	C16H32O2
21	Palmitic acid, ethyl ester	38.749	3.25	284.4772	C18H36O2
22	N-Nitrosodimethylamine	41.49	0.01	74.083	C2H6N2O
23	Linoleic acid	44.05	10.66	280.4	C18H32O2
24	Oleic acid, methyl ester	44.302	22.62	296.5	C19H36O2
25	6-Octadecenoic acid, methyl ester, (Z)-	44.473	0.6	296.494	C19 H36 O2
26	Methyl stearolate	45.091	4.3	298.5	C19H38O2
27	Elaidic Acid	45.28	4.62	282.5	C18H34O2
28	Methyl octadec-9-ynoate	45.737	2.57	294.5	C19H34O2
29	Ethyl oleate	45.903	13.31	310.5	C20H38O2
30	9-Tetradecenal	46.047	0.85	210.36	C14H26O
31	Ethyl stearate	46.495	1.08	312.5	C20H40O2
32	Phytol	47.395	1.62	296.5	C20H40O
33	Hexadecanal (Palmitaldehyde)	47.6	0.39	240.42	C16H32O
34	Tridecanol	48.134	0.37	200.36	C13H28O
35	Eicosanoic acid, methyl ester	49.325	0.46	326.557	C21H42O2
36	Eicosanoic acid, methyl ester (Methyl arachisate)	49.425	0.58	125.13	C5H7N3O
37	(9,12-Octadecadienoic acid (Z,Z)-	49.559	1.03	198.3	C12H22O2
38	4α-Methylandrostane-2,3-diol-1,17-dione	54.37	0.09	280	C18H32O2

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 2. *Chemical composition of C. ternatea flower*

Chemical	Amount	Unit
Calcium	340	mg
Copper	0.03	mg
Iron	0.9	mg
Magnesium	30	mg
Phosphorus	90	mg
Potassium	155	mg
Zinc	0.2	mg
Protein	0	g
Fat	1.70	g
Carbohydrate	0	g
Vitamin A	7	mg
Vitamin B1	0.04	mg
Vitamin B2	0.1	mg
Vitamin B3	0.45	mg
Vitamin C	200	mg

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on seed germination percentage of A. fragrantissima

The data in *Figure 1* indicated that an increase in salinity decreased the germination percentage of *A. fragrantissima* seeds, according to single factor analysis of the salinity treatments. The results of the single factor analysis for the CTFAE treatments showed that the seed germination % was positively impacted by both CTFAE concentrations (0.5 g/L and 1 g/L), with the 1 g/L CTFAE performing better than the 0.5 g/L. The enhancing effects of CTFAE treatments enhanced seed germination % under salinity level compared to control salinity when the effects of both the salinity and CTFAE treatments were studied together. Under salinity levels of 2000 and 4000 ppm, the CTFAE at 1 g/L provided the maximum germination percentage.

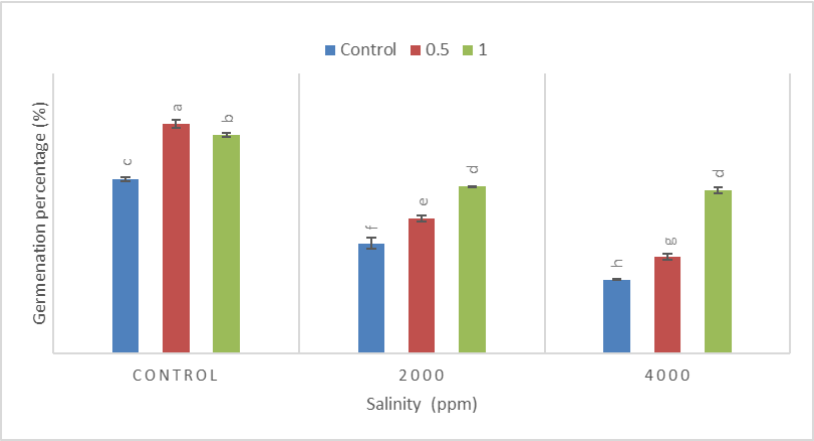

Figure 1. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on seed germination percentage of A. fragrantissima. * Means followed by the same letter are not significantly different at 0.05 level of probability according to Duncan test*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Effects of salinity levels, CTFAE (g/L) concentrations, and their interactions on multiple shoots induction of A. fragrantissima

Excision of the shoot tips (1.0 cm) from the in-vitro seedlings was followed by culture on shoots multiplication media supplemented with MS media supplemented with varying salinity levels (control, 2000 and 4000 ppm) and/or CTFAE (0.0, 0.5 and 1.0 g/L). The analyses of the salinity and CTFAE effects on multiplication stage of *A. fragrantissima* are presented in *Table 3* and *Figures 2,3 and 4*. According to the single factor analysis of the salinity treatments, *A. fragrantissima* shoot numbers were shown to decrease in a dose-dependent manner as salinity increased (*Table 3a* and *Figure 2*). In contrast, the height of the longest shoot, the fresh weight of the entire explant, and the callus percentage all significantly increased as the salinity concentration rose (*Table 3a*). Single factor analyses of the effects treatments of CTFAE revealed that a concentration of 0.5 g/L significantly increased the number of *A. fragrantissima* shoots; in contrast, a concentration of 1.0 g/L significantly increased the callus percentage, the fresh weight of the entire explant, and the height of the longest shoot (*Table 3b* and *Figure 3*). Upon combining the analysis of the effects of the salinity and CTFAE concentrations treatments, it was observed that the number of shoots, plant height, and explant fresh weight significantly increased with increasing CTFAE concentrations under salinity control treatment (*Table 3c*). Conversely, the callus % dropped dramatically (*Table 3c* and *Figure 4*). Under the effect of salinity level 2000 ppm, 0.5 g/L CTFAE gave the highest shoot number, and 1.0 g/L gave the length of the longest shoot, fresh weight and callus % (*Table 3c*). With the exception of callus %, which increased with 1.0 g/L of CTFAE, all the above metrics decreased with CTFAE concentrations under salinity levels of 4000 ppm (*Table 3c*).

Table 3. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on multiple shoots induction of A. fragrantissima*

Treatments		No. of shoots/ explant (n)	Explant's fresh weight (g)	Length of the longest shoot (cm)	callus %
Salinity (ppm)	**CTFAE (g/L)**				
(a) Main effect of salinity					
Control		60.25 a*	1.98 b	1.78 b	0.06 c
2000		56.73 b	2.01 a	2.15 a	0.16 a
4000		51.92 c	2.09 a	2.25 a	0.10 b
(b) Main effect of CTFAE					
	0.0	54.25 b	2.01 a	2.13 a	0.15 a
	0.5	61.91 a	1.75 b	1.72 b	0.0 b
	1.0	53.17 b	2.08 a	2.29 a	0.17 a
(c) Interacting effects of salinity CTFAE					
Control	0.0	38 f	1.33 d	1.63 c	0.19 a
	0.5	66.5 c	1.80 c	1.63 c	0.0 b
	1.0	76.25 a	2.83 a	2.0 b	0.0 b
2000	0.0	51.25 d	1.85 c	1.95 b	0.19 a
	0.5	74 b	1.87 c	1.8 c	0.0 b
	1.0	49.25 d	2.28 b	2.63 a	0.25 a
4000	0.0	34.0 c	1.60 c	1.18 c	0.06 b
	0.5	73.5 b	2.85 a	2.75 a	0.0 b
	1.0	48.25 e	1.83 c	2.25 b	0.25 a

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Figure 2. *Effects of salinity levels (ppm) on multiple shoots induction of A. fragrantissima. (A) is control, (B) is 2000 ppm and (C) is 4000 ppm salinity level respectively. Each square box represents 5 mm x 5mm*

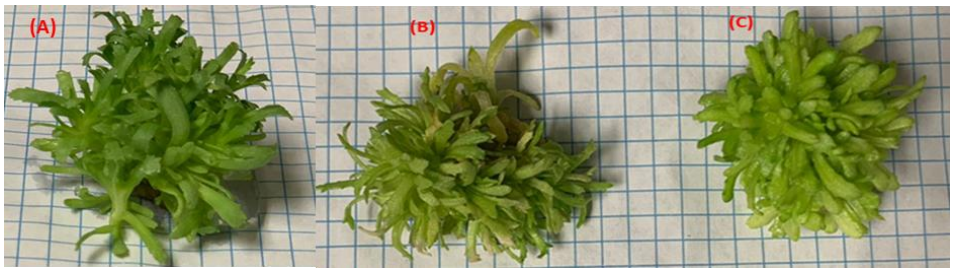

Figure 3. *Effect of CTFAE (g/L) concentrations on multiple shoots induction of A. fragrantissima. (A) is 0.5 g/L CTFAE (,(B) is 0.5 g/L CTFAE +2000 ppm salinity levels and (C) is 0.5 g/L CTFAE+ 4000 ppm salinity level respectively. Each square box represents 5 mm x 5 mm*

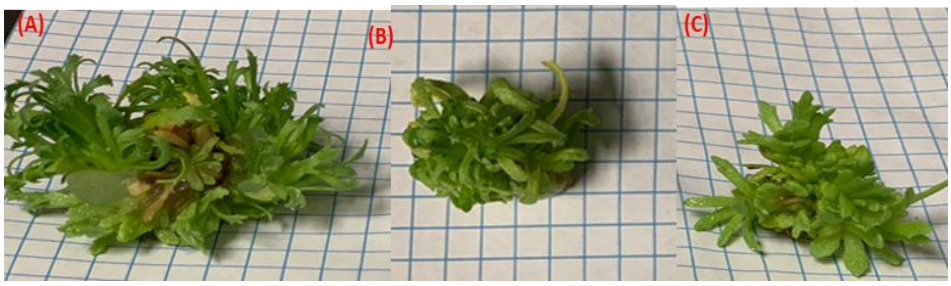

Figure 4. *Effect of salinity levels (ppm) and CTFAE (g/l) concentrations on multiple shoots induction of A. fragrantissima. (A) is 1 g/L CTFAE ,(B) is 1 g/L CTFAE +2000 ppm salinity levels and (C) is 1 g/L CTFAE 4000 ppm salinity level respectively. Each square box represents 5 mm x 5 mm*

Effects of salinity levels, CTFAE (g/L) extract concentrations, and their interactions on rooting induction of A. fragrantissima

Table 4a and *Figure 5* shows that as the salinity level in the MS media increased, the length of the longest root, root number, and explant fresh weight of *A. fragrantissima* decreased significantly when compared to the control treatments, whereas explant height and callus percentage increased significantly. On the other hand, the CTFAE concentration significantly increased the above parameters of *A. fragrantissima*. with the exception of the callus percentage, which showed the highest significant percentage in the control treatments compared to the CTFAE treatments. The highest values of root

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

length and number of roots were obtained with 0.5 (ppm) CTFAE, and the highest values of shoot length and explant fresh weight were obtained with 1.0 (ppm) CTFAE (*Table 4b*). Regarding the examination of the effects of the salinity and CTFAE concentration treatments. Data in *Table 4c* showed that CTFAE concentrations under control salinity treatment significantly improved the length of the longest root, root number, and explant fresh weight of *A. fragrantissima* as compared to the control treatment. With an increase of 0.5 g/L CTFAE, further increase in CTFAE concentration (1.0 g/L) demonstrated fewer enhancing effects on the above-mentioned growth parameters compared to (0.5 g/L) concentration (*Table 4c*).

Table 4. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on rooting induction of A. fragrantissima*

Treatments		Length of the longest Root (cm)	Shoot length (cm)	No. of roots/ explant (n)	Explant's fresh weight (g)	Callus %
Salinity (ppm)	**CTFAE (g/L)**					
(a) Main effect of salinity						
Control		2.06 a*	1.54 b	3.67 a	1.5 a	0.22 c
2000		1.55 c	1.65 a	2.3 b	1.11b	0.30 b
4000		1.87 b	1.61 a	1.33 c	0.92 c	0.42 a
(b) Main effect of CTFAE						
	0.0	0.75 b	1.44 b	1.4 b	1.02 a	0.52 a
	0.5	3.33 a	1.56 b	4.22 a	1.2 a	0.14 c
	1.0	1.5 b	1.83 a	1.78 b	1.32 a	0.25 b
(c) Interacting effects of salinity and CTFAE						
Control	0.0	1.4 c	1.63 abc	1.0 d	0.93 bc	0.57 b
	0.5	4.3 a	1.33 c	8.67 a	1.87 a	0.08 e
	1.0	1.83 b	1.66 abc	2.33 c	1.70 a	0.0 f
2000	0.0	1.3 c	1.83 ab	0.9 d	0.80 bc	0.25 d
	0.5	1.88 b	1.38 c	3.5 bc	1.48 ab	0.57 b
	1.0	2.67 b	1.84 ab	3.0 bc	0.8 3bc	0.0 f
4000	0.0	0.0 c	1.33 c	0.0 e	0.37 c	0.42 c
	0.5	5.67 a	1.5 bc	4.0 b	0.93 bc	0.08 e
	1.0	0.0 c	2.0 a	0.0 e	1.47 ab	0.75 a

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

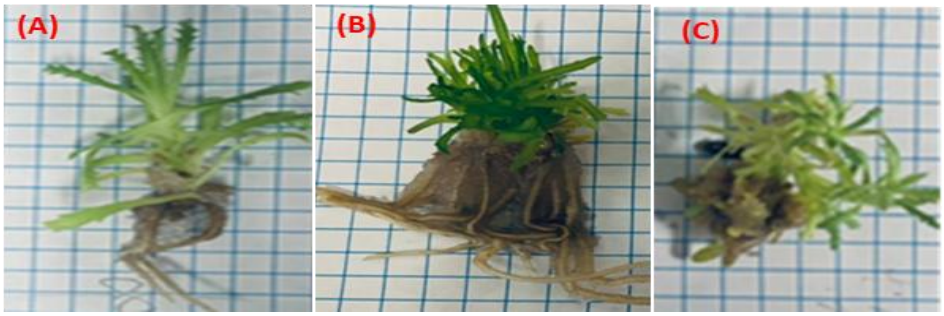

Figure 5. *Effect of salinity (ppm) and CTFAE (g/L) on root induction of A. fragrantissima . (A) is control treatment ,(B) is 0.5 g/L CTFAE and is (C) 4000 ppm salinity level +1.0 g/L CTFAE, respectively. Each square box represents 5 mm x 5 mm*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Under the influence of a salinity level of 2000 ppm, 0.5 g/L produced the highest fresh weight of explant and callus percentage, while 0.5 and 1.0 g/L CTFAE produced significantly longer and higher number of roots as compared to that without CTFAE (*Table 4c*). At salinity levels of 4000 ppm, no root was induced at the (0.0 and 1.0 g/L) CTFAE; however, the maximum plant height, plant fresh weight, and callus percentage were formed at 1.0 g/L CTFAE (*Table 4c*). The acclimatization techniques used in this study proved to be effective. When regenerated plantlets were placed in soil, they survived 80% of the time (data not shown).

