Pharmacological and Biological Activities of Artemisia Species in Libya: A Comprehensive Review Article

Fatma Elshibani[1*], Eman Z[2]. Younis Nour Elmiladi[3], Shurok Algilale[3], Sondos Alhassi[3], Narjis M. Husayn[4]

1)Department of Pharmacognosy, Faculty of Pharmacy, Benghazi University, Benghazi, Libya.
2)Department of Biomedical science, Faculty of Pharmacy, Benghazi University, Benghazi, Libya.
3) Department of Pharmacognosy, Faculty of Pharmacy, Assalam International University, Benghazi, Libya.
4)Department of Clinical Nutrition , Faculty of Health and Medical Sciences . Alssalam international University, Benghazi, Libya.

Abstract

Artemisia comprises more than 500 species, making it as one of the cosmopolitan genera of the family Astraceae. Temperate zones of North America, Asia, North Africa and Europe are the main regions of Artemisia growing. It has been reported as one of the plant derived medication for treating different ailment including digestive illness, menstrual cycle disturbance, typhoid, morning sickness, renal complications, bronchitis epilepsy, as well as malaria, etc. There is a direct relation between several other health benefits and traditional uses of Artemisia. This review is mainly aimed to survey and evaluate the biological and pharmacological effects of the essential oil and extracts obtained by using different solvents and their respective fractions of Artemisia species in Libya. Furthermore, the plant secondary metabolites viz, glycosides, terpenoids, saponins, flavonoids, and lactons were discussed. According to the collected data, Artemisia has divers therapeutic benefits like antimalarial, anxiolytic, antiepileptic, antihypertensive, antihyperlipidemic, antiasthmatic, antidiabetic, antiemetic, gastroprotective, antidepressant, antiparasitic, antitubercular, anticancer, insecticidal, antiviral activities, and potential effects against COVID-19.

Key words: Artemisia, Libya, secondary metabolites, pharmacological effects, anticancer.

INTRODUCTION

Despite the great progress in orthodox medicine, plants still play a vital role in health care. Indeed, they afford an incomparable source of molecular diversity and bioactivity, which has led to the development of hundreds of pharmaceuticals. Therefore, a continuous chemical and/or biological screening of unexplored flora is necessary to find out natural bioactive products for incorporation in drug industry.

Artemisia L. is established as the widest-spread herb of the Daisy (Asteraceae or Compositae) family and the largest genus of the tribe (Anthemideae), The name of the genus is derived from the Greek goddess of hunt "Artemis", forests and childbirth (Mucciarelli and Maffei, 2002). The number of species reported within the genus ranges from about 380 as mentioned by Ling *et al*. (2006) to more than 500 according to other publications (Bisht et al 2021; Trifa et al 2022). Plants vary from dwarf herbs to tall shrubs, and are mostly perennial. They grow and occurring in temperate climates, and a diversity of habitats between mountainous areas to arid zones and deserts (Mucciarelli and Maffei, 2002; Watson *et al*., 2002). The end of summer or during autumn is a time of blooming of *Artemisia* species, while the spring and summer are the typical time for flowring of other Anthemideae genera, in addition they are characterized by being almost exclusively wind pollinated **(**Garnock-Jones, 1986; Valles *et al*., 1987). Many *Artemisia* species have pharmaceutical, culinary and economical applications (Bora and Sharma, 2011). The plants have a vast array of folk and conventional medicinal uses due to the chemical diversity of their metabolites; besides, their characteristic scents and tastes have been attributed to their terpenoid components, especially the volatiles (Mucciarelli and Maffei, 2002; Kordali *et al*., 2005; Bora and Sharma, 2011). These facts account for the inclusion of several *Artemisia* species in pharmacopeias all over the world (Proksch, 1992, Rustaiyan and Faridchehr, 2014). A notably important drug isolated from this genus, mainly from *A. annua*, is artemisinin the well-known antimalarial (Bora and Sharma, 2011); which has been recognized by WHO and is considered as lead compound for production of novel drugs useful for treatment of quinine-resistant malignant cell lines(Zinczuk *et al*., 2007). From the economic standpoint (Bora and Sharma, 2011, Chauhan *et al*., 2010;), genus *Artemisia* is considered as an important biological source of natural insecticides and fungicides, which are efficient as crop and wood protective. In addition, certain species are used as forage in steppes and semi-deserts, while others are cultivated as either ornamentals or soil stabilizers in disturbed habitats. Regarding the numerous publications on *Artemisia*, the phytochemicals analysis and biological potential study researches of this plant in Libya remain limited. *Artemisia* L. species, usually aromatic shrubs or herbs (Jafri and El-gadi, 1983), are of worldwide distribution especially in Northern temperate regions, Asia, North America, Western South America, Europe and Southern and North Africa (Mabberley, 1997; Bora and Sharma, 2011). The variation of the chemistry of the metabolites produced by *Artemisia* species leads to a broad spectrum of the biological effects among these members. Besides volatile constituents (terpenoids and non-terpenoids), coumarins, flavonoids, caffeoylquinic acids, acetylenes, sterols have been identified and reported as main phytochemicals in the genus. According to previous researches, *Artemisia* species exhibit, antiviral, antimalarial, antipyretic, antitumor, antihaemorrhagic, antiulcerogenic, antiinflammatory, anticoagulant, antioxidant, antihepatitis, and antispasmodic propertie (Bora and Sharma, 2011).

This literature survey valorize and sheds light on data concerning the active ingredients and biological activities of the different species of *Artemisia* that growing as a native plant in Libya. Moreover, the current review will provide valuable information to help researchers for develop safe formulations for treating various illnesses

Method

In this review article, data were collected from the published studies in the scientific databases: incuding Web of science, PubMed and Google scholar. All the duplicated and irrelevant papers were excluded while the original articles that focusing on phytochemical profile and biological properties were involved.

1. Geographical distribution

Artemisia represented by nine recorded species in Libya. These species are widely distributed across different regions, with high population density in Northeastern, particularly in Al-Jaba Al-Akhder and southwest region. *Artemisia absithium* is one of the widely distributed Artemisia, intrinsic in Europe, Asia and North Africa (Szopa et al 2020). Nevertheless, limited sources describe its presence in Libya (WFO 2025; Agiel, N., & Mericli, F. (2017). Meanwhile, *Artemisia arborescens*, a mediterranean native species in Libya, is an evergreen shrub characterized by grey-green to silver leaves and distinguished scent (Janacković et al 2015).

