Alqalam Journal of Medical and Applied Sciences. 2025;8(3):1646-1656
https://doi.org/10.54361/ajmas.258355

Original article

Estimate the Types and Contents of Phenolic Acid in *C. Parviflorus Lam* and *C. Salviifolius L* Plants Growing at Al-Gabal Al-Khder region

Hamad Hasan[1]*, Zaenab Habil[2], Najat Ben Arous[3]

[1]*Chemistry Department, Faculty of Science, Omar Al-Mukhtar University, Libya*
[2]*Chemistry Department, Faculty of Science (Derna), Derna University, Libya*
[3]*Chemistry Department, Faculty of Education, El-Mergieb University, Libya*
Corresponding email: hamad.dr@omu.edu.ly

Abstract
In this study, the leaves, stems, and roots of *C. parviflorus Lam* and *C. salviifolius* plants that are growing in the Al-Gabal Al-Akhder region of Libya were selected to estimate the contents and types of phenolic acids using by GCMs instrument. The study included information on chemical structure definitions and the effects of solvents. The types and contents of phenolic acid compounds and their derivatives detected in the studied samples showed small variations in their contents; some phenolic acids showed relative increases in alcoholic extracts when compared to aqueous extracts. The types and values of the phenolic compounds were dependent on the polarity of the solvents that were used in this study. In general, the types of phenolic compounds that were detected using the solvents that were used in this study are: chlorogenic acid, caffeic acid, 3,4-dihydroxybenzoic acid, 3,5-dihydroxybenzoic acid, cinnamic acid, gallic acid, geraniol, tannic acid, phloridzin, and quercetin. The phenolic acid concentration of the alcoholic and aqueous extracts varied little, according to the results.

Keywords. Determination, Phenolic Acid Types, Concentration, GC Mass Analysis.

Introduction

The identification of novel medicinal agents is made possible by natural products like plant extracts [1]. Since they are a vast source of beneficial phytochemicals that will aid in the creation of new medications, medicinal plants are currently regarded as being quite important. Most phytochemicals derived from plants, including flavonoids and phenols, have been shown to improve health and prevent cancer [2]. Since ancient times, people have used medicinal plants to treat ailments [3]. The therapeutic qualities of the plants are ascertained by their chemical constituents [4]. The usage of medicinal plants by indigenous people from around the world has been documented by the World Health Organization (WHO). In the latter part of the 1990s, the use of plant derivatives as therapeutic agents became increasingly common. About 80% of the world's population relies on herbal therapy, and most developing nations employ traditional medicine and medicinal plants as a standard base for sustaining good health. Many secondary metabolites, including phenols, flavonoids, quinones, tannins, alkaloids, saponins, and sterols, are typically produced by plants and are significant sources of biocides and numerous other pharmaceutical medications [5].

Drug development and pharmacological research both benefit from the use of medicinal plants [6]. Plants are the source of around 7,000 of the therapeutic substances listed in the Western Pharmacopoeia [7]. Because they generate a wide variety of bioactive chemicals, the majority of which most likely developed as chemical defenses against infection or predation and antioxidant substances, plants have been a rich source of medicinal products [8]. Numerous plants have antibacterial properties, and various actions are employed to treat various illnesses. In rural Libya, medicinal plants have been utilized in traditional medicine; regions have comparatively lower costs than contemporary medicine, and they have been extensively utilized as topical anti-inflammatory drugs, diuretics, and hemostatic [9]. The Cistus plant that is flourishing at Al-Gabal is the subject of this investigation. Al-Khder (Libya) was chosen, and the following is a summary of this plant's description: Cistus plant: There are 180 species in the family Cistaceae, which includes 8 genera. Species, five Mediterranean-native genera (Halimium, Cistus, Tuberaria, Fumaria, and Helianthemum). There are 21 species in the genus Cistus [3]. Cistus (derived from kistos, a Greek term). The name of this family is Rock. Rose plants [10]. These plants are lovely bushes that are classified into several types based on the color of their pink or white blooms [11]. Spread throughout the regions of western Africa, Asia, Europe, and the Mediterranean [12]. It is well known that the Mediterranean region is the typical home of the genus Cistus [13]. These plants can thrive in challenging soil, rocky, and climate conditions. [14]. The heterosexual In Mediterranean traditional medicine, many of these have been utilized as herbal plants to cure colds and intestinal issues, as well as extracts for therapy for illnesses. The illnesses and ailments that are being targeted include anxiety, bronchitis, arthrosis, asthma, and many malignancies, duodenosis, cardiopathies, catarrh, bacterial and fungal diseases, headache, dyspnea, diarrhea, and dysentery [10].

Tea made from C. salviifolius leaves is used to treat cancer. In Libya, Cistus species are utilized in traditional medicine. For a variety of reasons. For instance, a root decoction is used to treat infertility among women in Artvin. Various kinds of castus are utilized in Jordanian traditional medicine to treat numerous illnesses, including gout, ulcers, intestinal disorders, and anti-inflammatory diseases, as well as reducing blood sugar [15]. Current scientific studies have concentrated on the identification and isolation of substances found in

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

resins and extracts made from several Cistus species. Additionally, research has examined its pharmacological and biological properties. This has therapeutic qualities for a variety of illnesses [16].
Chemical analyses carried out on various Cistus species showed that terpenes, flavonoids, and phenolic compounds make up their constituents. acids, bornyl esters, and resacetophenone glucoside. lipids (from the seeds), gum, resin, and essential oils. The basic oil composition of Cistus species is examined. The existence of aromatics, sesquiterpenes, and oxygenated monoterpenes Sesqui terpenes with oxygen and trace amounts of carbonyl compounds. Cistus species' leaves have convered structures that release Terpenoids make up most of the resin and basic oil [17]. This study aims to estimate the types and contents of phenolic acids in plants collected from the Al Gabal Al Khder region, Libya.

Methods

Sampling

Two plants (*C. parviflorus and C. salviifolus*) were chosen IN this study because of their significant medical uses. There are numerous plants used in the AL-Gabal AL-Khder region of Libya. The samples were gathered in the spring of 2023 from the Al-Gabel Al-Kadar region. Taxonomy of Plants: The Seliphium Herbarium, Botany Department, Faculty of Science, Omar Al-Mukhtar University, identified the samples that were gathered. The taxonomy of plants was shown in (Figures 1 & 2), as well as (Table 1).

Figure 1. C. Parviflorus Lam

Figure 2. C. Salviifolius L

Table 1: The taxonomy of the studied plants.