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on the chlorophyll a, b and carotenoid contents of A. fragrantissima

Salinity and CTFAE increased photosynthetic pigment (Chl a, Chl b, and carotenoids) contents in *A. fragrantissima* leaves compared to control treatments (*Table 5a* and *b*), based on single factor analyses. Analysis of the interaction effects of salinity and CTFAE revealed that, at control salinity, the presence of CTFAE significantly raised the Chl a, Chl b, and carotenoid content (*Table 5c*). Under 2000 ppm salinity, the application of CTFAE boosted Chl a, Chl b, and carotenoid levels compared to 2000 (ppm) salinity level (without CTFAE) (*Table 5c*). While adding CTFAE to explants grown at salinity (4000 ppm) reduced the concentrations of Chl a, b, and carotenoid, the variations in carotenoid were not statistically significant when compared to the 4000 ppm salinity treatment (without CTFAE) (*Table 5c*).

Table 5. *Effects of salinity levels (ppm), C. ternatea flower Aquatic extract (g/L) concentrations, and their interactions on the compositions (mg/100 g fresh weight of leaves) of chlorophyll a (Chl a), chlorophyll b (Chl b), and carotenoids in A. fragrantissima in-vitro plantlets rooting stage*

Treatments		Chl a (mg/100 g F.W.)	Chl b (mg/100 g F.W.)	Carotenoids (mg/100 g F.W.))
Salinity (ppm)	**CTFAE (g/L)**			
(a) Main effect of salinity				
Control		171.894 b*	239.909 c	181.151 b
2000		195.866 a	265.541 a	208.685 a
4000		173.544b	249.054b	181.676 b
(b) Main effect of CTFAE				
	0.0	165.287b	158.124 c	187.419c
	0.5	188.430 a	270.549 a	192.819 a
	1.0	187.586 a	225.831 b	191.274 b
(c) Interacting effects of salinity and CTFAE				
Control	0.0	128.99 j	211.401h	154.887f
	0.5	186.249 c	228.657f	190.158 c
	1.0	200.433 b	279.669 c	198.407 c
2000	0.0	182.645e	192.11 i	201.175 b
	0.5	199.438 b	323.821 a	205.598 b
	1.0	205.513 a	280.689b	219.285 a
4000	0.0	184.218 d	273.978d	188.087 d
	0.5	179.603 f	259.171 e	186.702 d
	1.0	156.811 i	214.012g	170.239 e

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on the mineral contents in A. fragrantissima leaves

Tables 6a and *7a* reveal that a rise in salinity significantly decreased the quantity of N and Fe, but significantly increased the K, Mg, and Ca content in *A. fragrantissima* leaves compared to the salinity control treatment. Salinity levels of 4000 ppm greatly reduced the amount of P and Zn, while salinity levels of 2000 ppm significantly increased these elements (*Tables 6a* and *7a*). The amount of Na decreased significantly at a salinity level of 2000 ppm in the explant leaves (*Tables 6a* and *7a*). The application of CTFAE resulted in increases in N, K, and Zn content, as well as decreases in P, Mg, Ca, and Na content, and these effects were significant when compared to the control treatment (without CTFAE) (*Tables 6b* and *7b*). Fe content increased substantially at 0.5 g/L and decreased significantly at 1.0 g/L CTFAE as compared to the control without CTFAE (*Tables 6b* and *7b*), respectively. The combined effects of CTFAE and salinity results showed that, compared to the control salinity treatment, plants treated with 0.5 and 1.0 g/L CTFAE contained the highest N, P, K, Mg, Ca, and Fe but the lowest Na and Fe contents (*Tables 6c* and *7c*), respectively. under salinity (2000 and 4000 ppm), the plants treated with CTFAE also contained the highest N, but lowest Ca and Na compared with the control (without CTFAE), respectively (*Tables 6c and 7c*). Under 2000 ppm salinity, the P content increased significantly in the salinity control (without CTFAE), whereas Ca and Mg elements increased significantly in the salinity control (without CTFAE) treatments at 4000 ppm salinity levels. Under 2000 ppm salinity, plants treated with 0.5 g/L CTFAE contained the least amount of K and Mg, whereas plants treated with 1.0 g/L contained the highest amounts of the same components. A similar impact was demonstrated under 4000 ppm salinity levels for K and Zn elements, respectively (*Tables 6c and 7c*).

Table 6. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on Nitrogen (N), Phosphorus (P), potassium (K), magnesium (Mg) and Calcium (Ca) content (ppm) in A. fragrantissima in-vitro plantlets rooting stage*

Treatments		N	P	K	Mg	Ca
Salinity (ppm)	**CTFAE (g/L)**					
(a) Main effect of salinity						
Control		1992.17 a*	5.09 b	231.59 c	2.42 c	15.55 c
2000		1627.80 c	6.47 a	248.03 b	2.51 b	17.79 a
4000		1881.70 b	4.86 c	248.48 a	2.52 a	15.84 b
(b) Main effect of CTFAE						
	0.0	1607.13 c	6.18 a	191.80 c	2.49a	17.98 a
	0.5	1823.88 b	4.80 c	210.66 b	2.47 c	14.74 c
	1.0	2090.65 a	5.44 b	325.64 a	2.49 b	16.47 b
(c) Interacting effects of salinity and CTFAE						
Control	0.0	1583.30 g	5.03 e	101.94 i	2.42 i	13.56 h
	0.5	1961.35 c	5.21 d	241.69 e	2.42 h	15.45 f
	1.0	2431.85 a	5.03 e	351.16 a	2.43 f	17.71 c
2000	0.0	1577.75 i	9.51 a	201.75 f	2.52 c	20.46 a
	0.5	1677.30 f	4.51 g	196.19 g	2.49 f	17.45 d
	1.0	1688.35 e	5.38 c	347.15 b	2.53 b	15.45 f
4000	0.0	1660.35 g	3.99 h	271.72 d	2.54 a	19.92 b
	0.5	1833.00 d	4.69 f	194.09 h	2.50 e	11.36 i
	1.0	2151.75 b	5.90 b	279.62 c	2.51 e	16.25 e

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 7. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on sodium (Na), zinc (Zn), and iron (Fe) content (ppm) in A. fragrantissima in-vitro plantlets rooting stage*

Treatments		Na	Zn	Fe
Salinity (ppm)	**CTFAE (g/L)**			
(a) Main effect of salinity				
Control		3437.456 b*	0.038 b	5.497 a
2000		2642.76 c	0.0656 a	4.9775 b
4000		4749.995 a	0.0231 c	4.143 c
(b) Main effect of CTFAE				
	0.0	4868.41 a	0.02585 c	5.068 b
	0.5	2913.59 b	0.06468 a	5.169 a
	1.0	3048.17 b	0.0362 b	4.381 c
(c) Interacting effects of salinity and CTFAE				
Control	0.0	4334.955 b	0.02065 h	6.63395 a
	0.5	2136.985 i	0.04985 b	5.356 c
	1.0	3840.425 d	0.04355 c	4.5014 f
2000	0.0	2880.595 f	0.03055 e	5.02885 d
	0.5	2726.855 g	0.12865 a	5.5792 b
	1.0	2320.835 h	0.03755 d	4.325 g
4000	0.0	7389.665 a	0.02635 g	3.5416 i
	0.5	3876.935 c	0.01555 i	4.57025 e
	1.0	2983.235 e	0.0275 f	4.317 h

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on the carbohydrate contents in A. fragrantissima

Table 8 shows the effect of a single factor analysis of salinity treatment, CTFAE, and their interaction on carbohydrate content in *A. fragrantissima* leaves during the rooting stage. The data showed that salinity levels as well as CTFAE significantly increased carbohydrate contents, with the greatest effect of 1.0 g/L CTFAE under salinity control treatments as well as 2000 ppm and 4000 ppm compared to salinity and CTFAE control treatments.

Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on the compositions of essential oil prepared from A. fragrantissima in-vitro plantlets multiplication stage

Different salinity levels (control, 2000, and 4000 ppm) have an impact on the phytochemical composition of methanol leaf extracts from *A. fragrantissima*, as *Table 9* illustrates. Methyl alpha-D-glucopyranoside (monosaccharide) had the highest area% in the 4000-ppm group (33.13%) in comparison to the control (29.68%), and it decreased as salinity increased (18.77% at 2000 ppm). Methyl beta-D-glucopyranoside, a monosaccharide, rose with salinity in comparison to the control (3.37%; 6.8% at 2000 ppm and 6.64% at 4000 ppm). As salinity rose, the concentration of melatitose (a disaccharide) significantly decreased; the control group had the greatest area (6.12%), while the 4000 ppm group had the lowest (2.57%).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 8. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on carbohydrate continent (ppm) of A. fragrantissima in-vitro plantlets rooting stage*

Treatments		Carbohydrate (ppm)
Salinity (ppm)	**CTFAE (g/L)**	
(a) Main effect of salinity		
Control		10104.5 a*
2000		6541.833 c
4000		6850.166 b
(b) Main effect of CTFAE		
	0.0	6220.5 b
	0.5	6120.166 c
	1.0	11155.8 a
(c) Interacting effects of salinity and CTFAE		
Control	0.0	5747.5 h
	0.5	9873.5 c
	1.0	14692.5 a
2000	0.0	5962.5 g
	0.5	6741.5 f
	1.0	6921.5 e
4000	0.0	6951.5 d
	0.5	1745.5 i
	1.0	11853.5 b

* Means followed by the same letter within a column are not significantly different at 0.05 level of probability according to Duncan test

The concentration of alpha-lactose, a disaccharide, increased with salinity; it peaked at 4000 ppm (1.15%) compared to lower levels at 2000 ppm (0.65%) and control (0.36%). Ester compounds, (R)-dimethyl 2-hydroxysuccinate, peak at 2000 ppm (1.51%) and slightly increase with salinity. The 5-acetyl valeric acid, methyl ester is only present in the control (1.36%), and it is missing at greater salinities. While methyl palmitate declined as salinity rose, methyl tetradecanoate stayed constant throughout treatments (fatty acid esters). With increasing salinity, fatty acids and their derivatives, such as pentadecylic acid, decreased (from 7.36% in the control to 4.94% at 4000 ppm). While methyl 9-octadecenoate significantly rose at 4000 ppm (2.6%), methyl oleate decreased as salinity increased. Phenolic substances, the level of 2,4-Di-tert-butylphenol rose to 2000 ppm (1.01%) and then somewhat down to 4000 ppm (0.97%). A rise of 4000 ppm (1.64%) was seen in 3,5-Di-tert-butyl-4-hydroxybenzaldehyde. Terpenoids and other organic compounds, Megastigmatrienone and (Z)-9-Hexadecenoic acid, methyl ester, both showed decreased levels with increased salinity. N-nitrosohexamethyleneimine (organic hydrazide), present only at 4000 ppm (3.18%). Acetylacetophenone and propofol, emerged only at 4000 ppm. Beta-Sitosterol (Sterol), Only present in the control (0.83%). n-nitrosodiethylamine and 2(1H)-quinolinone, 4-methyl, present only at higher salinity levels.