Another common one plant is *Artemisia campestris*, which distributed in Asia, Europe, and North africa (Al-Snafi, A. E. (2015).

On the other hands, *Artemisia judiaca* is widely found in the desert of Libya, which characterized by bushy herbs and woody base with strong aromatic leaves (Janacković et al 2015*)*.

Artemisia monosperma is a perennial plant that growing broadly in the Arabian deserts including the east arid and semiarid zones in Libya, and is characterized by its distinctive aroma (El Zalabani et al 2017). In fact, *Artemisia inculta* Delile is one of the rare Artemisia species native to Libya. It was firstly registered in Libyan flora (Jafri & El-Gadi 1983; El-Barasi et al 2013; Giweli et al 2025; Mahklouf, & Sh-hoob, (2023); Elturbi, et al 2009;Saad et al 2021 and .Janacković et al 2015) under *Artemisia herba-alba* and recently classified as *Artemisia herba-alba* var. densiflora Boiss**.** which is heterotypic synonym of *A. inculta* Delile. According to (POWO) Plants of the World Online and flora of egypt, this species occurs in Libya, Egypt and Crete (POWO; Royal Botanic Gardens, Kew, 2024) and no records was found for its herbarium specimens using its recent accepted name. Additionally, *Artemisia annua L.* has been reported as a native species in Libya, however, there is a limited data about its current distribution in specific habitats.

Artemisis Vulgaris was reported as introduced species in Libya**,** it was cultivated in western region, particularly in Khallet Alforjan south of Tripoli (Abuhadra et al 2017), and known as heavily invasive weed and easily spreads under the different climatic conditions (Siwan et al 2022). The species and locations of Artemisia were illustrated in **(Table 1 and Figure 1)**

Major Constituents

According to a recent review on the essential oils of *Artemisia* (Bisht *et al.*, 2021), the distinctive odour of certain species is mainly due to the accumulation of the volatile mono and sesquiterpens in the aerial parts, especially the flowers. The significant disparity in the yield, chemistry, and quality of the oils is influenced by several factors such as season of collection, use of fertilizers, pH of soils, drying and storage conditions, altitude, chemotype or variety, genotype or used parts of the plant, extraction method. Moreover, 1,8-cineole, *α*- and *β*-thujone, *trans*-anethole, artemisia ketone, borneol and camphor, were identified as a major compounds. **Table 2** summarizes the reports concerning the essential oils of Libyan *Artemisia* L. The structures of selected compounds reported in these oils are displayed in **Figure 2**.

Sesquiterpene lactones isolated from genus *Artemisia* have gained an increasing importance due to their application in medicinal and agricultural fields (Ivanescu *et al.*, 2015). The most commonly occuring sesquiterpene lactones in *Artemisia* species belong to guaianolides, germacranolides and eudesmanolides classes, while cadinanolides, elemanolides and psilostachyanolides have also been found in considerable concentration (Ivanescu *et al.*, 2015). Reports on sesquiterpene lactones of genus *Artemisia* are summarized in **Table 3** and the structures of selected constituents of the Artemisia are represented in **Figure 3.**

A number of triterpenoids and phytosterols were reported in *Artemisia* species including *α*-amyrin, lupeol, *β*-sitosterol , *β*-amyrin, campesterol, stigmasterol and daucosterol (Elgamal *et al.*, 1997; Ivanescu *et al.*, 2013). **Table 4** summarizes the literature reports concerned with these constituents and structural formulae of representatives of the group are demonstrated in **Figure 4.**

Several phenolic classes such as phenolic acids, flavonoids and coumarins that identified in *Artemisia* species were summarized in **(Table 5** and **Figure 5 a, b & c).**

Additionally, both free and glycosidic flavones, flavonols, methoxylated flavones *viz.*, *O*-glycosides of luteolin, apigenin, quercetin, kaempferol, isorhamnetin and chrysoeriol, were isolated and identified from *Artemisia* species; Bohlmann *et al.*, 1985; Shilin *et al.*, 1989; Deng *et al.*, 2008).

Caffeic and vanillic acids are frequently identified phenolic acids in artemisia ; similarly, the coumarins scopoletin, isoscopolin, scoparone, coumarin, herniarin and isofraxidin were isolated from several *Artemisia* species (Trifan et al 2022).

Biological Activities

According to the literature, the main use of *Artemisia* species in folk medicine are primarily as antispasmodic, anthelmintic and anti-hypertensive (Chakravarty, 1976); additionally, leaves of certain *Artemisia* are used in Jordan to facilitate labour (Hijazi and Salhab, 2010). The antioxidant, insecticidal, anti-malarial, antimicrobial, anti-inflammatory and anticancer efficiencies of several species have been explored (Pozdnyakov et al 2022; Trifan et al 2022). Moreover, the biological potencies of various constituents *viz.*, sesquiterpene lactones and essential oils have been extensively investigated (Ivanescu *et al.*, 2015; Bisht et al 2021). Summarized reports concerned with the bioactivities of the plants of the genus are collected in **Table 6**

Table (1) Species and locations of Artemisia species in Libya:

Species	locations	References
A. absinthium	Unfortunately, there is no reliable information regarding the locality of this species in libya	https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:300106-2 Agiel, N., & Mericli, F. (2017).
A. arborescens	Zintan and Al-Jabal Al-Akhder	Janacković et al 2015
A. annua L.	The species is recorded in Libya according to *Plants of the World Online*.	https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:304416-2
A. campestris	Al-Jabal Al-Akhder, Gabel Nafusa, Zawia and Zintan	El-Barasi et al 2013, Janacković et al 2019, Mahklouf, & Sh-hoob, (2023) andGiweli et al 2025
A.judaica	Western Hamada and Zintan	Janacković et al 2015
A. inculta* Delile *Artemisia herba-alba var. densiflora Boiss (heterotypic synonum)	Gabel Nafusa, Zintan, south of Tripoli (Tarhona city) and Al-Jabal Al-Akhder areas around the city of Albayda	El-Barasi et al 2013, Giweli et al 2025, Mahklouf, & Sh-hoob, (2023), Elturbi, et al 2009, Saad et al 2021 and .Janacković et al 2015
A. monosperma	Has reported in Tobruk in northeast of Libya	El Zalabani et al 2017 and Saad et al 2023
***A. scoparia* Waldst. & Kit.**	Was reported in Sirte at 2016	www.floraoflibya.services.ly
A. Vulgaris	Khallet Alforjan about 18km south of Tripoli (introduced)	Abuhadra et al 2017