Kingdom	**Plant**	
Clade	Tracheophytes and Angiosperms	Tracheophytes and Angiosperms
Family	*Cistaceae*	*Cistaceae*
Genus	*Cistus*	*Cistus*
Species	*C. Parviflorus Lam*	*C. Saiviifolius L*
Vernacular name	Torrashe Ahmar, Birabash Ahmar	Torrashe Abiad, Birabash Abiad

Sample preparation

The plants under study had their leaves, stems, and roots removed and repeatedly washed with distilled water. After that, the samples were dried in a dry, dark environment. Following a mortar grind, the samples were kept in plastic bottles pending analysis [18-30].

Extraction

Two different solvents were used in this study: Water (aqueous) and Ethanol (Alcoholic),10 grams of each sample (leaves, stems, or roots) were transferred to beakers containing 100 ml of each solvent, and the samples were mixed. Then it is input in the evaporator system until dryness [31-48].

Chemical studies

The Determination of phenolic acids GC mass: At Alexandria University's Central Lab in Egypt, the phenolic acids were estimated using a GC-MS equipment [49-51].

Results

There are several types and amounts of phenolic acids recorded in the studied samples; the results indicated

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

https://doi.org/10.54361/ajmas.258355

that there are small variations in the detected phenolic acids of the samples by the GC-MS analysis. The following phenolic acids were found in the extracts of the chosen plants used in this investigation: Chlorogenic acid; caffeine; 3,4-dihydroxybenzoic acid; 3,5-dihydroxybenzoic acid; 4,5-dihydroxybenzoic acid; cinnamic acid; gallic acid; geraniol; tannic acid; phloridzin; quercetin; and chlorogenic acid. The results of this study were given in (Tables 2 & 3): where the aqueous phenolic acid concentrations ranged as follows: 0.012–0.042, 0.014–0.080, 0.0019–0.0081, 0.010– 0.062, 0.038–0.077, 0.0015–0.0037, 0.0047–0.048, 0.0029–0.0064, 0.0043–0.070, 0.032–0.076, 0.0051–0.038, and 0.019–0.029 μg/g for the phenolic acid compounds mentioned above, in that order. Conversely, the concentrations of phenolic acids in alcoholic extracts varied between 0.016 and 0.053, 0.015 and 0.073, 0.0017 and 0.0064, 0.016 and 0.071, 0.041 and 0.079, 0.0021 and 0.0051, 0.0052 and 0.046, 0.0034 and 0.0076, 0.0054 and 0.084, 0.043 and 0.092, 0.0043 and 0.033, and 0.016 and 0.054 μg/g. for the phenolic acid compounds mentioned above. Alcoholic extracts have a comparatively higher phenolic acid concentration than water extracts. The types and amounts of phenolic acids in the aqueous extracts of the plants under study are listed in (Tables 2 & 3).

Table 2: The types and contents of phenolic acids of aqueous extracts of the studied plants

Phenolic acids μg/g	**Samples**					
	***Parvifloru* leafs**	***Parvifloru* Steams**	***Parvifloru* Roots**	***Salviifolius* leafs**	***Salviifolius* Steams**	***Salviifolius* Roots**
Chlorogenic acid	0.012	0.016	0.042	0.019	0.022	0.031
Caffeic acid	0.020	0.014	0.039	0.025	0.080	0.032
3,4-Dicaffeoly guinic acid	0.009	0.0081	0.0040	0.0053	0.0076	0.0019
3,5-Dicaffeoyl guinic acid	0.047	0.036	0.062	0.041	0.010	0.029
4,5-Dicaffeoyl guinic acid	0.077	0.054	0.038	0.065	0.070	0.064
2,5-dihydroxy Benzoic acid	0.0020	0.0031	0.0015	0.0037	0.0028	0.0043
Cinnamic acid	0.031	0.048	0.030	0.0047	0.0080	0.0065
Galic acid	0.0060	0.0029	0.0063	0.0064	0.0029	0.0057
Geraniol	0.027	0.045	0.070	0.052	0.0090	0.0043
Tannic acid	0.076	0.032	0.058	0.078	0.039	0.060
Phloridzin	0.0085	0.020	0.0051	0.038	0.0070	0.0090
Quercetin	0.023	0.019	0.034	0.029	0.024	0.028
Average	0.028	0.024	0.032	0.030	0.023	0.022
Total	0.338	0.291	0.389	0.367	0.382	0.275

The types and amounts of phenolic acids in the alcoholic extracts of the plants under study are shown in (Table 3).

Table 3: The types and contents of phenolic acids of alcoholic extracts of the studied plants

Phenolic acids μg/g	**Samples**					
	***Parvifloru* leafs**	***Parvifloru* Steams**	***Parvifloru* Roots**	***Salviifolius* leafs**	***Salviifolius* Steams**	***Salviifolius* Roots**
Chlorogenic acid	0.016	0.018	0.053	0.031	0.041	0.028
Caffeic acid	0.018	0.015	0.042	0.019	0.073	0.026
3,4-Dicaffeoly guinic acid	0.007	0.0064	0.0035	0.0062	0.0081	0.0017
3,5-Dicaffeoyl guinic acid	0.052	0.038	0.071	0.046	0.016	0.033
4,5-Dicaffeoyl guinic acid	0.065	0.080	0.041	0.072	0.079	0.071
2,5-dihydroxy Benzoic acid	0.0043	0.0040	0.0021	0.0046	0.003	0.0051
Cinnamic acid	0.046	0.039	0.034	0.0052	0.0090	0.0083
Galic acid	0.0055	0.0034	0.0070	0.0076	0.0038	0.0061
Geraniol	0.032	0.068	0.084	0.049	0.0075	0.0054
Tannic acid	0.057	0.044	0.063	0.092	0.043	0.074
Phloridzin	0.0090	0.015	0.0046	0.033	0.0065	0.0089
Quercetin	0.043	0.016	0.030	0.045	0.032	0.054
Average	0.029	0.028	0.036	0.034	0.026	0.0267
Total	0.354	0.346	0.435	0.410	0.321	0.321

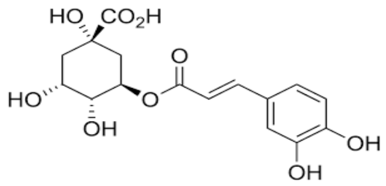
Discussion

Chlorogenic acid

As an intermediary in the production of lignin, chlorogenic acid (CGA) is the ester of caffeic acid and (−) quinic acid. A related class of esters known as "chlorogenic acids" includes quinic acid and hydroxycinnamic acids (caffeic acid, ferulic acid, and p-coumaric acid) [52].