The results presented in *Table 10* and *Sup. Table 2* demonstrated the impact of varying concentrations of CTFAE on the phytochemical composition of methanol leaf extracts obtained from *A. fragrantissima in vitro* plantlets throughout the multiplication stage.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 9. *Effect of different concentration Salinity levels (ppm) on the phytochemical composition of methanol leaf extracts from A. fragrantissima in-vitro plantlets multiplication stage*

Compound Name	Area%		
	Salinity levels (ppm)		
	Control	2000	4000
Melezitose	6.12 a*	5.6 b	2.57 c
pyrrolidin-2-ylmethanol	3.12c	5.88 a	3.99 b
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	10.19 b	13.11b	9.42c
4,4,6-Trimethyl-1,3-oxazinane-2-thione	0.31a	0 b	0 b
(R)-Dimethyl 2-hydroxysuccinate	1.31 b	1.51 a	1.11 b
5-Acetyl Valeric acid, methyl ester	1.36 a	0 b	0 b
DL-Proline, 5-oxo-, methyl ester	0.37b	0.36 b	0.39 a
Anisole	1.02 a	0.24 b	0.31 b
Acetophenone	0.29 a	0 b	0 b
1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	4.52 a	0 b	0 b
2,4-Di-tert-butylphenol	0.88 c	1.01 a	0.97 b
Lauric acid methyl ester	0.28 a	0.26 b	0.25 b
o-Ethoxybenzylamine	0.76 a	0 b	0 b
Methyl alpha-D-glucopyranoside	29.68 b	18.77 c	33.13 a
Methyl tetradecanoate	0.33 a	0.30 a	0.30 a
Methyl beta-D-glucopyranoside	3.37 b	6.8 a	6.64 a
Myristic Acid	0.48 a	0.31 b	0 c
alpha-Lactose	0.36 c	0.65 b	1.15 a
Beta-Sitosterol	0.83 a	0 b	0 b
(Z)-9-Hexadecenoic acid, methyl ester	0.84 a	0.42 b	0.5 b
Methyl palmitate	2.17 a	1.82 b	1.64 c
3,5-Di-tert-butyl-4-hydroxybenzaldehyde	0.41 b	0 c	1.64 a
(S)-10-camphorsulfonic acid	3.93 a	1.15 b	0.79 c
2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl	4.97 a	0 b	0 b
Pentadecylic Acid	7.36 a	6.81 b	4.94 c
Megastigmatrienone	0.82 a	0.52 b	0.53 b
9,19-Cyclolanostan-3-ol, acetate, (3beta)	0.28 a	0 b	0 b
1-Nonadecene	0.74 b	0.76 b	0.89 a
Methyl oleate	3.39 a	2.91 b	0.49 c
Methyl 9-octadecenoate	0.49 b	0.44 b	2.6 a
Methyl stearate	0.51 a	0.51 a	0 b
9,12-Octadecadienoic acid	1 b	1.14 a	1.15 a
5-Hydroxymethylfurfural	1.78 a	1.51 b	1.34 b
octadecanoic acid	1.26 a	1.11 b	1.03 b
cis-9-Tricosene	0.12 c	0.18 b	0.23 a
1-Hexacosanol	0.92 a	0.82 a	0.5 b
Undecane	0 b	0.03 a	0 b

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Compound Name	Area%		
	Salinity levels (ppm)		
	Control	2000	4000
(S)-2,3,4,5-tetrahydropyridine-2-carboxylic acid	0 b	0.17 a	0 b
N-nitrosodiethylamine	0 b	0.08 a	0 b
1,4-Anhydro-d-mannitol	0 b	0.15 a	0 b
2(1H)-Quinolinone, 4-methyl-	0 c	2.32 a	2.2 a
Ribitol	0 c	8.36 a	5.38 b
2-Pentanone	0 b	1.65 a	0 b
Guanosine	0 c	2.99 b	3.08 b
Benzaldehyde, 6-hydroxy-4-methoxy-2,3-dimethyl-	0 b	1.13 a	0 b
Cardenolide	0 b	1.3 a	0 b
2-Deoxy-D-ribose	0 b	0.13 a	0 b
(Z,E)-7,11-Hexadecadien-1-yl acetate	0 b	1.17 a	0 b
DL-1,2-Hexanediol	0 b	0.33 a	0 b
N-Nitrosohexamethyleneimine	0 b	0 b	3.18 a
Oxamic hydrazide	0 b	0 b	0.79 a
Durenol	0 b	0 b	0.22 a
Acetylacetophenone	0 b	0 b	0.24 a
Propofol	0 b	0 b	0.19 a
(-)-(Z)-Verbenol	0 b	0 b	0.22 a
Octyl beta-D-glucopyranoside	0 b	0 b	1.32 a
1,6-Anhydro-.beta.-D-glucopyranose	0 b	0 b	0.26 a
2,2-Dimethylglutaric acid	0 b	0 b	0.59 a
Methyl stearolate	0 b	0 b	0.27 a
(Z)-9-Tricosene	0 b	0 b	0.08 a

* Means followed by the same letter within a row are not significantly different at 0.05 level of probability according to Duncan test

The data revealed that alpha-lactose and methyl alpha-d-glucopyranoside was only present in the control treatments, whereas melezitose and Methyl beta-D-glucopyranoside was highest in the control and significantly reduced with CTFAE concentration. (R)-dimethyl 2-hydroxysuccinate and 5-acetyl valeric acid, methyl ester exclusive to the control group (1.31% and 1.36%, respectively). Methyl palmitate displayed erratic reactions, peaking at 1 g/L CTFAE extract (2.3%). Methyl tetradecanoate was detected on control and 1 g/l CTFAE. When CTFAE was used at 0.5 g/L, 2,4-di-tert-butylphenol levels increased to 1.12% from the control's 0.88%. Only the control group (0.41%) contains3,5-di-tert-butyl-4-hydroxybenzaldehyde. (S)-10-camphorsulfonic acid and 2-cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl compounds significantly increased with CTFAE 1g/L concentration compared to control treatment. Methyl oleate and methyl 9-octadecenoate were elevated at 1g/L of CTFAE, whereas pentadecylic acid and methyl stearate were only detected in the control (7.36% and 0.51%, respectively).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 10. *Effect of different concentration CTFAE (g/L) on the phytochemical composition of methanol leaf extracts from A. fragrantissima in-vitro plantlets multiplication stage*

Compound Name	Area%		
	CTFAE (g/L)		
	Control	0.5	1
Melezitose	6.12 a*	3.29 c	4.32 b
pyrrolidin-2-ylmethanol	3.12 c	4.65 a	3.64 b
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	10.19 b	11.53 a	11.26 a
4,4,6-Trimethyl-1,3-oxazinane-2-thione	0.31 a	0 b	0 b
(R)-Dimethyl 2-hydroxysuccinate	1.31 a	0 b	0 b
5-Acetyl Valeric acid, methyl ester	1.36 a	0 b	0 b
DL-Proline, 5-oxo-, methyl ester	0.37 b	0.37 b	0.56 a
Anisole	1.02 a	0 b	0 b
Acetophenone	0.29 a	0 b	0 b
1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	4.52 a	0 c	2.26 b
2,4-Di-tert-butylphenol	0.88 b	1.12 a	0.73 b
Lauric acid methyl ester	0.28 b	0.36 a	0.3 ab
o-Ethoxybenzylamine	0.76 c	22.14 a	12.98 b
Methyl alpha-D-glucopyranoside	29.68 a	0 b	0 b
Methyl tetradecanoate	0.33 a	0 b	0.34 a
Methyl beta-D-glucopyranoside	3.37 a	3.29 a	2.04 b
Myristic Acid	0.48 a	0 b	0 b
alpha-Lactose	0.36 a	0 b	0 b
Beta-Sitosterol	0.83 a	0 b	0 b
(Z)-9-Hexadecenoic acid, methyl ester	0.84 a	0.6 b	0.68 b
Methyl palmitate	2.17 a	1.67 b	2.3 a
3,5-Di-tert-butyl-4-hydroxybenzaldehyde	0.41 a	0 b	0 b
(S)-10-camphorsulfonic acid	3.93 b	3.79 b	7.22 a
2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl	4.97 c	5.12 b	10.39 a
Pentadecylic Acid	7.36 a	0 b	0 b
Megastigmatrienone	0.82 b	0.89 b	1.17 a
9,19-Cyclolanostan-3-ol, acetate, (3beta)	0.28 a	0 b	0 b
1-Nonadecene	0.74 b	0c	1.02 a
Methyl oleate	3.39 b	2.62 c	3.91 a
Methyl 9-octadecenoate	0.49 a	0 b	0 b
Methyl stearate	0.51 a	0 b	0 b
9,12-Octadecadienoic acid	1 b	0c	2.51 a
5-Hydroxymethylfurfural	1.78 a	0 b	0 b
octadecanoic acid	1.26 c	1.76 b	2.41 a
cis-9-Tricosene	0.12 a	0 b	0 b
1-Hexacosanol	0.92 a	0.49 b	0c
2(1H)-Quinolinone, 4-methyl-	0c	1.04 b	1.9 a

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Compound Name	Area%		
	CTFAE (g/L)		
	Control	0.5	1
N-Nitrosohexamethyleneimine	0 b	2.98 a	0 b
N-Allylmorpholine	0 b	0.42 a	0 b
4-Methoxy-2,5-dimethylbenzaldehyde	0 b	1.11 a	0 b
Guanosine	0 b	1.97 a	0 b
Decane, 1-iodo-	0 b	0.35 a	0 b
1-Butanamine, N,N-dimethyl-	0 b	0.38 a	0 b
Benzaldehyde, 6-hydroxy-4-methoxy-2,3-dimethyl-	0 b	0.83 a	0 b
Beta-Sitosterol	0 b	0.85 a	0 b
2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl-	0 c	5.12 b	10.39 a
Palmitic acid	0 b	7.39 a	7.29 a
1,2-Hexanediol	0 b	0.49 a	0b
1-Octadecanol	0 c	1.03 a	0.34 b
Phytol	0 c	0.61 b	0.9 a
9,12,15-Octadecatrienoic acid, methyl ester	0 b	2.76 a	2.72 a
Tetraethoxypropane	0 b	0 b	1.31 a
2-Methyl-2-propyl-1,3-propanediol	0 b	0 b	2.01 a
4-Chloroanisole	0 b	0 b	0.42 a
Camphor oxime	0 b	0 b	0.32 a

* Means followed by the same letter within a row are not significantly different at 0.05 level of probability according to Duncan test

The levels of terpenoids such as phytol, megastigmatrienone, and 9,12,15-octadecatrienoic acid methyl ester were found to be higher at 1 g/L (1.17%, 0.9%, and 2.76%) when CTFAE was present. Whereas the presence of n-nitrosohexamethyleneimine is limited to 0.5 g/L (2.98%). Beta-sitosterol, present only on CTFAE at 0.5 g/L (0.83%). 1-Octadecanol was increased with CTFAE (1.03% at 0.5 g/L). Tetraethoxypropane and 2-methyl-2-propyl-1,3-propanediol were only present at 1 g/L (2.01% and 1.31%, respectively).

The effects of salinity and CTFAE on the phytochemical content of methanol leaf extracts from *A. fragrantissima* in-vitro plantlets multiplication stage were displayed in *Table 11 Sup. Table 2*. Melezitose was found to be most concentrated in the (2000 ppm + 1 g/L CTFAE) group (6.45%), but the lowest amount was seen when salinity was combined with 1 g/L of CTFAE (2.34% at 4000 ppm + 1 g/L CTFAE). The maximum concentrations of methyl alpha-D-glucopyranoside and beta-D-glucopyranoside were 4000 ppm + 1 g/L CTFAE 4000 ppm + 1 g/L CTFAE (33.1% and 11.06%), respectively. (R)-Dimethyl 2-hydroxysuccinate present at its highest level with the control (1.36%), and decreased with salinity and CTFAE treatments while, 5-Acetyl Valeric acid, methyl ester present only in the control (1.36%). The methyl laurate, 1-methylpiperidine, 1,4-diacetylbenzene, 1,4-anhydro-d-mannitol octyl beta-d-glucopyranoside, 2,2-dimethylglutaric acid, beta-Lactose and 1-tridecene found only in the plant which treated with 4000 ppm + 1 g/L CTFAE (*Table 11*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Table 11. *Effect of Interacting effects of salinity (ppm) and CTFAE (g/L) on the phytochemical composition of methanol leaf extracts from A. fragrantissima in-vitro plantlets multiplication stage*

Compound Name	Area%				
	Effects of salinity (ppm) and CTFAE (g/L)				
	Control	2000+0.5	2000+1	4000+0.5	4000+1
Melezitose	6.12 b*	2.44 d	6.45 a	4.32 c	2.34 d
pyrrolidin-2-ylmethanol	3.12 e	5.97 c	4.2 d	8.88 a	6.27 b
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	10.19 c	8.57 d	12.47 a	10.78 b	7 e
4,4,6-Trimethyl-1,3-oxazinane-2-thione	0.31 b	0 c	0 c	0 c	0.8 a
(R)-Dimethyl 2-hydroxysuccinate	1.31 a	0.85 b	0 c	0 c	0.82 b
5-Acetyl Valeric acid, methyl ester	1.36 a	0 b	0 b	0 b	0 b
DL-Proline, 5-oxo-, methyl ester	0.37 b	0.44 b	0.86 a	0.92 a	0.31 c
Anisole	1.02 a	0 b	0 b	0 b	0 b
Acetophenone	0.29 a	0 b	0 b	0 b	0 b
1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	4.52 a	3.92 b	4.11 a	3.25 c	0 d
2,4-Di-tert-butylphenol	0.88 b	0.51 c	1.03 a	0 d	0 d
Lauric acid methyl ester	0.28 a	0 b	0 b	0 b	0 b
o-Ethoxybenzylamine	0.76 a	0 b	0 b	0 b	0 b
Methyl alpha-D-glucopyranoside	29.68 b	26.45c	13.42 e	19.61 d	33.1 a
Methyl tetradecanoate	0.33 c	0.49 b	0.64 a	0.63 a	0.34 c
Methyl beta-D-glucopyranoside	3.37 d	4.92 c	1.55 e	5.04 b	11.06 a
Myristic Acid	0.48 a	0 b	0 b	0 b	0 b
alpha-Lactose	0.36 a	0 b	0 b	0 b	0 b
Beta-Sitosterol	0.83 a	0 b	0 b	0 b	0 b
(Z)-9-Hexadecenoic acid, methyl ester	0.84 b	0.46 c	0.8 b	1.02 a	0.53 c
Methyl palmitate	2.17 b	1.47 c	4.06 a	3.78 a	2.31 b
3,5-Di-tert-butyl-4-hydroxybenzaldehyde	0.41 a	0 c	0 c	0.3 b	0 c
(S)-10-camphorsulfonic acid	3.93 b	3.65 b	6.38 a	3.38 b	0 c
2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl	4.97 b	0 c	8.45 a	0 c	0 c
Pentadecylic Acid	7.36 a	0 b	0 b	0 b	0 b
Megastigmatrienone	0.82 b	1.15 a	0.75 b	0.78 b	0.52 c
9,19-Cyclolanostan-3-ol, acetate, (3beta)	0.28	0 b	0 b	0 b	0 b
1-Nonadecene	0.74 c	0.82 b	0.68 c	1.0 a	0.98 a
Methyl oleate	3.39 c	2.62 d	6.97 a	6.18 b	3.37 c
Methyl 9-octadecenoate	0.49 c	0 d	0.77 b	0.91 a	0.55 c
Methyl stearate	0.51 a	0 b	0 b	0 b	0 b