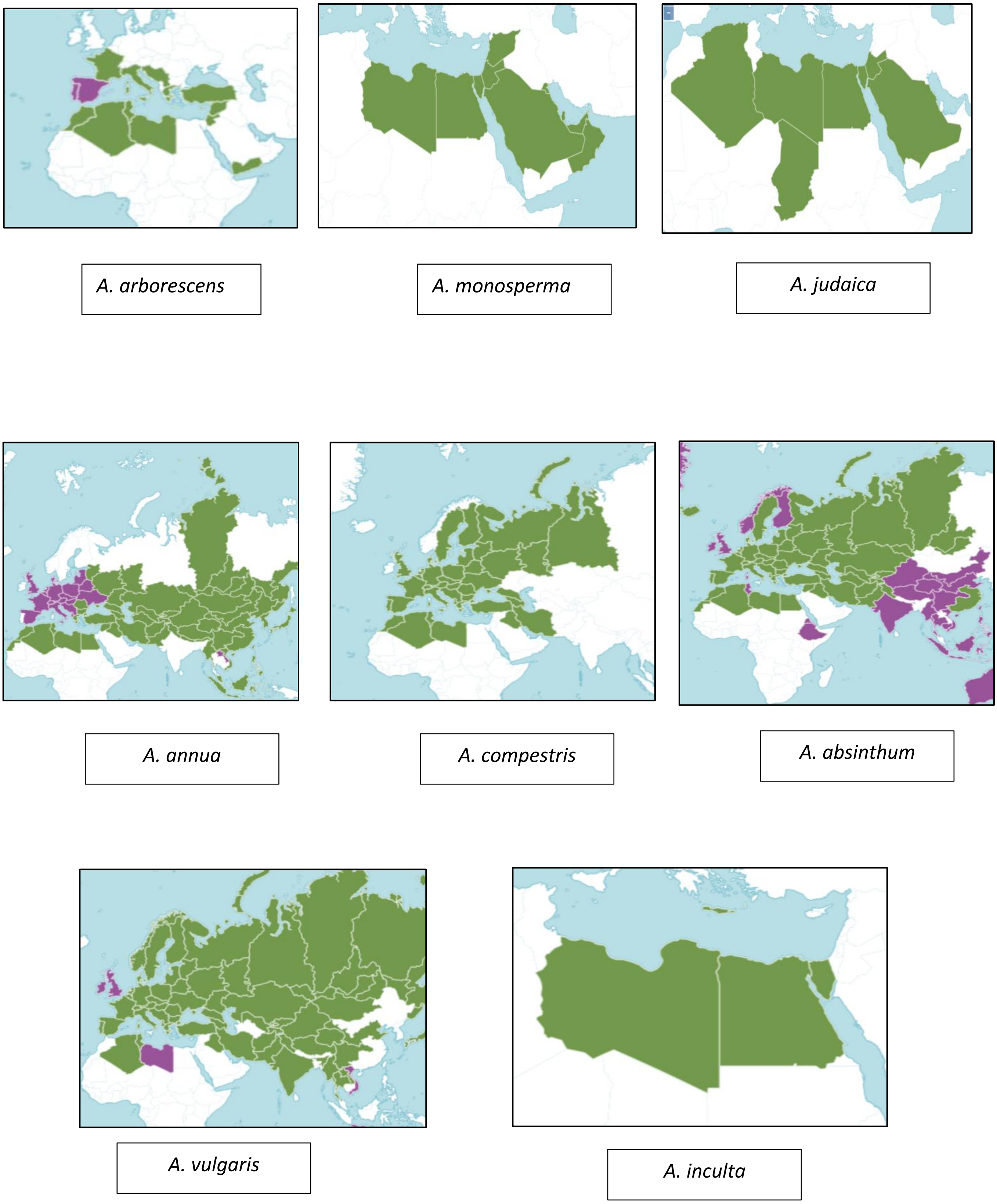


Fig (1) Distribution of Libyan native Artemisia around the world (according to POWO)

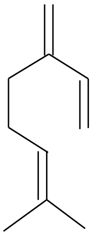
Table (2): Reports on essential oil components of genus *Artemisia* L were identified by GC/MS.

Author, Date	Species and area	Plant part	Summary
Hifnawy *et al.*, 1990	*A. monosperma* Del.	A.p	The oil was highly rich in dibenzofuran and 1-phenyl-bicyclo [3.3.1] non-2-en-9-ol benzoate while diphenylamine was reported with law concentration.
Goel *et al.*, 2007	*A. annua* L.	Roots	The oil highly rich with sesquiterpenes and their oxygenated derivatives, represented by cis-arteannuic alcohol, , *β*-caryophyllene and caryophyllene oxide as a major components.
Verdian-Rizi *et al.*, 2008	*A. annua* L.	A.p	1,8-cineole, camphor camphene and spathulenol were the major
Rezaeinodehl & Khangholi, 2008	*A. absinthium* L.	A. p	The main components of the essential oil of the Iranian plant at full blooming season were *β*-pinene and *β*-thujone.
Judzentiene *et al.*, 2010	*A. campestris* L. ssp. *campestris*	A.p	Caryophyllene oxide (8.5-38.8%) was the major, follwed by germacrene , *β*-ylangene, spathulenol, *β*-elemene, *β*-caryophyllene, junenol, D, humulene epoxide and *α*- or *β*-pinene.
Viuda-Martos *et al.*, 2010	*A. annua* L.(Egypt)	Leaves	Eucalyptol and artemisia ketone were predominant.
Joshi *et al.*, 2010	*A. scoparia* Waldst. & Kit.	A. p	*p*-cymene, *γ*-terpinene , and (*E*)-*β*-ocimene were the major in the Indian sample at mature stage of the plant.
Tzenkova *et al.*, 2010	*A. annua* L.	A. p	*α*-caryophyllene was the major, while artemisia ketone and camphor were the less.
Militello et al 2011	*A.arborescens (Sicily)*		β-thujone and sesquiterpene hydrocarbon chamazulene were the predominant.
Padalia *et al.*, 2011	*A. annua* L. (india)	A.p	The major constituents were 1, 8-cineole and camphor.
Williams *et al.*, 2012.	*A. vulgaris* L.	Leaves & buds	Caryophyllene, germacrene D and *alpha*-zingiberene were the chief of the leaf oil; whereas buds were rich in 1, 8-cineole (