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

https://doi.org/10.54361/ajmas.258355



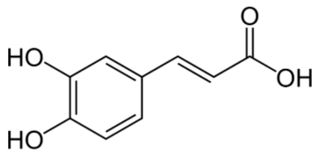
Among its many significant and medicinal functions are antioxidant activity, antibacterial, hepatoprotective, cardioprotective, anti-inflammatory, antipyretic, neuroprotective, anti-obesity, antiviral, antimicrobial, anti-hypertensive, free radical scavenger, and central nervous system stimulator. Chlorogenic is a biologically active dietary polyphenol. A potential chemical sensitizer linked to respiratory allergies to specific plant materials has been investigated: chlorogenic acid. Chlorogenic acid lowers blood pressure a little, whether taken as a dietary supplement or in coffee [53].

Caffeic acid

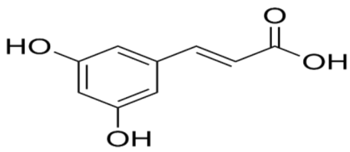
An organic substance categorized as a hydroxycinnamic acid is caffeine. Both phenolic and acrylic functional groups are present in this yellow solid. Since it is a crucial step in the manufacture of lignin, one of the main constituents of woody plant biomass and its byproducts, it is present in all plants. Ferulic acid is produced in plants by converting 4-hydroxycinnamic acid (left) to caffeic acid (center). In vitro research and animal models have shown that caffeine has a range of possible pharmacological effects. It has also recently been shown to have an oxidative mechanism that inhibits the proliferation of cancer cells in the human HT-1080 fibrosarcoma cell line [53]. Both in vitro and in vivo, caffeine has antioxidant properties. Additionally, caffeine has anti-inflammatory and immunomodulatory properties. With a more than 95% reduction in aflatoxin formation, caffeic acid fared better than the other antioxidants. These investigations are the first to demonstrate that caffeic acid can inhibit oxidative stress, which would otherwise cause or increase the synthesis of aflatoxin by Aspergillus flavus. Adding antioxidants to trees makes it possible to employ them as a natural fungicide. Research on caffeine's carcinogenicity has produced conflicting findings. It has been demonstrated to have carcinogenic effects in some experiments and to suppress carcinogenesis in others. Rats that received large oral dosages of caffeic acid developed stomach papillomas. Colon tumor growth was significantly inhibited by high dosages of combination antioxidants, including caffeic acid [52].

Caffaiec acid Isomers

Umbellic acid (2,4-dihydroxycinnamic acid) and 2,3-dihydroxycinnamic acid are isomers belonging to the hydroxycinnamic acid family that share the same chemical formula.



3,4-Dicaffeoly guinic acid

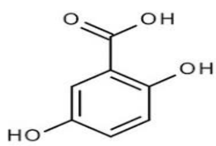


3, 5-Dicaffeoyl guinic acid

A carboxylic ester known as 3,5-di-O-caffeoyl quinic acid is produced when the carboxy group of trans-caffeic acid condenses with the hydroxy groups at positions 3 and 5 of (-) quinic acid. It has cytotoxic and hepatoprotective properties and was isolated from Suaeda glauca and Brazilian propolis. It functions as an antineoplastic, hepatoprotective, and metabolite. It is a carboxylic ester and cyclitol carboxylic acid. It comes from a trans-caffeic acid and a (-)-quinic acid [52].

2,5-Dicaffeoyl guinic acid

One type of dihydroxybenzoic acid is gentisic acid. The kidneys eliminate this small (1%) byproduct of the metabolic breakdown of aspirin, which is a derivative of benzoic acid. Except in certain pharmaceutical compositions, gentisic acid is used as an antioxidant and is easily oxidized as a hydroquinone [53].



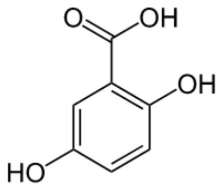
Cinnamic acid

The organic chemical cinnamic acid has the formula C6H5CH = CHCOOH. It is a white, crystalline substance that dissolves readily in a wide range of organic solvents and just minimally in water. It is found in many

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

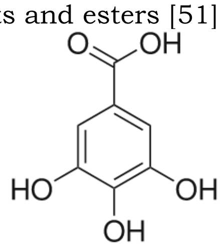
https://doi.org/10.54361/ajmas.258355

plants naturally and is categorized as an unsaturated carboxylic acid. Both a cis and a trans isomer exist; however, the latter is more prevalent. Flavorings, artificial indigo, and some medications all include cinnamic acid. Cinnamic acid is a precursor to the sweetener aspartame by enzyme-catalyzed amination to provide phenylalanine. It is also used extensively as a precursor to generate methyl, ethyl, and benzyl cinnamonate for the perfume business. In non-polar solvents, cinnamic acid can dimerize, producing distinct linear free energy correlations [53].



Galic acid

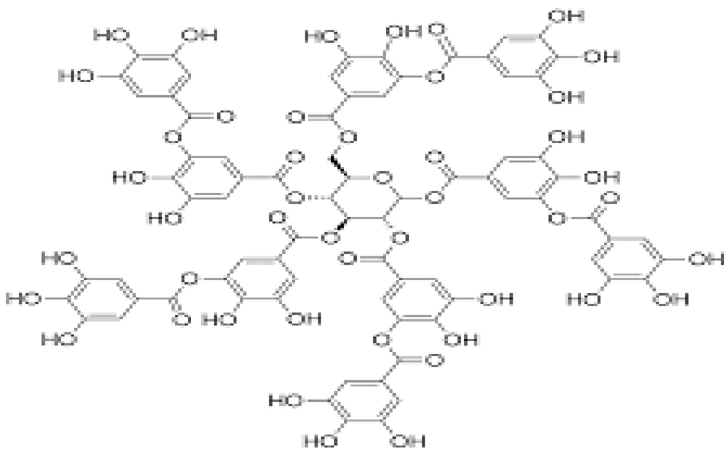
The tri-hydroxybenzoic acid, gallic acid (sometimes called 3,4,5-trihydroxybenzene acid, has the formula $C_6H_2(OH)_3COOH$. It falls within the category of phenolic acid. Gallnuts, tea leaves, witch hazel, sumac, oak bark, and other plants contain it. Although samples are usually dark due to partial oxidation, it is a white solid. The term "gallates" refers to gallic acid salts and esters [51].



Many terrestrial plants, including the aquatic plant Myriophyllum spicatum, the parasitic plant Cynomorium coccineum, and the blue-green alga Microcystis aeruginosa, contain gallic acid. Moreover, certain oak species, Caesalpinia mimosoides, and the stem bark of Boswellia dalzielii contain gallic acid. Gallic acid is present in many foods in varying concentrations, particularly fruits (bananas, strawberries, and grapes), teas, vinegars, and cloves.