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Compound Name	Area%				
	Effects of salinity (ppm) and CTFAE (g/L)				
	Control	2000+0.5	2000+1	4000+0.5	4000+1
9,12-Octadecadienoic acid	1.0 a	0 c	0 c	0 c	0.36 b
5-Hydroxymethylfurfural	1.78 a	0 c	0 c	0 c	0.84 b
octadecanoic acid	1.26 d	1.58 c	2.07 a	1.71 b	0.96 e
cis-9-Tricosene	0.12 a	0 b	0 b	0 b	0 b
1-Hexacosanol	0.92 b	0.96 b	1.46 a	0 d	0.56 c
Palmitic acid	0 e	6.56 a	4.31 c	5.66 b	3.43 d
1-Octadecanol	0 c	0.56 b	1.01 a	0 c	0 c
Camphor oxime	0b	0.4 a	0 b	0 b	0 b
Furaneol	0b	9.575 a	0 b	0 b	0 b
1-nitrosoazepan-3-ol	0 b	1.85 a	0 b	0 b	0 b
Mannose	0 c	1.34 a	0 c	0.8 b	1.4 a
Beta-Sitosterol	0b	1.4 a	0 b	0 b	0 b
D-erythro-Pentose, 2-deoxy	0b	0.36 a	0 b	0 b	0 b
beta-Caryophyllene	0c	0.44 a	0 c	0.5 b	0 c
Methyl linoleate	0b	1.77 a	0 b	0 b	0 b
9,12-Tetradecadien-1-ol, acetate, (9Z,12E)-	0c	2.11 a	1.22 b	0 c	0 c
N-nitrosodiethylamine	0 b	0 b	0.51 a	0 b	0 b
2,3-Dihydro-2,5-dihydoxy-6-methyl-4-H-pyran-4-one	0 b	0 b	2.77 a	2.99 a	0 b
1,1,3,3-Tetramethoxypropane	0 b	0 b	1.52 a	0 b	0 b
4-Chloroanisole	0 d	0.29 c	0.33 b	0.31 b	0.57 a
1-Pentadecanol	0 b	0 b	0.1a	0 b	0 b
2-Methyl-1,4-bis(trimethylsiloxy)butane	0 b	0 b	0.89 a	0 b	0 b
Hydroquinone	0 b	0 b	0.98 a	0 b	0 b
1-FLUORONONANE	0 b	0 b	0 b	0.55 a	0 b
4aH-Cycloprop[e]azulen-4a-ol, decahydro-1,1,4,7-tetramethyl-, [1aR-(1aα,4β,4aβ,7α,7aβ,7bα)]-	0 b	0 b	0 b	0.44 a	0 b
Citronellyl propionate	0 b	0 b	0 b	0.08 a	0 b
Anhydro-d-mannosan	0 b	0 b	0 b	0.13 a	0 b
Carvone Epoxide	0 b	0 b	0 b	0.25 a	0 b
8,11-Octadecadienoic acid, methyl ester	0 c	0 c	0c	0.59 a	0.49 b
stearic acid	0 c	0 c	0c	1.04 a	0.83 b
Erucamide	0 b	0 b	0 b	0.36 a	0 b
1,1,3,3-Tetraethoxypropane	0 b	0 b	0 b	1.16 a	0 b
Carcinogen	0 b	0 b	0 b	1.32 a	0 b
2,6-Diethylcyclohexanone	0 b	0 b	0 b	0.54 a	0 b
Quinuclidine	0 b	0 b	0 b	0.3 a	0 b
Methyl laurate	0 b	0 b	0 b	0.56 a	0.29 a

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Compound Name	Area%				
	Effects of salinity (ppm) and CTFAE (g/L)				
	Control	2000+0.5	2000+1	4000+0.5	4000+1
1-methylpiperidine	0 b	0 b	0 b	0 b	0.2 a
1,4-Diacetylbenzene	0 b	0 b	0 b	0 b	0.45 a
1,4-Anhydro-d-mannitol	0 b	0 b	0 b	0 b	2.56 a
Octyl beta-D-glucopyranoside	0 b	0 b	0 b	0 b	1.85 a
2,2-Dimethylglutaric acid	0 b	0 b	0 b	0 b	0.21 a
beta-Lactose	0 b	0 b	0 b	0 b	0.3 a
1-Tridecene	0 b	0 b	0 b	0 b	0.07 a

* Means followed by the same letter within a row are not significantly different at 0.05 level of probability according to Duncan test

Discussion

Plant products are thought to be restricted by salt stress. Thus, a variety of substances have been used to reduce the negative consequences of salt. Chemical analysis of *C. ternatea* flower powder reveals the presence of several compounds, including macro- and micro-nutrients, vitamins, fat, as well as fatty acids, esters, alcohols, aldehydes, terpenoids, and nitrogen-containing compounds which important for plant growth and its health, and particularly important in light of climate change as they can contribute to beneficial roles in plant growth and development (Niu et al., 2022). *C. ternatea* flower powder's GCMS analysis reveals that it contains 4α-Methylandrostane-2,3-diol-1,17-dione and stigmasterol is a steroid, which play a vital role in plant growth regulation by affecting cell elongation, division, and differentiation (Wei and Li, 2020). They also improve plant resistance to abiotic stimuli such as salinity, dehydration, and heat (Wei and Li, 2020; Chaudhuri et al., 2022). Terpene phytol is a precursor of vitamin E and chlorophyll that aids in plant development and metabolism (Byju et al., 2013; Niu et al., 2022). A variety fatty acid has been found in the *C. ternatea* flower powder including linoleic, oleic and palmitic. Linoleic acid, an essential part of membrane phospholipids, has an impact on the membrane's fluidity and integrity (Prochowska et al., 2024). It is the precursor of jasmonic acid, a plant hormone implicated in defense and stress responses (Zhang et al., 2019). It strengthens a plant's defenses against abiotic stresses such as drought and salinity (Ahmad et al., 2024). Oleic acid influences lipid metabolism, which in turn enhances seed germination and seedling vigor (Dhaliwal et al., 2024). Numerous hormonal signaling mechanisms that control growth and development are influenced by oleic acid (Yang et al., 2024). It has been demonstrated to enhance plants' reactions to stress (Gogna et al., 2020). Saturated fatty acids like palmitic and stearic acid are involved in membrane construction and energy storage (Ma et al., 2021).

One of the most frequent abiotic stressors that lowers crop plant yield is salt stress. In our research, saline levels reduced *A. fragrantissima* seed germination percentage and the growth of the explant at the multiplication and root stages over the control treatment with the exception of the multiplication stage, where we discovered that moderate salinity (2000 ppm) levels improved the explant's growth parameters compared to control treatment. These findings are consistent with past research on the responses of many plant species to salt stress during germination (Gholami et al., 2012; Molnar et al., 2024a,b; Arafa et al., 2024; Elkhodary et al., 2024.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Elevated salinity reduced seed water intake exacerbates the impacts of stress by reducing imbibition and seed turgescence (Tarchoun et al., 2022). Raising the saline concentration inhibits root development, and germination percentage via lowering the osmotic potential. Salinity also causes ion toxicity and oxidative stress which reduced plant growth (Atta et al., 2023). At low concentrations, salinity has a significant positive impact on shoot growth *in vitro* due to its ability to increase osmolarity (Gholami et al., 2012). The concentration of photosynthetic pigments and carbohydrate in *A. fragrantissima* leaves increased with increased salt levels, these results are consistent with findings from other plants (Trifunović-Momčilov et al., 2021; Zhang et al., 2024). Increased photosynthetic pigment levels in *A. fragrantissima* plants cultivated in salinity conditions—2000 ppm and 4000 ppm—play a crucial antioxidant role in mitigating the negative effects produced by the formation of reactive oxygen species (ROS) (Aslam et al., 2016). Salinity causes osmotic stress and reduces the amount of water that plants can absorb. Through controlling osmotic adjustment and carbon storage in plants, soluble carbohydrates serve critical functions as osmolytes in salt stress (Ahmad et al., 2017). The nutritional composition of *A. fragrantissima* leaves was strongly impacted by salinity, showing significant rises in potassium (K), magnesium (Mg), calcium (Ca) and sodium (Na) and significant reductions in nitrogen (N), iron (Fe), phosphorus (P) and zinc (Zn). Toxic ions including Na build up in high level of salinity, causing ion toxicity and reducing nutrient intake, which worsens damage to plant tissues and cells, may be the cause of the decrease in N and Fe (Isayenkov and Maathuis, 2019). Reduced zinc levels from high salinity affect photosynthesis and sugar transport in plants, which alters the control of carbohydrate metabolism and slows down plant growth (Fan et al., 2021). On the other hand, the elevated K, Mg, and Ca levels could be the result of the plant trying to preserve ionic homeostasis by counteracting the osmotic stress (Osakabe et al., 2013). The phytochemical profile of *A. fragrantissima* methanol leaf extracts is considerably impacted by salinity, with changes observed in sugars, esters, fatty acids, phenolics, and other organic compounds. The specific rise or fall in certain sugars, esters, fatty acids, phenolic compounds, terpenoids, and other organic compounds points to the distribution of resources in response to the stress of salt. Accumulation of sugar acts as an osmolyte to mitigate the deleterious consequences of salt stress (Almodares et al., 2008). Fatty acids may be involved in the plant's defense system against salt stress during development (Aziz et al., 2015). Phenolic molecules, such as 2,4-Di-tert-butylphenol and 3,5-Di-tert-butyl-4-hydroxybenzaldehyde, increase in response to salinity stress. phenolic compounds that scavenge reactive oxygen species (ROS) generated during stress. This helps shield biological tissues from oxidative damage (Rodrigues et al., 2024).

In our study, we found that CTFAE increased the percentage of *A. fragrantissima* seeds that germinated as well as the explant's growth during the multiplication and root stages as well as certain phytochemical component in plant tissue when compared to the control treatment. This increase was also associated with higher levels of photosynthetic pigments, carbohydrates, nutrients like N, P, K, Mg, Ca, and Zn in plant tissue. Suggests that the aquatic extract of CTFAE is a very promising bio stimulant, plant extracts with active ingredients that promote plant development also produced the similar outcomes (El Sherif et al., 2020; Peron et al., 2024; Kovács et al., 2024; Kaniyassery et al., 2024; Sohrabi et al., 2025). The current study's observations of the CTFAE enhancing effects on seed germination %, explant growth during multiplication, and rooting stages in *A. fragrantissima* plants cultivated under high saline (4000 ppm) were consistent with other results on a variety of plant species maintained under salinity (Mutlu-Durak et al.,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

2023; Melito et al., 2024; Kovács et al., 2024; Salvage et al., 2024). In addition to the previously mentioned characteristics, CTFAE increased the amount of carbohydrates and decreased the buildup of Na ions while boosting N, P, and K ions in plant cells exposed to 4000 ppm salt. Plants under salt stress have been shown to have higher osmo-tolerance in response to increases in K (Van Zelm et al., 2020). The plant under high salinity level also exhibited higher concentrations of certain effect compounds, including melezitose, methyl alpha-D-glucopyranoside, and beta-D-glucopyranoside, which are involved in defense and stress reactions (Al-Khayri et al., 2023).

Conclusions

CTFAE, used alone or in conjunction with varied salinity levels, boosted the growth and phytochemical compound of the *A. fragrantissima* plant, making it an especially effective biostimulant. Our findings showed that applying 1 g/L CTFAE resulted in the largest growth rate in the multiplication stage, whereas applying 0.5 g/l resulted in the highest growth parameter in the rooting stage. *A. fragrantissima* grows less in high salinity than the control and thrives in intermediate salinity (2000 ppm). At 4000 ppm of salinity, 0.5 g/LCTFAE might reduce the harmful effects of salt stress.

Supplementary materials. *Table S1*: title; Effects of salinity levels, CTFAE concentrations, and their interactions on the phytochemical composition of methanolic leaf extracts from *A. fragrantissima in-vitro plantlets.*

Author contributions. Conceptualization, F.E.S; M.M.A and S.K.; methodology and formal analysis, F.E.-S.; data curation, S.K. and F.E.-S.; writing—original draft preparation, M.M.A. and F.E.-S.; writing—review and editing, F.E.-S. All authors have read and agreed to the published version of the manuscript.