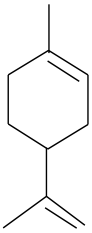
Cavar *et al.*, 2012	*A. annua* L.(Bosnia)	A.p	Artemisia ketone was the major.
Ornano et al 2013	*A.arborescens(*Italy*)*	A.p	Chamazulene and β-Thujone were the major
Wani *et al*., 2014	*A. absinthium* L. *(*Kashmir)	Leaves	Chrysanthenyl acetate and *β*-pinene the major.
Janacković et al 2015	*A.judaica; A. herba-alba; A.arborescens* (Libya)	A. p	were the major components in the essential oil of *A. arborescens* contained Camphor and chamazulene as a main constituents. Chrysanthenone and cis-thujone were dominant in the *A. herba-alba* oil, while piperitone and cis-chrysanthenol were the major ingredients in the oil of *A. judaica*
Shehata et al 2015	*A.arborescens A. inculta* Delile (Crete)	A. p	A. arborescens were found to be chamazulene, camphor and trans-thujone were the major, while those of *A. inculta* were, cis-thujone, trans-thujone and 1,8-cineole were the major.
Said-Al Ahl et al 2016	*A. vulgaris* L (Egypt)	A. p	Borneol, camphor, linalool, isoborneol, isobornyl, cineole, (α + β)-thujone, , myrcene, limonene β-pinene, were pridomenant
Abu-Shandi et al 2017	*A. vulgaris* L (Jordan)		Camphor D-limonene , 1,8-cenol , piperitone,and artemisia ketone
El Zalabani et al 2017	*A. monosperma (Libya)*	A.p	Sabinene, β-pinene and β-cis-ocimene were the majority; while sesquiterpenoids were absent and bornyl acetate was the major oxygenated monoterpenoid.
Alwahaibi et al 2016	*A. judaica (Saudi Arabia)*	A.p A.p	Thymol and its isomer carvacrol were the main components followed by hexadecanoic acid, eudesma-4 (15),7-dien-1-α-ol, spathulenol,and β-eudesmol
Farah et al2017	*A. judaica (Algeria)*		Contained mainly piperitone
Dib *et al* 2019	*A. campestris* L.	A. p	ß-pinene p-cymene α pinene, camphor and germacrene D. were the major in *(Tunisia)*, β-pinene, α-Terpenyl acetate, α-pinene and sabinene were the major in of *A. campestris* L. *(Algeria)*, the main constituents are: tremetone, capillin, α-thujone, methyl-eugenol and p-cymene in *A. campestris L* sample harvested from *Turkey*

Teshome, B. 2019	*A. absinthium* Ethiopia)		Camphor and Bornyl acetate showed the highest concentration
A Benkhaled et al 2020	*A. absinthium* (Algeria)	Flowering A.p	Camphor was the main component of *A. absinthium* essential oil followed by chamazulene.
Sahar M et al 2019	*Artemisia species from Egypt and aud Saudi Arabia*		The results in this study showed that *A. monosperma* plants growing in Saudi Arabia gave higher yield than the sample collected from Egypt.
Russo et al 2020	*A. arborescens (sicily)*	Leaves and flowers	Chamazulene was the major with considerable amount
Ramy M et al 2021	*A. monosperma (Northern region of Saudi Arabia)*	A. p	β-Pinene is a chief constituent.
El-Gohary, A et al 2021	*A. judaica (eastern desert of Egypt}* *A. monosperma (eastern of Egypt}*	A. p	Piperitone and artemisia ketone were the main components of Egyptian *A. judaica* essential oil δ-cadinene and β-pinene were the major followed by α-pinene, cis-β-ocimene and limonene .
Romeila et al 2021	*A. monosperma (Saudi Arabia)*	A. p	β-Pinene was principal component.
Singh et al 2023	*A. vulgaris*	Leaves	Eucalyptol was the main
Jaradat et al 2022	*A. arborescens (Palestinian)*	A. p	β-thujone was the major componenet among the various *A. arborescens* samples
Bendifallah et al 2023	*A.campestris (*Algeria)	A. p	β-Pinene α-pinene, limonene and β cymene

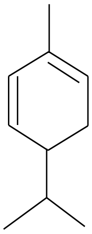
Giweli et al 2025,	*A. herba-alba (Libya)*	A. p	Camphor, thujone and sabenin were the major
Abdallah et al. 2025	*A. annua,* cultivated in Egypt. *A. monosperma and A. judaica Egypt)*	A. p	Camphor was a main constituent in the essential oils of both of both samples *A. annua* and *A. judaica*.. While α-pinene and β-pinene were constituted as the major components of *A. monosperma* oil.
Cherfi et al 2025	*A.campestris*	A. p	Linalyl acetate, geranyl acetate and eucalyptol were the major.