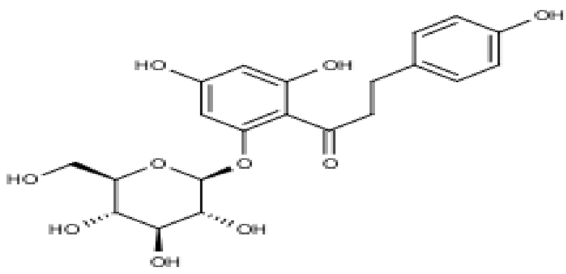
Tannic acid

Historically, it has been used to absorb poisons and act as an antidote. However, in everyday life, tannic acid is used to cure rashes, stop bleeding, and ease various soreness-related disorders [51].



Phloridzin

As a glucoside of phloretin, a dihydrochalcone belonging to the family of bicyclic flavonoids, phlorizin (also known as phloridzin or phloretin-2′-β-D-glucopyranoside) is a subgroup of the varied phenylpropanoid production pathway in plants.



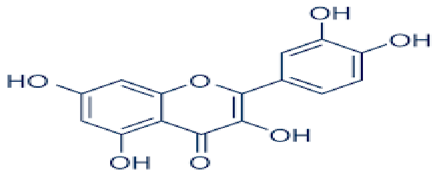
***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

https://doi.org/10.54361/ajmas.258355

Unripe Malus (apple) root bark is the main source of phenolizin, while minor levels have also been discovered in strawberries. It is more prevalent in seeds and vegetative tissues (like leaves and bark) in Malus. Phloridzin is absent from closely related species, including cherry, pear (Pyrus communis), and other Rosaceae fruit trees. One phytochemical that is a member of the polyphenol class is phenolidzin. It can be found in natural sources alongside other polyphenols as rutin, procyanidins, epicatechin, quercetin, and catechin. Because it competes with D-glucose for binding to the carrier, phorizin is a competitive inhibitor of SGLT1 and SGLT2, which lowers renal glucose transport and blood glucose levels. More selective and promising synthetic analogs, like empagliflozin, canagliflozin, and dapagliflozin, have supplanted phorizin, which was investigated as a possible pharmaceutical treatment for type 2 diabetes. When used orally, phlorizin is almost completely broken down by hydrolytic enzymes in the small intestine, making it an ineffective medication [52].

Quercetin

It belongs to the flavonoid category of polyphenols and is a plant flavonol. Numerous fruits, vegetables, leaves, seeds, and grains contain quercetin; typical foods that contain significant levels of this compound include kale and red onions. Foods, drinks, and dietary supplements all contain quercetin, which has a bitter taste [53].



One flavonoid that is abundant in nature is quercetin. Originating from quercetum (oak forest), after the genus Quercus, the term has been in use since 1857. It is a polar auxin transport inhibitor that occurs naturally. The average daily intake of quercetin is between 25 and 50 milligrams, making it one of the most prevalent dietary flavonoids. Higher levels of quercetin are found in the outermost rings and the area nearest the root of red onions, with the latter having the highest concentration. According to one study, tomatoes cultivated organically had 79% more quercetin than those grown non-organically [54-55]. The GC-Mass instrument is one of the most methods used to separate and identify the chemical compounds as amino acids, hydrocarbons, flavonoids, fatty acids, many studies were carried out by used this methods [56–60] In this study The GC mass chromatograms of the studied compounds were given in the (Figures 3 - 14).

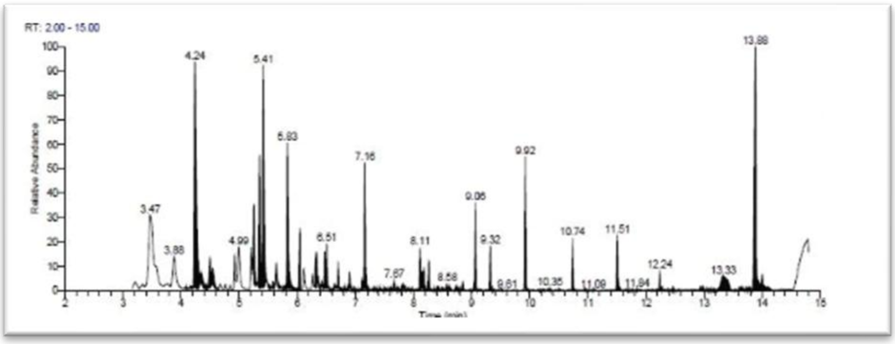


Figure 3: GC –Ms analysis of aqueous extract of leaves of C. Parviflorus Lam

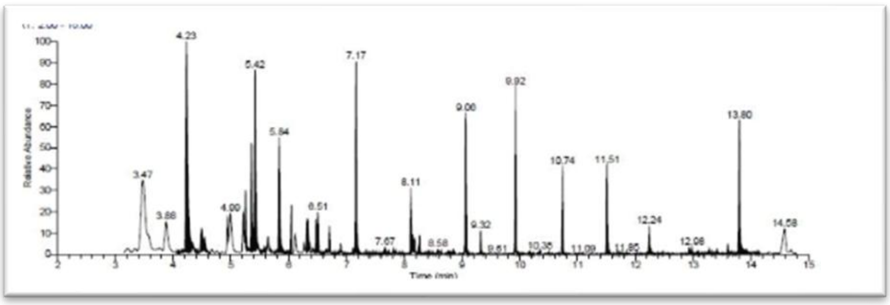


Figure 4: GC –Ms analysis of aqueous extract of stems of C. Parviflorus Lam.

Received*: 04-06-2025 -* ***Accepted****: 31-07-2025 -* ***Published****: 07-08-2025*