Funding. The authors extend their appreciation to the Deanship of Scientific Research, King Faisal University, for funding this research through grant number “KFU241759.

Acknowledgments. The authors are grateful for support from Yun-Kiam Yap of the Department of Biological Sciences, College of Science, King Faisal University, as well as Dr. Mohamed Khattab, Faculty of Clinical Farmacy, Suez Canal University, Egypt. As well as King Abdulaziz and His Companions Foundation for Giftedness and Creativity "Mawhiba" for their guidance through Mawhiba Mentorship program.

Conflicts of Interest. The authors declare no conflict of interest.

REFERENCES

[1] Ahmad, A., Ismun, A., Taib, M. (2017): Effects of Salinity Stress on Carbohydrate Metabolism in *Cryptocoryne elliptica* cultures. – J. Trop. Plant Physiol 9: 1-13. [Online]. Available at: https://cabidigitallibrary.org.

[2] Ahmad, I., Mashwani, Z. U. R., Younas, Z., Yousaf, T., El-Sheikh, M. A., Ahmad, P. (2024): Comprehensive approaches of phytonanoparticles for stress tolerance, growth performance, and improving oil yield in Sesame (*Sesamum indicum*): Mechanism, applications and future prospects. – Plant Stress 12. Elsevier B.V. [Online]. Available at: doi:10.1016/j.stress.2024.100498.

[3] Al-Khayri, J. M., Rashmi, R., Toppo, V., Chole, P. B., Banadka, A., Sudheer, W. N., Nagella, P., Shehata, W. F., Al-Mssallem, M. Q., Alessa, F. M., Almaghasla, M. I., Rezk,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

A. A. (2023): Plant Secondary Metabolites: The Weapons for Biotic Stress Management. – Metabolites 13(6). MDPI. [Online]. Available at: doi:10.3390/metabo13060716.

[4] Alkuwayti, M. A., El-Sherif, F., Yap, Y. K., Khattab, S. (2020): Foliar application of *Moringa oleifera* leaves extract altered stress-responsive gene expression and enhanced bioactive compounds composition in *Ocimum basilicum*. – South African Journal of Botany 129: 291-298. [Online]. Available at: doi:10.1016/j.sajb.2019.08.001.

[5] Almodares, A., Reza Hadi, M., Dosti, B. (2008): The Effects of Salt Stress on Growth Parameters and Carbohydrates Contents in Sweet Sorghum. – Research Journal of Environmental Sciences 2(4): 298-304. [Online]. Available at: doi:10.3923/rjes.2008.298.304.

[6] A.O.A.C. (1984): Official methods of analysis of the AOAC. – 14th ed. Howitz (ed). Washington, DC, USA: Association of Official Analytical Chemists.

[7] Arafa, R. N., Elsayh, S. A. A., Salwa, E. H., Ahmed, E., Afifi, E. H., El Aramany, R. W., Esraa, Shehata, H., Abdel Aziz, Y. S. G., Mageed, Y. A. A., Barakat, A., Dosoky, H. A. A. (2024): Impact of salinity on date palm shoots proliferation and rooting in vitro. – African Journal of Biological Sciences (South Africa) 6(5): 3441-3476. [Online]. Available at: doi:10.33472/AFJBS.6.5.2024.3441-3476.

[8] Aslam, M., Sultana, B., Anwar, F., Munir, H. (2016): Foliar spray of selected plant growth regulators affected the biochemical and antioxidant attributes of spinach in a field experiment. – Turkish Journal of Agriculture and Forestry 40(2): 136-145. [Online]. Available at: doi:10.3906/tar-1412-56.

[9] Atta, K., Mondal, S., Gorai, S., Singh, A. P., Kumari, A., Ghosh, T., Roy, A., Hembram, S., Gaikwad, D. J., Mondal, S., Bhattacharya, S., Jha, U. C., Jespersen, D. (2023): Impacts of salinity stress on crop plants: improving salt tolerance through genetic and molecular dissection. – Frontiers in Plant Science 14. Frontiers Media SA. [Online]. Available at: doi:10.3389/fpls.2023.1241736.

[10] Aziz, A., Siti-Fairuz, M., Abdullah, M. Z., Ma, N. L., Marziah, M. (2015): Fatty acid profile of salinity tolerant rice genotypes grown on saline soil. – Malays. Appl. Biol 44(1).

[11] Byju, K., Vasundhara, G., Anuradha, V., Nair, S. M., Kumar, N. C. (2013): Presence of Phytol, a Precursor of Vitamin E in *Chaetomorpha Antinnina*. – Mapana - Journal of Sciences 12(2): 57-65. Christ University Bangalore. [Online]. Available at: doi:10.12723/mjs.25.6.

[12] Chaudhuri, A., Halder, K., Abdin, M. Z., Majee, M., Datta, A. (2022): Abiotic Stress Tolerance in Plants: Brassinosteroids Navigate Competently. – International Journal of Molecular Sciences 23(23). MDPI. [Online]. Available at: doi:10.3390/ijms232314577.

[13] Chen, W.-S. (2019): Endogenous Growth Substances in Xylem and Shoot Tip Diffusate of Lychee in Relation to Flowering. – HortScience 25(3): 314-315. [Online]. Available at: doi:10.21273/hortsci.25.3.314.

[14] Cottenie, R., Camerlynck, M., Verloo, A. D., Dhaese, A. (1979): Fractionation and Determination of Trace Elements in Plants, Soils and Sediments. – 27th International Congress of Pure and Applied Chemistry, pp. 45-53.

[15] Dhaliwal, L. K., Shim, J., Auld, D., Angeles-Shim, R. B. (2024): Fatty acid unsaturation improves germination of upland cotton (*Gossypium hirsutum*) under cold stress. – Frontiers in Plant Science 15. Frontiers Media SA. [Online]. Available at: doi:10.3389/fpls.2024.1286908.

[16] DuBois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A., Smith, F. (1956): Colorimetric Method for Determination of Sugars and Related Substances. – Analytical Chemistry 28(3): 350-356. American Chemical Society [Online]. Available at: doi:10.1021/ac60111a017.

[17] El-Ashmawy, I. M., Al-Wabel, N. A., Bayad, A. E. (2016): *Achillea fragrantissima*, rich in flavonoids and tannins, potentiates the activity of diminazine aceturate against *Trypanosoma evansi* in rats. – Asian Pacific Journal of Tropical Medicine 9(3): 228-234. Elsevier (Singapore) Pte Ltd. [Online]. Available at: doi:10.1016/j.apjtm.2016.01.032.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

[18] ELFattah, A., Ali, S., Aly, H., AbdAlla, H., Shalaby, N., Saleh, M. (2018): Therapeutic potential of *Achillea fragrantissima* extracts in amelioration of high-fat diet and low dose streptozotocin diabetic rats. – Journal of Complementary Medicine Research 7(2): 115. [Online]. Available at: doi:10.5455/jcmr.20180121122758.

[19] Elkhodary, M. S., Baghdady, G. A., Abdrabboh, G. A., Abdel-Aziz, H. F., Hamdy, A. E. (2024): Effects of Salt stress on banana (*Musa acuminata* L.) cv. Grandinin growing in vitro. – Journal of Agricultural Research 49(1).

[20] El Sherif, F., Albotnoor, N., Yap, Y. K., Meligy, A., Khattab, S. (2020): Enhanced bioactive compounds composition in Lavandula officinalis in-vitro plantlets using NaCl and *Moringa oleifera*, *Aloe vera* and *Spirulina platensis* extracts. – Industrial Crops and Products 157: 112890. Elsevier B.V. [Online]. Available at: doi:10.1016/j.indcrop.2020.112890.

[21] Escher, G. B., Marques, M. B., do Carmo, M. A. V., Azevedo, L., Furtado, M. M., Sant'Ana, A. S., da Silva, M. C., Genovese, M. I., Wen, M., Zhang, L., Oh, W. Y., Shahidi, F., Rosso, N. D., Granato, D. (2020): *Clitoria ternatea* L. petal bioactive compounds display antioxidant, antihemolytic and antihypertensive effects, inhibit α-amylase and α-glucosidase activities and reduce human LDL cholesterol and DNA induced oxidation. – Food Research International 128: 108763. [Online]. Available at: doi:https://doi.org/10.1016/j.foodres.2019.108763.

[22] Fan, Y., Jiang, T., Chun, Z., Wang, G., Yang, K., Tan, X., Zhao, J., Pu, S., Luo, A. (2021): Zinc affects the physiology and medicinal components of *Dendrobium nobile* Lindl. Plant Physiology and Biochemistry 162: 656-666. Elsevier Masson. [Online]. Available at: doi:10.1016/J.PLAPHY.2021.03.040 [Accessed 7 January 2023].

[23] Farouk, A., Ali, H., Al-Khalifa, A. R., Mohsen, M., Fikry, R. (2019): Comparative study for the volatile constituents and the antioxidant activity of the essential oils of dried achillea fragrantissima cultivated in Madinah Monawara, Saudi Arabia and Egypt. – International Journal of Food Properties 22(1): 395-404. Taylor & Francis. [Online]. Available at: doi:10.1080/10942912.2019.1588901.

[24] Gholami, M., Bahmani, R., Mozafari, A.-A., Alivaisi, R. (2012): Effects of Salinity on *In vitro* Shoot Proliferation and Rooting of Apple Rootstock MM.106. – World Applied Sciences Journal 17(3): 292-295.

[25] Goda, S. M., Ahmed, S. A., El Sherif, F., Hassanean, H. A., Ibrahim, A. K. (2017): Genetically stable plants with boosted flavonoids content after in vitro regeneration of the endangered *Capparis spinosa* L. – Global Drugs and Therapeutics 2(3). [Online]. Available at: doi:10.15761/gdt.1000124.

[26] Goda, M. S., Ahmed, S. A., El Sherif, F., Khattab, S., Hassanean, H. A., Alnefaie, R., Althumairy, D., Abo-Elmatty, D. M., Ibrahim, A. K. (2023): *In Vitro* Micropropagation of Endangered *Achillea fragrantissima* Forssk. Combined with Enhancement of Its Antihyperglycemic Activity. – Agronomy 13(2). [Online]. Available at: doi:10.3390/agronomy13020278.

[27] Gogna, M., Choudhary, A., Mishra, G., Kapoor, R., Bhatla, S. C. (2020): Changes in lipid composition in response to salt stress and its possible interaction with intracellular Na^+-K^+ ratio in sunflower (*Helianthus annuus* L.). – Environmental and Experimental Botany 178: 104147. [Online]. Available at: doi:10.1016/J.ENVEXPBOT.2020.104147 [Accessed 21 August 2024].

[28] Isayenkov, S. V., Maathuis, F. J. M. (2019): Plant salinity stress: Many unanswered questions remain. – Frontiers in Plant Science 10. Frontiers Media S.A. [Online]. Available at: doi:10.3389/fpls.2019.00080.

[29] Jackson, M. L. (1967): Soil Chemica Analysis. – New Delhi, India, Prentice Hall.

[30] Jamil, N., Mohd Zairi, M. N., Mohd Nasim, N. A., Paée, F. (2018): Influences of Environmental Conditions to Phytoconstituents in *Clitoria ternatea* (Butterfly Pea Flower) - A Review. – Journal of Science and Technology 10(2). [Online]. Available at: doi:10.30880/jst.2018.10.02.029.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

[31] Kaniyassery, A., Thorat, S. A., Shanthi, N., Tantry, S., Sudhakar, M. P., Arunkumar, K., Muthusamy, A. (2024): *In Vitro* Plant Growth Promoting Effect of Fucoidan Fractions of *Turbinaria decurrens* for Seed Germination, Organogenesis, and Adventitious Root Formation in Finger Millet and Eggplant. – Journal of Plant Growth Regulation 43(1): 283-298. [Online]. Available at: doi:10.1007/s00344-023-11084-y.

[32] Khalifa, A. M., Eid, M. A., Gaafar, R. M., Saad-Allah, K. M., Gad, D. (2023): Induction of bioactive constituents and antioxidant enzyme activities in *Achillea fragrantissima* (Forskal) callus cultures using ZnO nanoparticles. – In Vitro Cellular and Developmental Biology - Plant 59(6): 808-824. [Online]. Available at: doi:10.1007/s11627-023-10388-8.

[33] Kovács, D., Horotán, K., Orlóci, L., Makádi, M., Mosonyi, I., Sütöri-Diószegi, M., Kisvarga, S. (2024): Histological and Physiological Study of the Effects of Biostimulants and Plant Growth Stimulants in *Viburnum opulus* 'Roseum'. – Plants 13(11). Multidisciplinary Digital Publishing Institute (MDPI). [Online]. Available at: doi:10.3390/plants13111446.

[34] Lee, K. B., Choi, J., Ahn, S. K., Na, J. K., Shrestha, K. K., Nguon, S., Park, S. U., Choi, S., Kim, J. K. (2018): Quantification of Arbutin in Plant Extracts by Stable Isotope Dilution Gas Chromatography–Mass Spectrometry. – Chromatographia 81(3): 533-538. Friedr. Vieweg und Sohn Verlags GmbH. [Online]. Available at: doi:10.1007/s10337-017-3461-5.