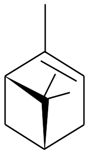
β-Myrcene



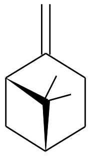
Limonene



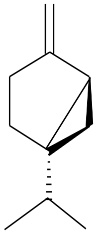
α-Phellandrene



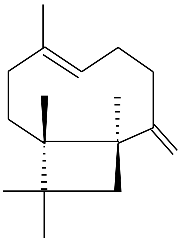
α-Pinene



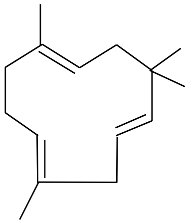
β-Pinene



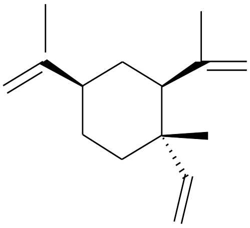
Sabinene



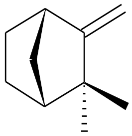
β-Caryophyllene



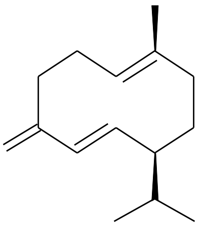
α-Caryophyllene or α-Humulene



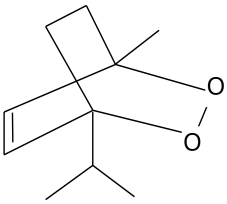
β-Elemene



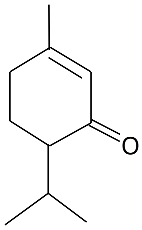
Camphene



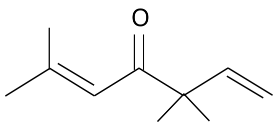
Germacrene D



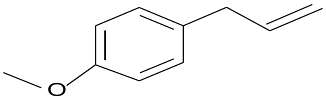
***Trans*-Ascaridol**



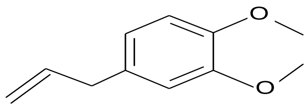
Piperitone



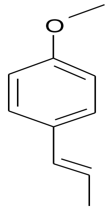
Artemisia ketone



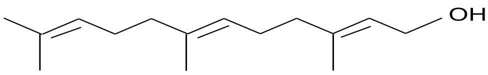
Estragole



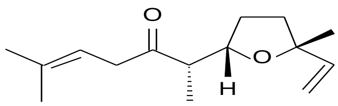
Methyleugenol



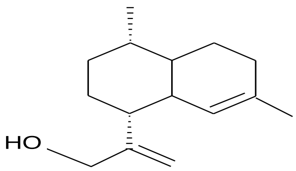
E-Anethole



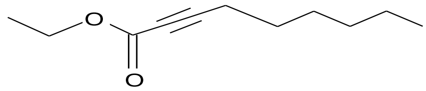
Farnesol



***Cis*-davanone**



***Cis*-arteannuic alcohol**

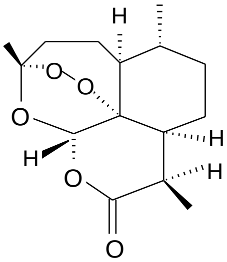


Ethyl 2-nonynoate

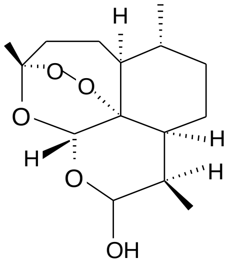
Fig. (2): Selected volatile components reported in genus *Artemisia* L.

Table (3): Reports on sesquiterpene lactones of genus *Artemisia* L.

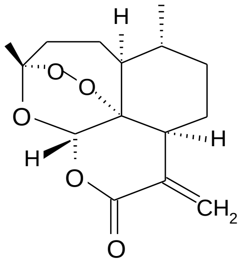
Author, Date	**Species**	**Plant part**	**Summary**
El-Sohly *et al*., 1990: Foglio *et al*., 2002 and Quispe-Condori *et al*., 2005	*A. annua* L.	Leaves	Artemisinin is the protype bioactive sesquiterpene lactone along to dihydro-epideoxyarteannuin B, and deoxyartemisinin. These compounds were extracted by from *A. annua* leaves using ethyl ether, hexane or chloroform.
Tzeng *et al.*, 2007	*A. annua* L.	A. p	Artemisinin yield was significantly enhanced by using supercritical fluid extraction.
de Souza-Chagas *et al*., 2011	*A. annua* L.	Leaves	Deoxyartemisinin contents in addition to Artemisinin were analysed and quantified in the EtOH fraction of *A. annua* leaves.
El Maggar, 2012	*A. monosperma* Del. & *A. herba alba* Asso	A. p	Artemisinin, *α*- and *β*- dihydroartemisinin, and dihydroartemisinic alcohol were detected and quantified in *A. monosperma*. Meanwhile, artemisinin, artemisitene and dihydroartemisinic acid, were detected in reasonable concentration in the MeOH extract of *A. herba alba*.
Zhu *et al*., 2013: Favero *et al*., 2014	*A.annua* L.	Leaves	Artemisinin, artemisinic acid and arteannuin B, In addition to deoxyartemisinin were identified as isolate compounds from the extract of *A. annua* leaves.
H. Ghafoori et al 2014	*A. absinthium L*		Anabsinthin and derivatized artemisinin
Mashraqi et al., 2024	*A. herba-alba* Asso. *A. absinthium L.*	Entire plant	(-)-caryophyllene oxide was the major in both plants (42 and 19% respectively)



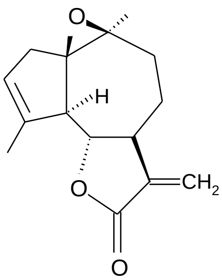
Artemisinin



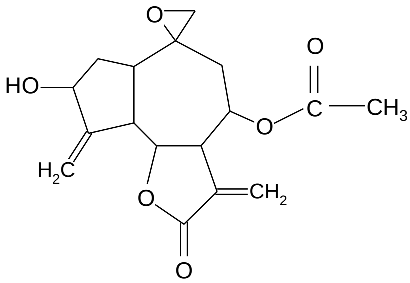
Dihydroartemisinin



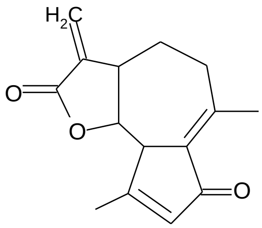
Artemisitene



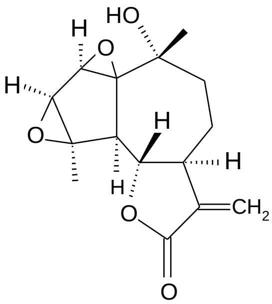
Arglabin



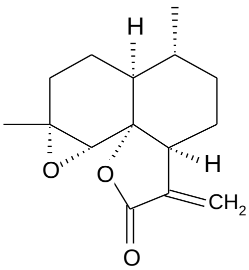
Artefransin



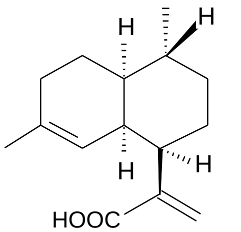
Dehydroleucodine



Artecanin



Arteannuin B



Artemisinic acid

Fig. (3): Selected examples of sesquiterpene lactones reported in genus *Artemisia* L.