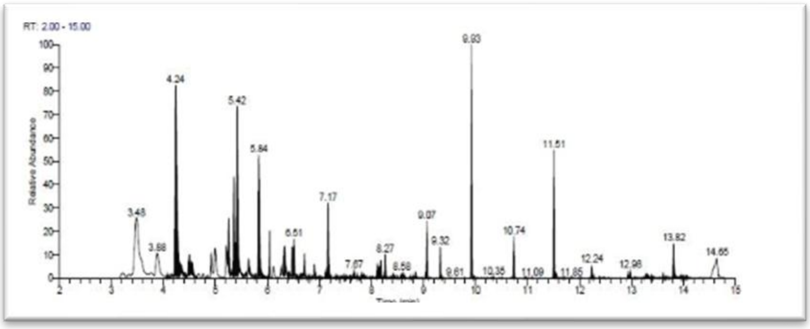


Figure 5: GC –Ms analysis of aqueous extract of roots of C. Parviflorus Lam

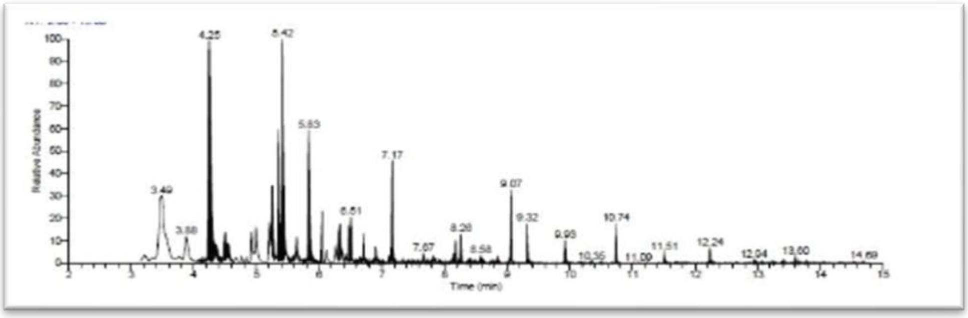


Figure 6: GC –Ms analysis of alcoholic extract of leaves of C. Parviflorus Lam

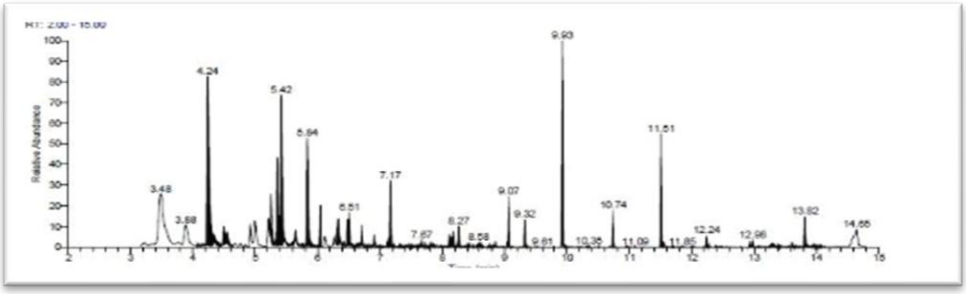


Figure 7: GC –Ms analysis of alcoholic extract of stems of *C. Parviflorus Lam*

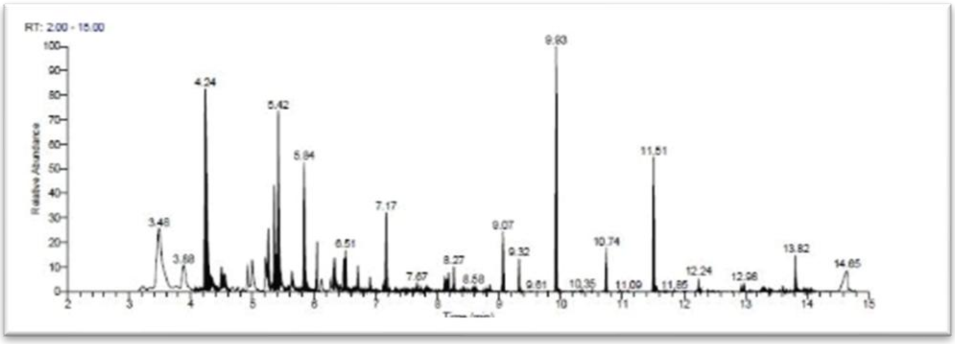


Figure 8: GC –Ms analysis of alcoholic extract of roots of C. Parviflorus Lam

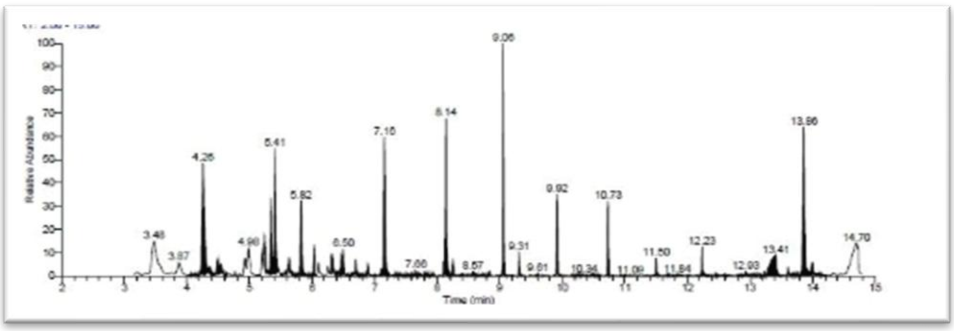


Figure 9: GC –Ms analysis of aqueous extract of leaves of C.Savifolius L

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

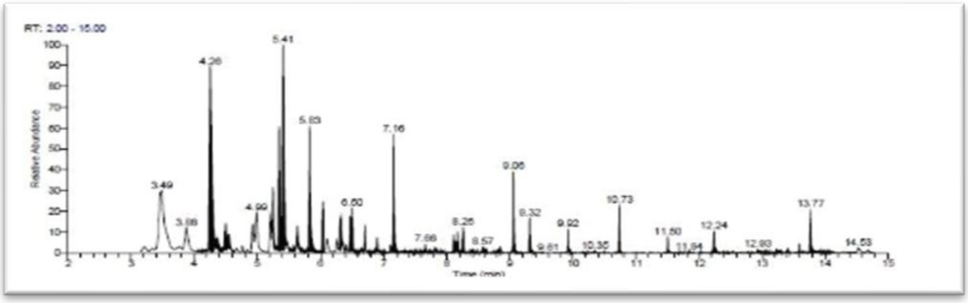


Figure 10: GC –Ms analysis of aqueous extract of stems of C.Savifolius L

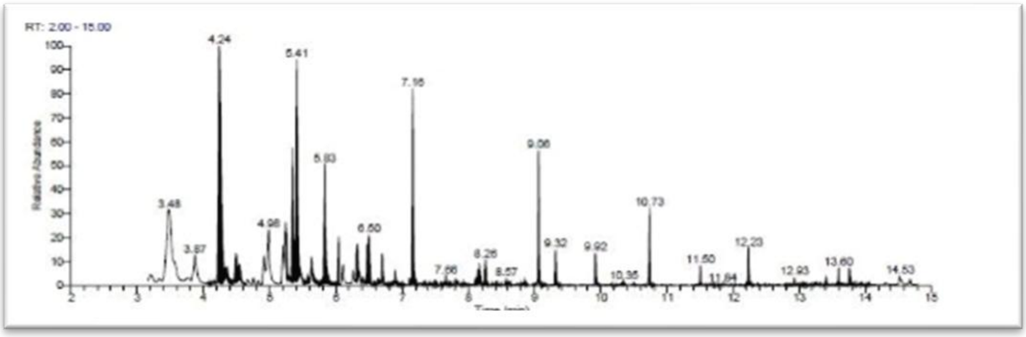


Figure 11: GC –Ms analysis of aqueous extract of roots of C.Savifolius L

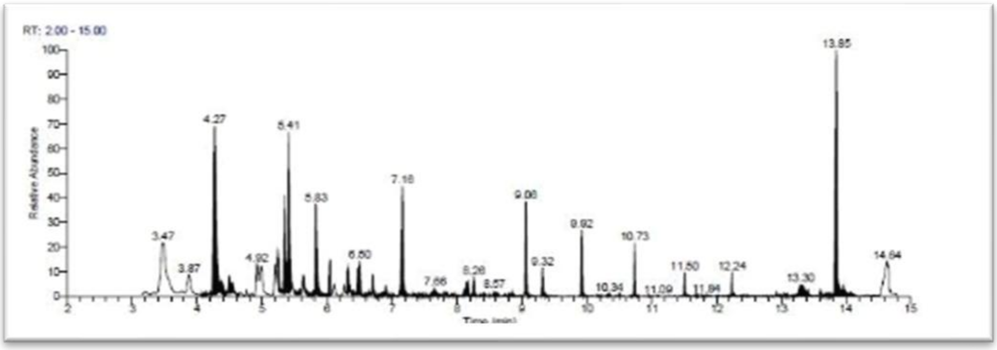


Figure 12: GC –Ms analysis of alcoholic extract of leaves of C.Savifolius L.

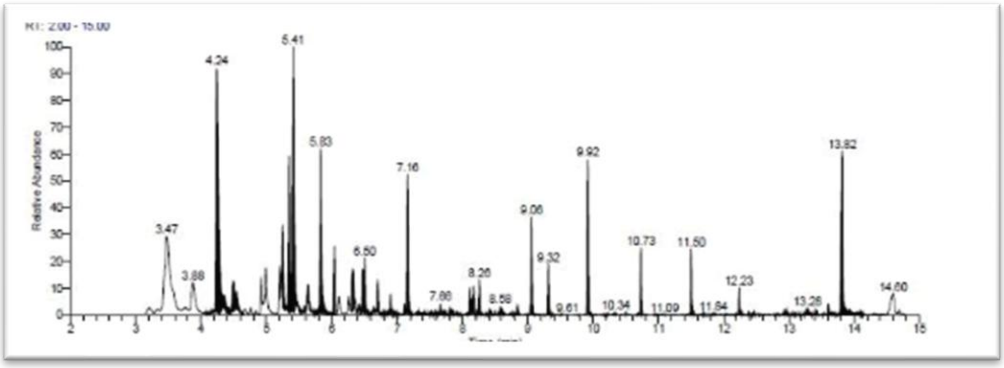


Figure 13: GC –Ms analysis of alcoholic extract of stems of C.Savifolius L.

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

https://doi.org/10.54361/ajmas.258355

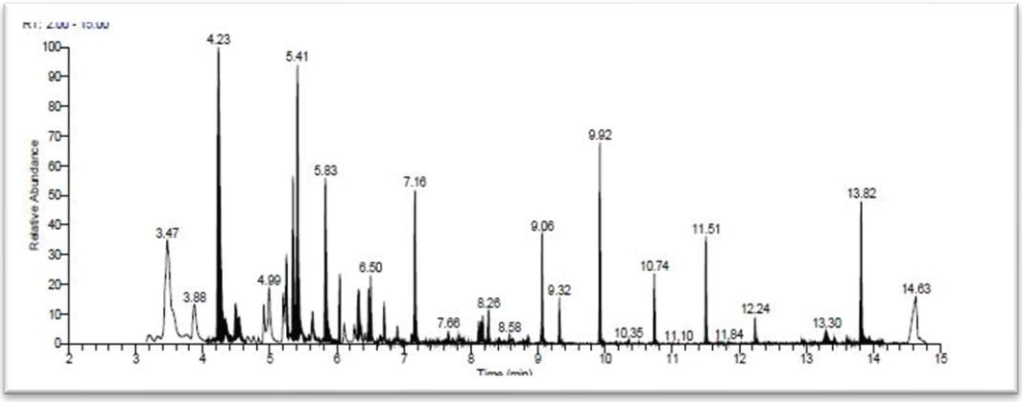


Figure 14: GC–MS analysis of the alcoholic extract of the roots of C. Savifolius L

Conclusion

The results of this study showed different types and contents of phenolic acids; there are small variations in their contents in the selected parts of the studied plants of leaves, stems, and roots.

Acknowledgement

The authors highly appreciate the collaboration of staff members of the Central Laboratory of Chemical Analysis at Omar Al-Muktar University during the chemical analysis of this study.

Conflict of interest. Nil

References

1. Cosa P, Vlietinck AJ, Berghe DV, Maes L. Anti-infective potential of natural products: How to develop a stronger in vitro proof-of-concept. J Ethnopharmacol. 2006;106(3):290-302.
2. Venugopal R, Liu RH. Phytochemicals in diets for breast cancer prevention: The importance of resveratrol and ursolic acid. Food Sci Hum Wellness. 2012;1(1):1-13.
3. Bouyahya A, Talbaoui A, Et-Touys A, Chatoui K, Harhar H, Bakri Y, Dakka N. Phytochemical screening, antiradical and antibacterial activities of Cistus crispus from Morocco. J Mater Environ Sci. 2017;8(5):1560-1566.