[35] Ma, K., Kou, J., Khashi U Rahman, M., Du, W., Liang, X., Wu, F., Li, W., Pan, K. (2021): Palmitic acid mediated change of rhizosphere and alleviation of Fusarium wilt disease in watermelon. – Saudi Journal of Biological Sciences 28(6): 3616-3623. Elsevier B.V. [Online]. Available at: doi:10.1016/j.sjbs.2021.03.040.

[36] Mazumdar, B., Majumder, K. (2003): Methods of Physiochemical Analysis of Fruits. – Daya Publi. India: Daya Publishing House Delhi, India.

[37] Melito, S., Sarais, G., Desai, D., Santaniello, A., Povero, G., Piga, G., Giannini, V. (2024): Root-promoting Biostimulant Enhances Salinity Tolerance in Wild and Cultivated Rocket Salads. – Journal of Soil Science and Plant Nutrition. [Online]. Available at: doi:10.1007/s42729-024-01960-1.

[38] Molnar, S., Clapa, D., Pop, V. C., Hárta, M., Andrecan, F. A., Bunea, C. I. (2024a): Investigation of salinity tolerance to different cultivars of highbush blueberry (*Vaccinium corymbosum* L.) grown in vitro. – Notulae Botanicae Horti Agrobotanici Cluj-Napoca 52(1): 1-17. [Online]. Available at: doi:10.15835/nbha52113691.

[39] Molnar, S., Clapa, D., Pop, V. C., Hárta, M., Andrecan, F. A., Bunea, C. I. (2024b): Investigation of salinity tolerance to different cultivars of highbush blueberry (*Vaccinium corymbosum* L.) grown in vitro. – Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 52(1). Academic Press. [Online]. Available at: doi:10.15835/nbha52113691.

[40] Murphy, J., Riley, J. P. A. (1962): Modified single-solution method for the determination of phosphorus in natural water. – Analytica Chimica Acta 27: 31-36.

[41] Murtaza, G., Usman, M., Iqbal, J., Tahir, M. N., Elshikh, M. S., Alkahtani, J., Toleikienė, M., Iqbal, R., Akram, M. I., Gruda, N. S. (2024): The impact of biochar addition on morpho-physiological characteristics, yield and water use efficiency of tomato plants under drought and salinity stress. – BMC Plant Biology 24(1): 1-15. [Online]. Available at: doi:10.1186/s12870-024-05058-9.

[42] Mutlu-Durak, H., Arikan, Y., Kutman, B. Y. (2023): Willow (*Salix babylonica*) Extracts Can Act as Biostimulants for Enhancing Salinity Tolerance of Maize Grown in Soilless Culture. – Plants 12(4). MDPI. [Online]. Available at: doi:10.3390/plants12040856.

[43] Niu, Y., Zhang, Q., Wang, J., Li, Y., Wang, X., Bao, Y. (2022): Vitamin E synthesis and response in plants. – Frontiers in Plant Science 13. Frontiers Media S.A. [Online]. Available at: doi:10.3389/fpls.2022.994058.

[44] Noreen, S., Saleem, S., Iqbal, U., Mahmood, S., Salim Akhter, M., Akbar, N., El-Sheikh, M., Kaushik, P. (2024): *Moringa olifera* leaf extract increases physio-biochemical properties, growth and yield of *Pisum sativum* grown under salinity stress. – Journal of

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

King Saud University – Science 36(2): 103056. Elsevier B.V. [Online]. Available at: doi:10.1016/j.jksus.2023.103056.

[45] Osakabe, Y., Arinaga, N., Umezawa, T., Katsura, S., Nagamachi, K., Tanaka, H., Ohiraki, H., Yamada, K., Seo, S. U., Abo, M., Yoshimura, E., Shinozaki, K., Yamaguchi-Shinozaki, K. (2013): Osmotic stress responses and plant growth controlled by potassium transporters in Arabidopsis. – Plant Cell 25(2): 609-624. American Society of Plant Biologists [Online]. Available at: doi:10.1105/tpc.112.105700.

[46] Pecetti, L., Tlahig, S., Confalonieri, M., Cornacchione, M. V., Hayek, T., Angueira, S. P., Annicchiarico, P. (2024): A comparison of procedures for evaluating and selecting alfalfa landrace germplasm for tolerance to salinity. – Crop Science 2: 1-15. [Online]. Available at: doi:10.1002/csc2.21258.

[47] Peron, G., Franceschi, C., Da Dalt, C., Ferrarese, I., Sut, S., Dall'Acqua, S. (2024): Biostimulation of *Calendula officinalis* with a soy protein hydrolysate induces flower and plant biomass and flower count by reversibly altering the floral metabolome. – Industrial Crops and Products 214. Elsevier B.V. [Online]. Available at: doi:10.1016/j.indcrop.2024.118508.

[48] Prochowska, S., Bonarska-Kujawa, D., Bobak, Ł., Eberhardt, M., Niżański, W. (2024): Fatty acid composition and biophysical characteristics of the cell membrane of feline spermatozoa. – Scientific Reports 14(1). Nature Research. [Online]. Available at: doi:10.1038/s41598-024-61006-5.

[49] Qian, H., Sheng, M. (1998): Simultaneous determination of fat-soluble vitamins A, D and E and pro-vitamin D2 in animal feeds by one-step extraction and high-performance liquid chromatography analysis. – Journal of Chromatography A 825(2): 127-133. [Online]. Available at: doi:https://doi.org/10.1016/S0021-9673(98)00733-X.

[50] Rodrigues, M. J., Neng, N., Custódio, L. (2024): NaCl elicitation enhances metabolite accumulation and stress resilience in *Inula crithmoides* L. shoot cultures: implications for its nutritional and medicinal value. – Plant Cell, Tissue and Organ Culture 157(1). Springer Science and Business Media B.V. [Online]. Available at: doi:10.1007/s11240-024-02750-4.

[51] Ryan, J., Estefan, G., Rashid, A. (2001): Soil and Plant Analysis Laboratory Manual. – 2nd ed. International Center for Agriculture Research in the Dryland Areas (ICARDA) and the National Agricultural Research Center. [Online]. Available at: https://books.google.com/books?hl=en&lr=&id=uYnZ2623GQ8C&oi=fnd&pg=PA2&ots=VaWgfr0WVH&sig=IK4_SkTrR0IPRaLA0atkY0P5cNM.

[52] Salvage, R., Cannon, T., Kingsmill, P., Liu, F., Fleming, C. C. (2024): A complex biostimulant based on plant flavonoids enhances potato growth and commercial yields. – Frontiers in Sustainable Food Systems 8. Frontiers Media SA. [Online]. Available at: doi:10.3389/fsufs.2024.1368423.

[53] Sarmoum, R., Haid, S., Biche, M., Djazouli, Z., Zebib, B., Merah, O. (2019): Effect of salinity and water stress on the essential oil components of rosemary (*Rosmarinus officinalis* L.). – Agronomy 9(5): 1-10. [Online]. Available at: doi:10.3390/agronomy9050214.

[54] Shindy, W. W., Smith, O. E. (1975): Identification of Plant Hormones from Cotton Ovules. – Plant Physiology 55(3): 550-554. [Online]. Available at: doi:10.1104/pp.55.3.550.

[55] Sohrabi, O., Hatamzadeh, A., Ghasemnezhad, A., Samizadeh, H., Erfani-Moghadam, V. (2025): A Preliminary Experimental Protocol for Enhanced Tomato Callus Formation and Growth via Several Medicinal Plant Extracts Article history. – International Journal of Horticultural Science and Technology Journal homepage 12(1). [Online]. Available at: http://ijhst.ut.ac.ir.

[56] Tarchoun, N., Saadaoui, W., Mezghani, N., Pavli, O. I., Falleh, H., Petropoulos, S. A. (2022): The Effects of Salt Stress on Germination, Seedling Growth and Biochemical Responses of Tunisian Squash (*Cucurbita maxima* Duchesne) Germplasm. – Plants 11(6). MDPI. [Online]. Available at: doi:10.3390/plants11060800.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

[57] Trifunović-Momčilov, M., Milošević, S., Marković, M., Đurić, M., Jevremović, S., Dragićević, I., Subotić, A. R. (2021): Changes in photosynthetic pigments content in non-transformed and atckx transgenic centaury (*Centaurium erythraea* rafn) shoots grown under salt stress *in vitro*. – Agronomy 11(10). MDPI. [Online]. Available at: doi:10.3390/agronomy11102056.

[58] Трушкин, Е. В., Сенявина, Н. В., Сахаров, Д. А., Русанов, А. Л., Маркс, У., Тоневицкий, А. Г. (2013): Современные Технологии in Vitro Тестирования Лекарств in Vitro: Использование Микробиореакторов. Биотехнология 38(1): 51-58. [Online]. Available at: doi:10.36253/ahsc.

[59] Van Zelm, E., Zhang, Y., Testerink, C. (2020): Salt Tolerance Mechanisms of Plants. – Annual Review of Plant Biology 71: 403-433. [Online]. Available at: doi:10.1146/annurev-arplant-050718-100005.

[60] Wei, Z., Li, J. (2020): Regulation of Brassinosteroid Homeostasis in Higher Plants. – Frontiers in Plant Science 11. Frontiers Media S.A. [Online]. Available at: doi:10.3389/fpls.2020.583622.

[61] Wei, H., Xu, T., Luo, C., Ma, D., Yang, F., Yang, P., Zhou, X., Liu, G., Lian, B., Zhong, F., Zhang, J. (2024): *Salix matsudana* fatty acid desaturases: Identification, classification, evolution, and expression profiles for development and stress tolerances. International Journal of Biological Macromolecules 278: 134574. [Online]. Available at: doi:10.1016/J.IJBIOMAC.2024.134574 [Accessed 21 August 2024].

[62] Yang, D., Wang, R., Lai, H., He, Y., Chen, Y., Xun, C., Zhang, Y., He, Z. (2024): Comparative Transcriptomic and Lipidomic Analysis of Fatty Acid Accumulation in Three *Camellia oleifera* Varieties During Seed Maturing. – Journal of Agricultural and Food Chemistry, American Chemical Society. [Online]. Available at: doi:10.1021/acs.jafc.4c03614.

[63] Zeedan, G. (2014): Antimicrobial, Antiviral Activity and GC-MS Analysis of Essential Oil Extracted from *Achillea fragrantissima* Plant Growing in Sinai Peninsula, Egypt. – Journal of Microbial & Biochemical Technology s8(01). [Online]. Available at: doi:10.4172/1948-5948.s8-006.

[64] Zhang, M., Demeshko, Y., Dumbur, R., Iven, T., Feussner, I., Lebedov, G., Ganim, M., Barg, R., Ben-Hayyim, G. (2019): Elevated α-Linolenic Acid Content in Extra-plastidial Membranes of Tomato Accelerates Wound-Induced Jasmonate Generation and Improves Tolerance to the Herbivorous Insects *Heliothis peltigera* and *Spodoptera littoralis*. – Journal of Plant Growth Regulation 38(2): 723-738. Springer New York LLC. [Online]. Available at: doi:10.1007/s00344-018-9885-9.

[65] Zhang, X., Qin, H., Kan, Z., Liu, D., Wang, B., Fan, S., Jiang, P. (2024): Growth and non-structural carbohydrates response patterns of *Eucommia ulmoides* under salt and drought stress. – Frontiers in Plant Science 15. Frontiers Media SA. [Online]. Available at: doi:10.3389/fpls.2024.1436152.

APPENDIX

Sup. Table 1. *Chemical properties and compositions of the seawater*

Salinity Level (ppm)	Cations (mg/L)			Anions (m/L)				Sodium Adsorption Ratio (SAR)
	Ca^{2+}	Mg^{2+}	Na^{+}	CO_3^{2-}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	
35000	520	1500	13.044	24	171	3100	23000	65

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

Sup. Table 2. *Effects of salinity levels (ppm), CTFAE (g/L) concentrations, and their interactions on the phytochemical composition of methanolic leaf extracts from A. fragrantissima in-vitro plantlets*

Treatments		Peak	Essential Oil Compounds	RT, min	Area, %	Molecular Weight (g/mol)	Molecular Formula
Salinity level (ppm)	CTFAE (g/L)						
Control	0						
		1	Melezitose	8.587	6.12	504.44	C18H32O16
		2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.868	10.19	144.12	C6H8O4
		3	pyrrolidin-2-ylmethanol	10.681	3.12	101.15	C5H11NO
		5	4,4,6-Trimethyl-1,3-oxazinane-2-thione	11.351	0.31	159.25	C7H13NOS
		6	(R)-Dimethyl 2-hydroxysuccinate	11.696	1.31	162.14	C6H10O5
		7	5-Acetyl Valeric acid, methyl ester	12.385	1.36	240.32	C12H16O3S
		9	DL-Proline, 5-oxo-, methyl ester	13.861	0.37	157.17	C6H9NO3
		10	Anisole	14.136	1.02	108.14	C7H8O
		11	Acetophenone	14.6	0.29	120.15	C6H5COCH3
		12	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	15.045	4.52	151.12	C4H9NO5
		14	2,4-Di-tert-butylphenol	15.627	0.88	206.32	C14H22O
		15	Lauric acid methyl ester	15.837	0.28	214.34	C13H26O2
		16	o-Ethoxybenzylamine	16.732	0.76	151.21	C9H13NO
		17	Methyl alpha-D-glucopyranoside	17.321	29.68	194.18	C7H14O6
		18	Methyl tetradecanoate	18.312	0.33	242.40	C15H30O2
		19	Methyl beta-D-glucopyranoside	18.568	3.37	194.18	C7H14O6
		20	Myristic Acid	18.707	0.48	228.37	C14H28O2
		21	alpha-Lactose	18.767	0.36	342.30	C12H22O11
		22	Beta-Sitosterol	18.889	0.83	414.70	C29H50O
		23	(Z)-9-Hexadecenoic acid, methyl ester	20.317	0.84	254.41	C16H30O2
		24	Methyl palmitate	20.543	2.17	270.50	C17H34O2
		25	3,5-Di-tert-butyl-4-hydroxybenzaldehyde	20.6	0.41	234.33	C15H22O2