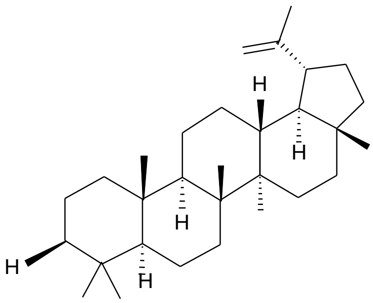
Table (4): Reports on triterpenoids and phytosterols of genus *Artemisia* L.

Author, Date	Species	Plant part	Summary
Ahmed & Misra, 1994	*A. annua* L.	A. p.	Stigmasterol, *β*- sitosterol, *α*- and *β*-amyrin acetate, *β*-amyrenone, *α*- amyrenone and *β*-amyrin were isolated from the hexane extract of *A. annua* L. aerial parts by silica gel column chromatography.
Elgamal *et al*., 1997	*A. monosperma*	Dried shoot	Taraxasterol, taraxasterol acetate, lupeol, and *β*-sitosterol were found to be the major constituents in the nonpolar fraction of the aerial part of *A. monosperma* .
jvanescu *et al.*, 2013	*A.absinthium* & L.,.*annua* L. and *A. vulgaris* L	A. p.	The *β*-sitosterol, stigmasterol, campesterol and ergosterol were found as a chief constituents of the

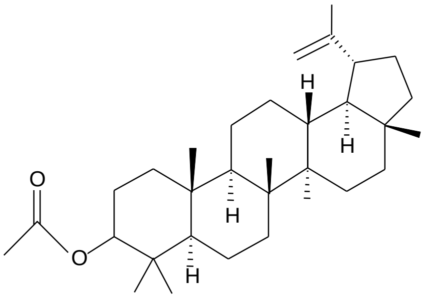
Table (5): Reports on phenolic components of genus *Artemisia* L.

Author,Date	Species	Plant part	Summary
Zhang, *et al*., 2002	*A. scoparia* Waldst. & Kit.	Flower buds	Four flavones were isolated and their structures identified as cirsilineol, cirsimaritin, arcapillin and cirsiliol.
Han *et al.*, 2008	*A. annua* L.	Leaves	Quinic acid derivatives were detected by HPLC/MS in the MeOH extract of the leaves.
Hammoda *et al*., 2008	*A. monosperma* Del.	Root	Two isolated new coumarins were identified, besides the known compounds; fraxinol, tomentin and methyl-*β*-*D*-fructofuranoside.
Ornano et al 2013	*A. arborescens*	A.p	Neochlorogenic acid the main constituent
Mouton & Van, 2014	*A. annua* L.	A. p	Chlorogenic acid and feruloylquinic acid were the predominant constituents.

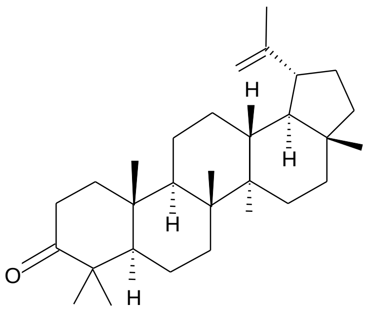
Zhao *et al.*, 2015	*A. annua* L.	A. p	Monocaffeoylquinic acids, dicaffeoylquinic acids, 1 feruloylquinic acid, caffeoylferuloylquinic acids, ferulylquinic acids, *p*-coumaroylquinic acid and dimethoxy-cinnamoylquinic acid were described for the first time.
Hussain et al 2017	*A. absinthium*	A.p.	Quercitin-3- O-d-glucoside, Rutin, isoquercitrin, isorhamnetin-3-glucoside and isorhamnetin-3-Orutinoside were identified
Pozdnyakov et al 2022	*A.scoparia*	A.p.	Chlorogenic acid, scopoletin, umbelliferone and scoparone
Slimestad et al. 2022	*A. annua* L.	leaves and stalks	The major were chlorogenic acid, the caffeic acid esters and quinic acid were the main.
Lantzouraki et al 2023	*A. arborescens and A. inculta.*	A. p.	isorhamnetin, kaempferol-3-O-rutinoside, kaempferol-3-O-glucoside and chlorogenic acid, were common in the extracts from both Artemisia species
Veagu et al 2023	*A. vulgaris and A. absinthium*	A. p	Both rosmarinic and chlorogenic acids, rutin in *A. absinthium*; chlorogenic acid, luteolin and rutin in *A. vulgaris*;



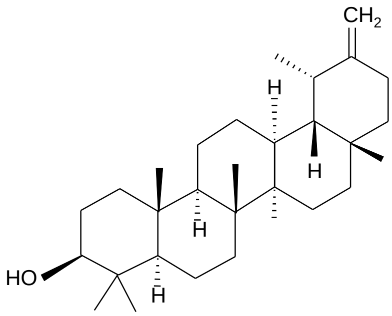
Lupeol



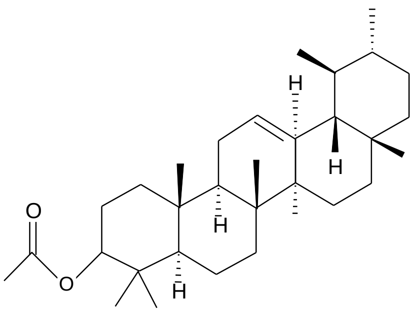
Lupenyl acetate
(Lupeol acetate)



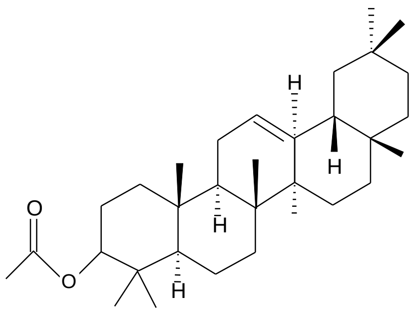
Lupenone



Taraxasterol

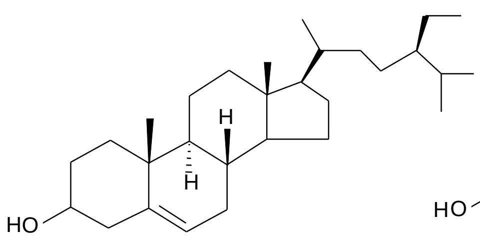


α **- Amyrin acetate**

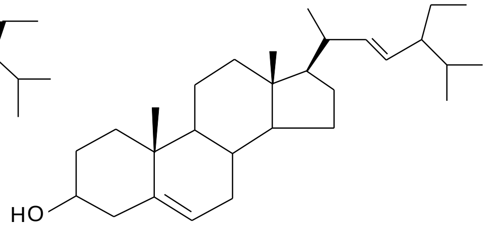


β **- Amyrin acetate**

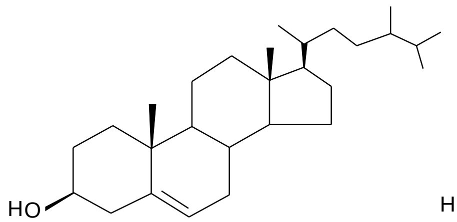
Fig. (4): Selected examples of triterpenoids reported in genus *Artemisia* L.