4. Ezeonu CS, Ejikeme CM. Qualitative and quantitative determination of phytochemical contents of indigenous Nigerian softwoods. New J Sci. 2016;2016:Article ID 5601327.
5. Naili MB. Evaluation of antibacterial and antioxidant activities of Artemisia campestris (Asteraceae) and Ziziphus lotus (Rhamnaceae). Arab J Chem. 2010;3(2):79-84.
6. Li JW, Vederas JC. Drug discovery and natural products: End of an era or an endless frontier? Science. 2009;325(5937):161-165.
7. Muhaisen HM, Ab-Mous MM, Ddeeb FA, Rtemi AA, Taba OM, Parveen M. Antimicrobial agents from selected medicinal plants in Libya. Chin J Integr Med. 2016;22(3):177-184.
8. Cosimir AC, Min BD. Antioxidants in food lipid chemistry, nutrition, and biotechnology. Boca Raton (FL): CRC Press; 2020. p. 236-409.
9. Burt S. Essential oils: Their antibacterial properties and potential applications in foods. Int J Food Microbiol. 2004;94(3):223-253.
10. Papaefthimiou D, Papanikolaou A, Falara V, Givanoudi S, Kostas S, Kanellis AK. Genus Cistus: A model for exploring labdane-type diterpenes' biosynthesis and a natural source of high-value products with biological, aromatic, and pharmacological properties. Front Chem. 2014;2:35.
11. Guvenc A, Yıldız S, Özkan AM, Erdurak CS, Coşkun M, Yılmaz G, Okuyama T, Okada Y. Antimicrobiological studies on Turkish Cistus species. Pharm Biol. 2005;43(2):178-183.
12. Catoni R, Gratani L, Varone L. Physiological, morphological, and anatomical trait variations between winter and summer leaves of Cistus species. Flora. 2012;207(6):442-449.
13. Skorić M, Todorović S, Gligorijević N, Janković R, Živković S, Ristić M, Radulović S. Cytotoxic activity of ethanol extracts of in vitro grown Cistus creticus subsp. creticus L. on human cancer cell lines. Ind Crops Prod. 2012;38:153-159.
14. Aronne G, Micco V. Seasonal dimorphism in the Mediterranean Cistus incanus L. subsp. incanus. Ann Bot. 2011;87(6):789-794.
15. Abu-Orabi ST, Al-Qudah MA, Saleh NR, Bataineh TT, Obeidat SM, Al-Sheraideh MS, Al-Jaber HI, Tashtoush HI, Lahham JN. Antioxidant activity of crude extracts and essential oils from flower buds and leaves of Cistus creticus and Cistus salviifolius. Arab J Chem. 2020;13(7):6256-6266.
16. Stępień A, Aebisher D, Aebisher DB. Biological properties of Cistus species. Eur J Clin Exp Med. 2018;16(2):127-132.
17. Fang X, Wang R, Sun S, Liu X, Liu X, Wang W, Okada Y. Chemical constituents from the leaves of Cistus parviflorus. J Chin Pharm Sci. 2018;27(1):40-50.