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		26	(S)-10-camphorsulfonic acid	20.668	3.93	231.29	C10H15O4S-
		27	2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl	20.79	4.97	164.24	C11H16O
		28	Pentadecylic Acid	20.906	7.36	242.40	C15H30O2
		29	Megastigmatrienone	20.998	0.82	190.28	C13H18O
		30	9,19-Cyclolanostan-3-ol, acetate, (3beta)	21.973	0.28	470.80	C32H54O2
		31	1-Nonadecene	22.173	0.74	266.50	C19H38
		32	Methyl oleate	22.317	3.39	296.50	C19H36O2
		33	Methyl 9-octadecenoate	22.375	0.49	296.50	C19H36O2
		34	Methyl stearate	22.567	0.51	298.5 0	C19H38O2
		35	9,12-Octadecadienoic acid	22.608	1	280.40	C18H32O2
		36	5-Hydroxymethylfurfural	22.666	1.78	504.44	$C_6H_6O_3$
		38	octadecanoic acid	22.896	1.26	284.50	C18H36O2
		39	cis-9-Tricosene	24.09	0.12	322.6	C23H46
		40	1-Hexacosanol	25.855	0.92	382.70	C26H54O
2000	0						
		1	Melezitose	8.575	5.6	504.44	C18H32O16
		2	Undecane	8.976	0.03	156.31	C11H24
		3	pyrrolidin-2-ylmethanol	9.121	0.17	101.15	C5H11NO
		4	N-nitrosodiethylamine	9.705	0.08	102.14	C4H10N2O
		5	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.875	13.11	144.12	C6H8O4
		6	1,4-Anhydro-d-mannitol	10.336	0.15	164.16	C6H12O5
		7	pyrrolidin-2-ylmethanol	10.718	5.88	101.15	C5H11NO
		8	2(1H)-Quinolinone, 4-methyl-	10.972	2.32	159.18	C10H9NO
		10	Ribitol	11.486	8.36	152.15	C5H12O5
		11	(R)-Dimethyl 2-hydroxysuccinate	11.687	1.51	162.14	C6H10O5
		12	2-Pentanone	12.413	1.65	86.13	C5H10O
		13	DL-Proline, 5-oxo-, methyl ester	13.845	0.36	157.17	C6H9NO3
		14	Anisole	14.119	0.24	108.14	C7H8O

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		15	Guanosine	14.962	2.99	283.24	C10H13N5O5
		16	2,4-Di-tert-butylphenol	15.612	1.01	206.32	C14H22O
		17	Lauric acid methyl ester	15.822	0.26	214.34	C13H26O2
		18	Benzaldehyde, 6-hydroxy-4-methoxy-2,3-dimethyl-	16.716	1.13	180.20	C10H12O3
		19	Methyl alpha-D-glucopyranoside	17.281	18.77	194.18	C7H14O6
		20	Methyl tetradecanoate	18.296	0.3	242.40	C15H30O2
		21	Methyl beta-D-glucopyranoside	18.56	6.8	194.18	C7H14O6
		22	Myristic Acid	18.692	0.31	228.37	C14H28O2
		23	alpha-Lactose	18.738	0.65	342.30	C12H22O11
		24	Cardenolide	18.865	1.3	342.50	C23H34O2
		25	2-Deoxy-D-ribose	19.939	0.13	134.13	C5H10O4
		26	(Z)-9-Hexadecenoic acid, methyl ester	20.299	0.42	254.41	C16H30O2
		27	Methyl palmitate	20.525	1.82	270.50	C17H34O2
		28	(S)-10-camphorsulfonic acid	20.65	1.15	231.29	C10H15O4S-
		29	(Z,E)-7,11-Hexadecadien-1-yl acetate	20.771	1.17	280.40	C18H32O2
		30	Pentadecylic Acid	20.891	6.81	242.40	C15H30O2
		31	Megastigmatrienone	20.98	0.52	190.28	C13H18O
		32	DL-1,2-Hexanediol	21.163	0.33	118.17	C6H14O2
		33	1-Nonadecene	22.154	0.76	266.50	C19H38
		34	Methyl oleate	22.299	2.91	296.50	C19H36O2
		35	Methyl 9-octadecenoate	22.358	0.44	296.50	C19H36O2
		36	Methyl stearate	22.55	0.51	298.50	C19H38O2
		37	9,12-Octadecadienoic acid	22.591	1.14	280.40	C18H32O2
		38	5-Hydroxymethylfurfural	22.647	1.51	504.44	$C_6H_6O_3$
		40	octadecanoic acid	22.877	1.11	284.50	C18H36O2
		41	cis-9-Tricosene	24.706	0.18	322.60	C23H46
		42	1-Hexacosanol	25.836	0.82	382.70	C26H54O
4000	0						

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		1	Melezitose	8.526	2.57	504.44	C18H32O16
		2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.864	9.42	144.12	C6H8O4
		3	pyrrolidin-2-ylmethanol	10.691	3.99	101.15	C5H11NO
		4	2(1H)-Quinolinone, 4-methyl-	10.97	2.2	159.18	C10H9NO
		6	N-Nitrosohexamethyleneimine	11.342	3.18	128.17	C6H12N2O
		7	Ribitol	11.551	5.38	152.15	C5H12O5
		8	Oxamic hydrazide	11.675	0.79	103.08	C2H5N3O2
		10	Durenol	12.8	0.22	150.22	C10H14O
		11	DL-Proline, 5-oxo-, methyl ester	13.841	0.39	157.17	C6H9NO3
		12	Anisole	14.12	0.31	108.14	C7H8O
		13	p-Acetylacetophenone	14.587	0.24	162.18	C10H10O2
		14	Guanosine	14.954	3.08	283.24	C10H13N5O5
		15	Propofol	15.201	0.19	178.27	C12H18O
		16	2,4-Di-tert-butylphenol	15.615	0.97	206.32	C14H22O
		17	Lauric acid methyl ester	15.825	0.25	214.34	C13H26O2
		18	(-)-(Z)-Verbenol	16.719	0.22	152.23	C10H16O
		19	Methyl alpha-D-glucopyranoside	17.374	33.13	194.18	C7H14O6
		20	Methyl tetradecanoate	18.298	0.3	242.40	C15H30O2
		21	Methyl beta-D-glucopyranoside	18.558	6.64	194.18	C7H14O6
		22	alpha-Lactose	18.734	1.15	342.30	C12H22O11
		23	Octyl beta-D-glucopyranoside	18.839	1.32	292.37	C14H28O6
		24	1,6-Anhydro-.beta.-D-glucopyranose	19.939	0.26	162.14	C6H10O5
		25	(Z)-9-Hexadecenoic acid, methyl ester	20.301	0.5	254.41	C16H30O2
		26	Methyl palmitate	20.526	1.64	270.50	C17H34O2
		27	3,5-Di-tert-butyl-4-hydroxybenzaldehyde	20.583	0.24	234.33	C15H22O2
		28	(S)-10-camphorsulfonic acid	20.652	0.79	231.29	C10H15O4S-
		30	Pentadecylic Acid	20.89	4.94	242.40	C15H30O2
		31	Megastigmatrienone	20.983	0.53	190.28	C13H18O

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		32	2,2-Dimethylglutaric acid	21.179	0.59	160.17	C7H12O4
		33	1-Nonadecene	22.156	0.89	266.50	C19H38
		34	Methyl stearolate	22.233	0.27	294.50	C19H34O2
		35	Methyl 9-octadecenoate	22.301	2.6	296.50	C19H36O2
		36	Methyl oleate	22.367	0.49	296.50	C19H36O2
		37	9,12-Octadecadienoic acid	22.592	1.15	280.40	C18H32O2
		38	5-Hydroxymethylfurfural	22.649	1.34	504.44	$C_6H_6O_3$
		40	octadecanoic acid	22.877	1.03	284.50	C18H36O2
		41	cis-9-Tricosene	24.708	0.23	322.60	C23H46
		42	1-Hexacosanol	25.838	0.5	382.70	C26H54O
		43	(Z)-9-Tricosene	27.706	0.08	322.60	C23H46
Control	0.5						
		1	Melezitose	8.561	3.29	504.44	C18H32O16
		2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.886	11.53	144.12	C6H8O4
		3	pyrrolidin-2-ylmethanol	10.716	4.65	101.15	C5H11NO
		4	2(1H)-Quinolinone, 4-methyl-	10.981	1.04	159.18	C10H9NO
		6	N-Nitrosohexamethyleneimine	11.343	2.98	128.17	C6H12N2O
		7	(R)-Dimethyl 2-hydroxysuccinate	11.694	1.11	162.14	C6H10O5
		10	DL-Proline, 5-oxo-, methyl ester	13.844	0.37	157.17	C6H9NO3
		11	N-Allylmorpholine	14.708	0.42	127.18	C7H13NO
		12	4-Methoxy-2,5-dimethylbenzaldehyde	14.825	1.11	164.20	C10H12O2
		13	Guanosine	14.955	1.97	283.24	C10H13N5O5
		14	Decane, 1-iodo-	15.358	0.35	268.19	C10H21I
		15	2,4-Di-tert-butylphenol	15.616	1.12	206.32	C14H22O
		16	1-Butanamine, N,N-dimethyl-	15.701	0.38	101.19	C6H15N
		17	Lauric acid methyl ester	15.826	0.36	214.34	C13H26O2
		18	Benzaldehyde, 6-hydroxy-4-methoxy-2,3-dimethyl-	16.72	0.83	180.20	C10H12O3
		19	Methyl alpha-D-glucopyranoside	17.328	22.14	194.18	C7H14O6

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		20	Methyl beta-D-glucopyranoside	18.56	3.29	194.18	C7H14O6
		21	alpha-Lactose	18.743	0.94	342.30	C12H22O11
		22	Beta-Sitosterol	18.876	0.85	414.70	C29H50O
		23	(Z)-9-Hexadecenoic acid, methyl ester	20.303	0.6	254.41	C16H30O2
		24	Methyl palmitate	20.529	1.67	270.50	C17H34O2
		25	(S)-10-camphorsulfonic acid	20.656	3.79	231.29	C10H15O4S-
		26	2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl-	20.779	5.12	164.24	C11H16O
		27	Palmitic acid	20.9	7.39	256.42	C16H32O2
		28	Megastigmatrienone	20.983	0.89	190.28	C13H18O
		29	1,2-Hexanediol	21.175	0.49	118.17	C6H14O2
		30	1-Octadecanol	22.159	1.03	270.49	C18H38O
		31	Methyl oleate	22.303	2.62	296.50	C19H36O2
		32	Phytol	22.4	0.61	296.50	C20H40O
		33	9,12-Octadecadienoic acid	22.602	2.96	280.40	C18H32O2
		34	9,12,15-Octadecatrienoic acid, methyl ester	22.658	2.76	292.50	C19H32O2
		36	octadecanoic acid	22.886	1.76	284.50	C18H36O2
		37	cis-9-Tricosene	24.711	0.49	322.60	C23H46
		40	1-Hexacosanol	25.841	2	382.70	C26H54O
		42	(Z)-9-Tricosene	27.71	0.71	322.60	C23H46
Control	1						
		1	Melezitose	8.562	4.32	504.44	C18H32O16
		2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.865	11.26	144.12	C6H8O4
		3	pyrrolidin-2-ylmethanol	10.669	3.64	101.15	C5H11NO
		4	2(1H)-Quinolinone, 4-methyl-	10.975	1.9	159.18	C10H9NO
		6	Tetraethoxypropane	11.691	1.31	220.31	C11H24O4
		7	2-Methyl-2-propyl-1,3-propanediol	12.364	2.01	132.20	C7H16O2
		8	DL-Proline, 5-oxo-, methyl ester	13.841	0.56	157.17	C6H9NO3
		10	4-Chloroanisole	14.129	0.42	142.58	C7H7ClO