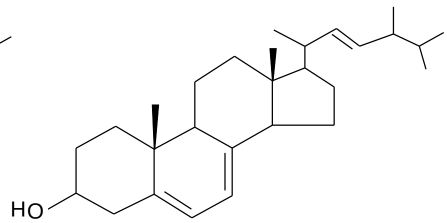
β - Sitosterol



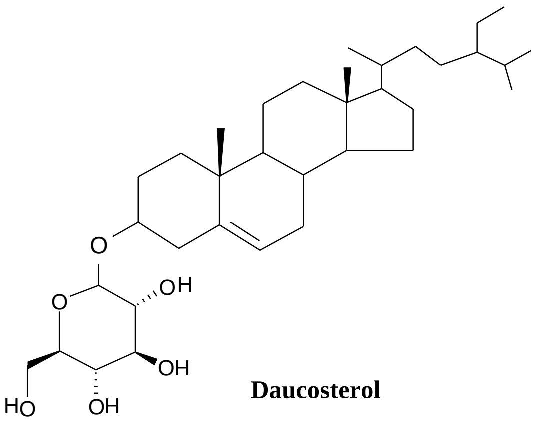
Stigmasterol



Campesterol



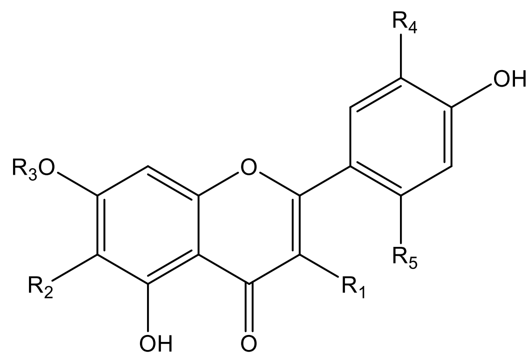
Ergosterol



Daucosterol

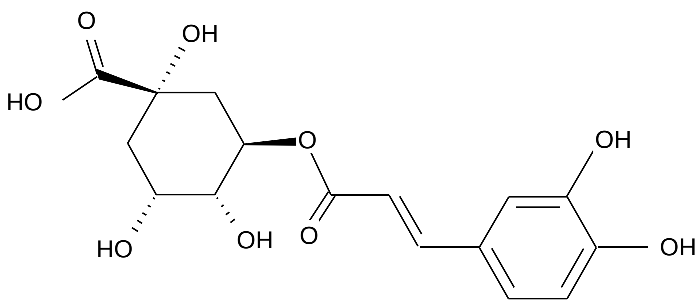
(β - Sitosterol glucoside)

Fig. (4) continued: Selected examples of phytosterols reported in genus *Artemisia* L.

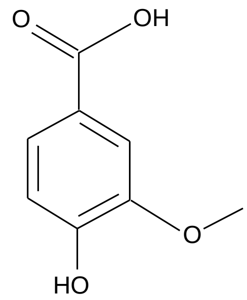


Name	R_1	R_2	R_3	R_4	R_5
Quercetin	OH	H	H	OH	H
Rutin	O-Glc-Rha	H	H	OH	H
Kaempferol-3-O-Glucoside	O-Glc	H	H	H	H
Isorhamnetin	OH	H	H	OCH_3	H
Isorhamnetin-3-O-galactoside	O-Gal	H	H	OCH_3	H
Isorhamnetin-3-O-glucoside	O-Glc	H	H	OCH_3	H
Isorhamnetin-3-O-arabinoside	O-Arab	H	H	OCH_3	H
Hyperoside	O-Gal	H	H	OH	H
Luteolin	H	H	H	OH	H
Cirsimaritin	H	OCH_3	CH_3	H	H
Cirsiliol	H	OCH_3	CH_3	OH	H
Hispidulin	H	OCH_3	H	H	H
Luteolin-7-O-Glucoside	H	H	Glc	OH	H
Jaceosidin	H	OCH_3	H	OCH_3	H
Chrysoeriol	H	H	H	OCH_3	H
Arcapillin	H	OCH_3	CH_3	OCH_3	OH

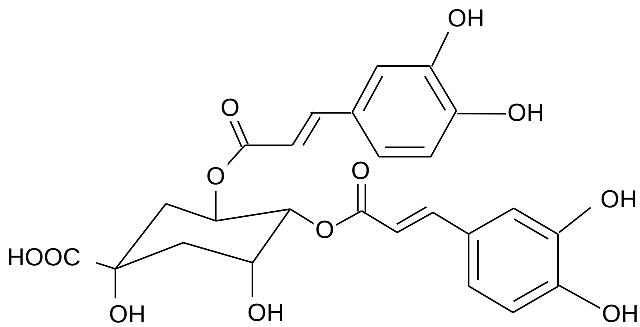
Fig. (5 a): Selected examples of flavonoids isolated from genus *Artemisia* L.



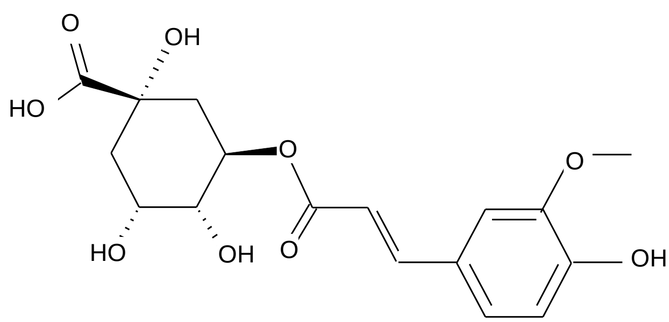
Chlorogenic acid



Vanillic acid

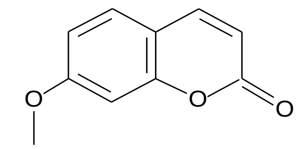


4,5-Di-O-caffeoylquinic acid

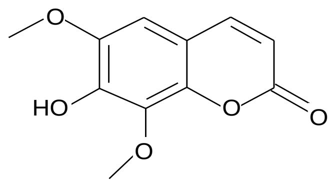


3-Feruloylquinic acid

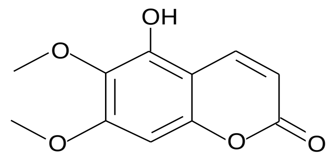
Fig. (5 b): Selected examples of phenolic acids isolated from genus *Artemisia* L.