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

https://doi.org/10.54361/ajmas.258355

18. Hasan HM, Ibrahim H, Gonaid MA, Mojahidul I. Comparative phytochemical and antimicrobial investigation of some plants growing in Al Jabal Al-Akhdar. J Nat Prod Plant Resour. 2011;1(1):15-23.
19. Hasan H, Jadallah S, Zuhir A, Ali F, Saber M. The anti-cancer, anti-inflammatory, antibacterial, antifungal, anti-oxidant and phytochemical investigation of flowers and stems of Anacyclus clavatus plant extracts. AlQalam J Med Appl Sci. 2025;2025:415-427.
20. Hasan H, Zuhir A, Shuib F, Abdraba D. Phytochemical investigation and exploring the Citrullus colocynthis extracts as antibacterial agents against some Gram-negative bacteria species. AlQalam J Med Appl Sci. 2025;2025:392-400.
21. Alaila AK, El Salhin HE, Ali RF, Hasan HM. Phytochemical screening of some herbal plants (Mentha, Origanum and Salvia) growing at Al-Gabal Al-Akhder region, Libya. Int J Pharm Life Sci. 2017;8(4):5500-5503.
22. Aljamal MA, Hasan HM, Al Sonosy HA. Antibacterial activity investigation and antibiotic sensitivity for different solvents (ethanol, propanol, DMSO, and diethyl ether) extracts of seeds, leaves, and stems of (Laurus azorica and Avena sterilis) plants. Int J Curr Microbiol Appl Sci. 2024;13(11):175-190.
23. Elsalhin H, Abobaker HA, Hasan H, El-Dayek GA. Antioxidant capacity and total phenolic compounds of some algae species (Anabaena and Spirulina platensis). Sch Acad J Biosci. 2016;4(10):782-786.
24. Eltawaty SA, Abdalkader GA, Hasan HM, Houssein MA. Antibacterial activity and GC-MS analysis of chloroform extract of bark of the Libyan Salvia fruticosa Mill. Int J Multidiscip Sci Adv Technol. 2021;1(1):715-721.
25. Hamad MAS, Ali AR. Separation and identification of the speciation of the phenolic compounds in fruits and leaves of some medicinal plants (Juniperus phoenicea and Quercus coccifera) growing at Algabal Al Akhder region, Libya. Indian J Pharm Educ Res. 2016;51(3):299-303.
26. Hamade MH, Abdelraziq SA, Gebreel AA. Extraction and determination of beta-carotene content in carrots and tomato samples collected from some markets at ElBeida City, Libya. EPH Int J Appl Sci. 2019;1(1):105-110.
27. Hasan HM, Ibrahim H, Gonaid MA, Mojahidul I. Comparative phytochemical and antimicrobial investigation of some plants growing in Al Jabal Al-Akhdar. J Nat Prod Plant Resour. 2011;1(1):15-23.
28. Hasan H, Jadallah S, Zuhir A, Ali F, Saber M. The anti-cancer, anti-inflammatory, antibacterial, antifungal, anti-oxidant and phytochemical investigation of flowers and stems of Anacyclus clavatus plant extracts. AlQalam J Med Appl Sci. 2025;2025:415-427.
29. Hasan H, Zuhir A, Shuib F, Abdraba D. Phytochemical investigation and exploring the Citrullus colocynthis extracts as antibacterial agents against some Gram-negative bacteria species. AlQalam J Med Appl Sci. 2025;2025:392-400.
30. Md Zeyaullah RA, Naseem A, Badrul I, Hamad MI, Azza SA, Faheem AB, Moshed AR, Arif A. Catechol biodegradation by Pseudomonas strain: A critical analysis. Int J Chem Sci. 2009;7(3):2211-2221.
31. El-Mehdawy MF, Eman KS, Hamad MIH. Amino acids contents of leaves and stems for two types of herbal plants (Marjoram and Hybrid tea rose) at AL-Gabal AL-Akhder region. Der Pharma Chem. 2014;6(6):442-447.
32. Gonaid MH, Hasan HH, Ibrahim H, Islam M. Comparative phytochemical and antimicrobial investigation of some plants growing in Al Jabal Al-Akhdar. J Nat Prod Plant Resour. 2011;1(1):15-23.
33. El-Mehdawy MF, Eman KS, Hamad MIH. Amino acid contents of leaves and stems for three types of herbal plants at Al-Gabal Al-Akhder region. World J Chem. 2014;9(1):15-19.
34. Hamad MH, Noura AAM, Salem AM. Phytochemical screening, total phenolic, antioxidant, metals and minerals contents in some parts of Plantago albicans grown in Libya. World J Pharm Res. 2024;13(3):1-17.
35. Anees AS, Hamad MIH, Mojahidul I. Antifungal potential of 1,2,4-triazole derivatives and therapeutic efficacy of Tinea corporis in albino rats. Der Pharm Lett. 2011;3(1):228-236.
36. Hamad H, Marwa M, Amal H. Determining the contents of antioxidants, total phenols, carbohydrate, total protein, and some elements in Eucalyptus gomphocephala and Ricinus communis plant samples. Libyan Med J. 2015;10:222-231.
37. Hamad H, Zuhir A, Farag S, Dala A. Efficiency of Cynara cornigera fruits on antibacterial, antifungal and its phytochemical, anti-oxidant screening. Libyan Med J. 2025;2025:120-128.
38. Hanan MA, Hamida E, Hamad MAH. Nitrogen, phosphorus and minerals (sodium, potassium and calcium) contents of some algae species (Anabaena and Spirulina platensis). Int J Curr Microbiol Appl Sci. 2016;5(11):836-841.
39. Hasan H, Mariea FE, Eman KS. The contents of some chemical compounds of leaves and stems of some herbal plants (Thymus, Rosemary, Salvia, Marjoram and Hybrid Tea Rose) at Al-Gabal Al-Akhder region. EPH Int J Appl Sci. 2014;6(3):1-10.
40. El-Mehdawe MF, Saad EK, Hamad MIH. Heavy metals and mineral elements contents of leaves and stems for some herbal plants at AL-Gabal AL-Akhder region. Chem Sci Rev Lett. 2014;3(12):980-986.
41. Hamad H, Ashour S, Ahmed A. Estimation of amino acid composition, total carbohydrate, and total protein content in Ballota pseudodictamnus plant extracts from Al Jabal Al Akhdar region, Libya. Libyan Med J. 2015;10:266-271.
42. Hamad H, Ahmed H, Wafa A. Evaluation of anti-oxidant capacity, total phenol, metal, and mineral contents of Ziziphus lotus plant grown at some regions of AlGabal AlKhder, Libya. Libyan Med J. 2025;2025:137-143.
43. Rehab AHY, Amira AKA, Ahlaam MA, Hamad MAH. Determination of the anti-oxidant capacity, total phenols, minerals and evaluation of the anti-bacteria activity of leaves and stems of Gaper plant extracts. Sch J Appl Med Sci. 2024;12(4):451-457.
44. Hamad MAH, Noura AAM, Salem AM. Total carbohydrate, total protein, minerals and amino acid contents in fruits, pulps and seeds of some cultivars of muskmelon and watermelon fruit samples collected from Algabal Alkhder region. Der Pharma Chem. 2024;16(3):330-334.