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		11	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	14.863	2.26	151.12	C4H9NO5
		12	2,4-Di-tert-butylphenol	15.621	0.73	206.32	C14H22O
		13	Lauric acid methyl ester	15.831	0.3	214.34	C13H26O2
		14	Oxotremorine	16.726	0.28	206.28	C12H18N2O
		15	Methyl alpha-D-glucopyranoside	17.182	12.98	194.18	C7H14O6
		16	Methyl tetradecanoate	18.306	0.34	242.40	C15H30O2
		17	Methyl beta-D-glucopyranoside	18.545	2.04	194.18	C7H14O6
		18	Nonanoic acid	18.692	0.84	158.24	C9H18O2
		19	beta-Caryophyllene	18.882	0.59	220.35	C15H24O
		20	(Z)-9-Hexadecenoic acid, methyl ester	20.308	0.68	254.41	C16H30O2
		21	Methyl palmitate	20.535	2.3	270.50	C17H34O2
		22	(S)-10-camphorsulfonic acid	20.662	7.22	231.29	C10H15O4S-
		23	2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl-	20.786	10.39	164.24	C11H16O
		24	Palmitic acid	20.9	7.29	256.42	C16H32O2
		25	Megastigmatrienone	20.991	1.17	190.28	C13H18O
		27	1-Nonadecene	22.165	1.02	266.51	C19H38
		28	Methyl linoleate	22.241	0.42	294.50	C19H34O2
		29	Methyl oleate	22.309	3.91	296.50	C19H36O2
		30	Phytol	22.404	0.9	296.50	C20H40O
		31	9,12-Octadecadienoic acid	22.605	2.51	280.40	C18H32O2
		32	9,12,15-Octadecatrienoic acid, methyl ester	22.661	2.72	292.50	C19H32O2
		34	octadecanoic acid	22.895	2.41	284.50	C18H36O2
		35	1-Octadecanol	24.082	0.34	270.49	C18H38O
		36	Camphor oxime	24.502	0.32	167.25	C10H17NO
		40	(Z)-9-Tricosene	25.847	3.43	322.60	C23H46
		42	1-Hexacosanol	27.718	1.31	382.70	C26H54O
2000	0.5						
		1	Melezitose	8.526	2.44	504.44	C18H32O16

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		2	Furaneol	9.575	0.74	128.13	C6H8O3
		3	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.864	8.57	144.12	C6H8O4
		4	pyrrolidin-2-ylmethanol	10.73	5.97	101.15	C5H11NO
		5	2(1H)-Quinolinone, 4-methyl-	10.983	1.09	159.18	C10H9NO
		7	1-nitrosoazepan-3-ol	11.337	1.85	144.17	C6H12N2O2
		8	R)-Dimethyl 2-hydroxysuccinate	11.692	0.85	162.14	C6H10O5
		10	DL-Proline, 5-oxo-, methyl ester	13.842	0.44	157.17	C6H9NO3
		11	4-Chloroanisole	14.126	0.29	142.58	C7H7ClO
		13	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	14.999	3.92	151.12	C4H9NO5
		14	2,4-Di-tert-butylphenol	15.618	0.51	206.32	C14H22O
		16	Methyl alpha-D-glucopyranoside	17.356	26.45	194.18	C7H14O6
		17	Methyl tetradecanoate	18.302	0.49	242.40	C15H30O2
		18	Methyl beta-D-glucopyranoside	18.567	4.92	194.18	C7H14O6
		19	Mannose	18.74	1.34	180.16	C6H12O6
		20	Beta-Sitosterol	18.877	1.4	414.70	C29H50O
		21	D-erythro-Pentose, 2-deoxy	19.947	0.36	134.13	C5H10O4
		22	beta-Caryophyllene	20.1	0.44	220.35	C15H24O
		23	(Z)-9-Hexadecenoic acid, methyl ester	20.305	0.46	254.41	C16H30O2
		24	Methyl palmitate	20.532	1.47	270.50	C17H34O2
		25	(S)-10-camphorsulfonic acid	20.658	3.65	231.29	C10H15O4S-
		27	Palmitic acid	20.899	6.56	256.42	C16H32O2
		28	Megastigmatrienone	20.988	1.15	190.28	C13H18O
		29	1-Nonadecene	22.16	0.82	266.51	C19H38
		30	Methyl oleate	22.305	2.62	296.50	C19H36O2
		31	Phytol	22.399	0.56	296.50	C20H40O
		32	Methyl linoleate	22.6	1.77	294.50	C19H34O2
		33	9,12-Tetradecadien-1-ol, acetate, (9Z,12E)-	22.657	2.11	252.39	C16H28O2
		35	octadecanoic acid	22.886	1.58	284.50	C18H36O2

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		36	Camphor oxime	24.492	0.4	167.25	C10H17NO
		37	Methyl oleate	24.712	0.4	296.50	C19H36O2
		38	1-Octadecanol	24.77	0.45	270.49	C18H38O
		39	1-Hexacosanol	25.842	0.96	382.70	C26H54O
		41	(Z)-9-Tricosene	27.712	0.15	322.60	C23H46
2000	1						
		1	Melezitose	8.537	6.45	504.44	C18H32O16
		2	N-nitrosodiethylamine	9.65	0.51	102.14	C4H10N2O
		3	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.853	12.47	144.12	C6H8O4
		4	pyrrolidin-2-ylmethanol	10.639	4.2	101.15	C5H11NO
		5	2,3-Dihydro-2,5-dihydoxy-6-methyl-4-H-pyran-4-one	10.971	2.77	144.12	C6H8O4
		7	1,1,3,3-Tetramethoxypropane	11.689	1.52	164.20	C7H16O4
		10	DL-Proline, 5-oxo-, methyl ester	13.844	0.86	157.17	C6H9NO3
		11	4-Chloroanisole	14.126	0.33	142.58	C7H7ClO
		12	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	14.758	4.11	151.12	C4H9NO5
		13	1-Pentadecanol	15.517	0.1	228.41	C15H32O
		14	Methyl dodecanoate	15.831	0.61	214.34	C13H26O2
		15	Methyl alpha-D-glucopyranoside	17.1	13.42	194.18	C7H14O6
		16	2-Methyl-1,4-bis(trimethylsiloxy)butane	17.46	0.89	248.51	C11H28O2Si2
		17	Methyl tetradecanoate	18.307	0.64	242.40	C15H30O2
		18	Methyl beta-D-glucopyranoside	18.524	1.55	194.18	C7H14O6
		19	Hydroquinone	18.569	0.98	110.11	C6H6O2
		20	1-FLUORONONANE	18.717	0.55	146.25	C9H19F
		22	4aH-Cycloprop[e]azulen-4a-ol, decahydro-1,1,4,7-tetramethyl-, [1aR-(1aα,4β,4aβ,7α,7aβ,7bα)]-	18.879	0.44	222.37	C15H26O
		23	Citronellyl propionate	19.584	0.08	212.33	C13H24O2
		24	Anhydro-d-mannosan	19.936	0.13	162.14	C6H10O5
		25	Carvone Epoxide	20.102	0.25	166.22	C10H14O2

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		26	(Z)-9-Hexadecenoic acid, methyl ester	20.308	0.8	254.41	C16H30O2
		27	Methyl palmitate	20.534	4.06	270.50	C17H34O2
		28	(S)-10-camphorsulfonic acid	20.658	6.38	231.29	C10H15O4S-
		29	2-Cyclopenten-1-one, 3-methyl-2-(2Z)-2-pentenyl	20.78	8.45	164.24	C11H16O
		30	Palmitic acid	20.887	4.31	256.42	C16H32O2
		31	Megastigmatrienone	20.989	0.75	190.28	C13H18O
		32	1-Nonadecene	22.164	0.68	266.51	C19H38
		33	8,11-Octadecadienoic acid, methyl ester	22.241	0.59	294.50	C19H34O2
		34	Methyl oleate	22.308	6.97	296.50	C19H36O2
		35	Methyl 9-octadecenoate	22.367	0.77	296.50	C19H36O2
		36	Phytol	22.402	1.01	296.50	C20H40O
		37	octadecanoic acid	22.563	2.07	284.50	C18H36O2
		38	cis-9-Hexadecenal	22.654	1.92	238.41	C16H30O
		39	9,12-Tetradecadien-1-ol, acetate, (9Z,12E)-	22.784	1.22	252.39	C16H28O2
		41	Spiro[4.5]decane	23.151	0.1	138.25	C10H18
		42	1-Nonadecene	24.08	0.17	266.51	C19H38
		44	1-Hexacosanol	25.844	1.46	382.70	C26H54O
		46	(Z)-9-Tricosene	27.716	0.18	322.60	C23H46
4000	0.5						
		1	Melezitose	8.524	4.32	504.44	C18H32O16
		2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.85	10.78	144.12	C6H8O4
		3	pyrrolidin-2-ylmethanol	10.686	8.88	101.15	C5H11NO
		4	2,3-Dihydro-2,5-dihydoxy-6-methyl-4-H-pyran-4-one	10.971	2.99	144.12	C6H8O4
		5	Palmitic acid, trimethylsilyl ester	11.186	1.37	328.60	C19H40O2Si
		6	1,1,3,3-Tetraethoxypropane	11.69	1.16	220.31	C11H24O4
		7	Carcinogen	12.332	1.32	144.13	C4H8N4O2
		8	2,6-Diethylcyclohexanone	12.442	0.54	154.25	C10H18O
		9	DL-Proline, 5-oxo-, methyl ester	13.836	0.92	157.17	C6H9NO3

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		10	4-Chloroanisole	14.124	0.31	142.58	C7H7ClO
		11	1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	14.833	3.25	151.12	C4H9NO5
		12	Quinuclidine	15.502	0.3	111.18	C7H13N
		13	2,4-Di-tert-butylphenol	15.618	1.03	206.32	C14H22O
		14	Methyl laurate	15.828	0.56	214.34	C13H26O2
		16	Methyl alpha-D-glucopyranoside	17.156	19.61	194.18	C7H14O6
		17	N-Methylindole	17.461	0.45	131.17	C9H9N
		18	Methyl tetradecanoate	18.304	0.63	242.40	C15H30O2
		19	Methyl beta-D-glucopyranoside	18.534	5.04	194.18	C7H14O6
		20	Mannose	18.733	0.8	180.16	C6H12O6
		21	Isopropyl hexanoate	18.821	0.45	158.24	C9H18O2
		22	beta-Caryophyllene	18.882	0.5	220.35	C15H24O
		23	(Z)-9-Hexadecenoic acid, methyl ester	20.306	1.02	254.41	C16H30O2
		24	Methyl palmitate	20.532	3.78	270.50	C17H34O2
		25	3,5-Di-tert-butyl-4-hydroxybenzaldehyde	20.592	0.3	234.33	C15H22O2
		26	(S)-10-camphorsulfonic acid	20.656	3.38	231.29	C10H15O4S-
		28	Palmitic acid	20.889	5.66	256.42	C16H32O2
		29	Megastigmatrienone	20.987	0.78	190.28	C13H18O
		30	1-Nonadecene	22.161	1	266.51	C19H38
		31	8,11-Octadecadienoic acid, methyl ester	22.239	0.49	294.50	C19H34O2
		32	Methyl oleate	22.307	6.18	296.50	C19H36O2
		33	Methyl 9-octadecenoate	22.367	0.91	296.50	C19H36O2
		34	octadecanoic acid	22.562	1.71	284.50	C18H36O2
		35	cis-9-Hexadecenal	22.652	1.39	238.41	C16H30O
		37	stearic acid	22.885	1.04	284.50	C18H36O2
		38	Erucamide	24.711	0.36	337.60	C22H43NO
		39	(Z)-9-Tricosene	25.843	0.52	322.60	C23H46
4000	1						

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		1	Melezitose	8.525	2.34	504.44	C18H32O16
		2	(S)-2,3,4,5-tetrahydropyridine-2-carboxylic acid	9.1	0.23	127.14	C6H9NO2
		3	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	9.857	7	144.12	C6H8O4
		4	pyrrolidin-2-ylmethanol	10.706	6.27	101.15	C5H11NO
		7	4,4,6-Trimethyl-1,3-oxazinane-2-thione	11.342	0.8	159.25	C7H13NOS
		8	(R)-Dimethyl 2-hydroxysuccinate	11.69	0.82	162.14	C6H10O5
		10	1-methylpiperidine	12.86	0.2	99.17	C6H13N
		11	4-Chloroanisole	13.845	0.57	142.58	C7H7ClO
		12	DL-Proline, 5-oxo-, methyl ester	14.128	0.31	157.17	C6H9NO3
		13	1,4-Diacetylbenzene	14.594	0.45	162.18	C10H10O2
		15	1,4-Anhydro-d-mannitol	14.837	2.56	164.16	C6H12O5
		17	Methyl laurate	15.833	0.29	214.34	C13H26O2
		18	Methyl alpha-D-glucopyranoside	17.314	33.1	194.18	C7H14O6
		19	Methyl tetradecanoate	18.307	0.34	242.40	C15H30O2
		20	Methyl beta-D-glucopyranoside	18.564	11.06	194.18	C7H14O6
		21	Mannose	18.74	1.4	180.16	C6H12O6
		22	Octyl beta-D-glucopyranoside	18.842	1.85	292.37	C14H28O6
		23	(Z)-9-Hexadecenoic acid, methyl ester	20.309	0.53	254.41	C16H30O2
		24	Methyl palmitate	20.537	2.31	270.50	C17H34O2
		27	Palmitic acid	20.893	3.43	256.42	C16H32O2
		28	Megastigmatrienone	20.991	0.52	190.28	C13H18O
		29	2,2-Dimethylglutaric acid	21.177	0.21	160.17	C7H12O4
		30	beta-Lactose	21.709	0.3	342.30	C12H22O11
		32	1-Nonadecene	22.166	0.98	266.51	C19H38
		33	9,12-Octadecadienoic acid	22.243	0.36	280.40	C18H32O2
		34	Methyl oleate	22.31	3.37	296.50	C19H36O2
		35	Methyl 9-octadecenoate	22.375	0.55	296.50	C19H36O2
		36	octadecanoic acid	22.566	0.96	284.50	C18H36O2

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299

		37	5-Hydroxymethylfurfural	22.658	0.84	504.44	$C_6H_6O_3$
		38	stearic acid	22.886	0.83	284.50	C18H36O2
		42	1-Hexacosanol	25.847	0.56	382.70	C26H54O
		46	1-Tridecene	28.094	0.07	182.35	C13H26

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2302_32593299