***Received**: 04-06-2025 - **Accepted**: 31-07-2025 - **Published**: 07-08-2025*

45. Ben Areos N, Naser ME, Hamad MAH. Phytochemical screening, anti-bacterial and anti-fungi activities of leaves, stems and roots of C. parviflorus Lam and C. salviifolius L plants. Int J Curr Microbiol Appl Sci. 2014;13(11):262-280.
46. Anas FAA, Hamad MAH, Salim AA, Azza MH. Phytochemical screening, total phenolics, antioxidant activity and minerals composition of Helichrysum stoechas grown in Libya. Afr J Biol Sci. 2024;3(6):2349-2356.
47. Naseer RE, Najat MAB, Salma AA, Hamad MAH. Evaluation of metal and mineral contents of leaves, stems and roots of C. parviflorus Lam and C. salviifolius L plants growing at Al Ghabal Al-Khder (Libya). Int J Adv Multidiscip Res Stud. 2024;4(5):191-194.
48. Hamad MAH, Salem AM. Total carbohydrate, total protein, minerals and amino acid contents in fruits, pulps and seeds of some cultivars of muskmelon and watermelon fruit samples collected from Algabal Alkhder region. Sch J Appl Med Sci. 2024;12(1):1-7.
49. Haroon A, Hasan H, Wafa AAS, Baset ESM. A comparative study of morphological, physiological and chemical properties of leaves and stem samples of (E. gomphocephala) (Tuart) plant growing at coastal (Derna city) and inland regions. J Res Environ Earth Sci. 2024;9(12):10-18.
50. Ali RFM, Hamad MAH, Ahlam KA, Hammida MEH. Phytochemical screening of some herbal plants (Mentha, Origanum and Salvia) growing at Al-Gabal Al-akhder region-Libya. Afr J Basic Appl Sci. 2017;9(3):161-164.
51. Ali RFA, Hamad MAH, Ahlam KA, Hammida MEH. Phytochemical screening of some herbal plants (Mentha, Origanum and Salvia) growing at Al-Gabal Al-akhder region-Libya. Int J Pharm Life Sci. 2017;8(4):5500-5503.
52. Huang D, Ou BX, Prior RL. The chemistry behind antioxidant capacity assays. J Agric Food Chem. 2005;53(6):1841-1856.
53. Huang L, Lin C, Li A, Wei B, Teng J, Li L. Pro-coagulant activity of phenolic acids isolated from Bhimea riparia. Nat Prod Commun. 2010;5(8):1263-1266.
54. Mastino PM, Marchetti M, Costa J, Usai M. Comparison of essential oils from Cistus species growing in Sardinia. Nat Prod Res. 2017;31(3):299-307.
55. Wangensteen H, Samuelsen AB, Malterud KE. Antioxidant activity in extracts from coriander. Food Chem. 2004;88(2):293-297.
56. Hamad IH, Nuesry MS. The polycyclic hydrocarbons levels in some fishes tissues collected from Derna City (Libya) Coast. Int Conf Chem Agric Med Sci. 2014;2014:52-56.
57. Hamad MAH, Mounera AE, Baseet ESM, Eman E, Mohammed A. Identification and detection of the aromatic and aliphatic hydrocarbons in Epinephelus marginatus fish samples collected from Benghazi Coast. Int J Adv Multidiscip Res Stud. 2023;6(3):107-113.
58. Mohammed A, Hamad MAH, Mounera AA, Eman IE. Extraction and identification of aliphatic hydrocarbons in marine sediment samples at Benghazi city and Dyriana town coasts (Libya). J Res Humanit Soc Sci. 2023;11(10):168-174.
59. Hasan HMA, Muftah HS, Abdelghani KM, Saad SI. Poly aromatic hydrocarbon concentrations in some shell samples at some Tobrouk city coast regions: Could the oil industry be significantly affecting the environment? Ukr J Ecol. 2022;12(3):21-28.
60. Salem GM, Aljidaemi FF, Hwisa SA, Hasan HMA, Zaid AA, Amer IO. Occupational exposure to benzene and changes in hematological parameters in East Tripoli, Libya. Nanotechnol Percept. 2024;20(S5):358-364.

Received*: 04-06-2025 -* ***Accepted****: 31-07-2025 -* ***Published****: 07-08-2025*