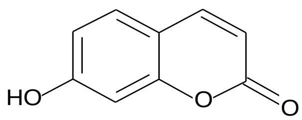
Herniarin



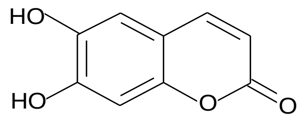
Fraxinol



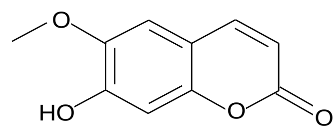
Tomentin



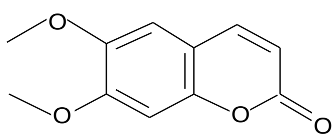
Umbelliferone



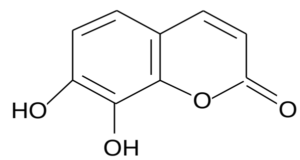
Esculetin



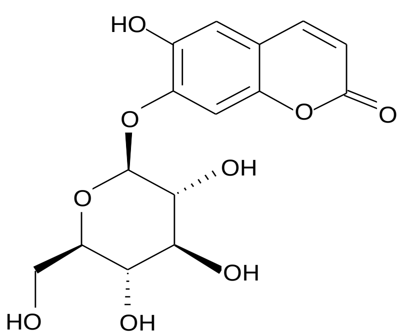
Scopoletin



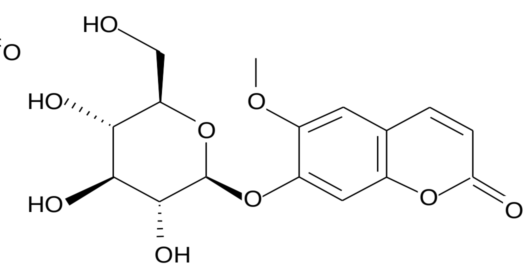
Scoparone



Daphnetin



Esculin



Scopolin

Fig. (5 c): Selected examples of coumarins isolated from genus *Artemisia* L.

Table (6): Reports on biological activities of genus *Artemisia* L.

Author, Date	Species	Plant part	Extract/Compounds	Effect
Foglio *et al.*, 2002	*A. annua* L.	A. parts	isolated sesquiterpene lactones	Antiulcer
Saleh *et al.*, 2006	*A. herba-alba* Asso	Leaves	Carvone and piperitone	Antifungal effect
Natividad *et al.*, 2011	*A. vulgaris* L.	Leaves	Extracts and pure 2,3,4-diepoxy-11(13)-eudesmen-12,8-olide and yomogin	Competitive histamine receptor antagonist
Shehata et al 2015	*A.arborescens* *A. inculta* Delile	A.p	Essential oil	Antiradical acivity
El-Toumy et al. , 2011	*A.monosperma*	A. p	Extract	Hepatoprotective effect
Al-Soqeer, 2011	*A.monosperma*	A. p	Extract	Antioxidant Activity.
Ornano et al 2013	*A. arborescens*	A. p	Essential oil	Antioxidant Activity.
Zengin & Baysal,, 2014	*A. absinthium (Turkey)*	A. p	Essential oil	Antimicrobial and antioxidant effect
Favero *et al.*, 2014	*A. annua* L.	A. p	Major Sesquiterpene lactone fractions	Anti-inflammatory effect
Talbi *et al.*, 2015	*A. herba-alba* Asso	A. p	Isolated Sesquiterpene lactones	Antimicrobial effect
El-Tantawy WH (2015	*A. vulgaris*	A. p	Extract	Anti-inflammatory, antioxidant, and antihyperlipidemic effects
Janacković et al 2015	*A.judaica; A. herba-alba; A.arborescens* (Libya)	A. p	Essential oils	Antimicrobial and antioxidant effect
Abushwereb *et al* 2016	*A. herba alba*	leaves	Extracts	Anti-ulcerative effect
Dabe *et al* 2017	*Artemisia species*		Extracts	Antidiabetic effect
El Zalabani et al 2017	*A. monosperma (Libya)*	A. p	*Essential oil*	Remarkable growth inhibitory potential against S. aureus, and with best efficiency as antifungal. Moreover, high potency as anti-inflammatory agents
Rahiminejad et al., 2018	*A. absinthium*	A. p	Hydroalcoholic extract	Anti-leishmania activity

Czechowski et al 2019	*Artemisia annua*	A. p	Flavonoids artemisinin	Antimalarial effect
Dib *et al* 2019	*A.campestris L.*	A. p	Extracts	Antioxidant, anti-inflammatory, and antimicrobial effects
Zayyat et al., 2018	*A. monosperma*	A. p	Extracts	Antimicrobial and anti-inflammatory effect
Batiha, G et al 2020	*A. absinthium*		*Extract*	Antiprotozoal activities
ABenkhaled et al 2020	*A.absinthium* (Algeria)	A.p	*Essential oil*	*Antioxidant effect*
Rameilah et al 2021	*A. monosperma (Northern region of Saudi Arabia)*	A. p	Essential oil	Antioxidant and cytotoxic effects
Jaradat et al 2022	*A. arborescens Palestinia)*		Essential oil	Antimicrobial and anticancer effects
Agrawal et al 2022	*A. annua*	A. p	Artemisinin and its derivatives	Showed promising effects against both COVID-19 and (SARS-CoV-2) infection.
Pozdnyakov et al 2022	*A.scoparia*	A. p	Ethaolic extract	local anti-inflammatory effect
Nida et al 2023	*A. monosperma*	A. p	Chloroform extract	Anicancer
Singh et al 2023	*A. vulgaris*	Leaves	Essential oil	Antimicrobial
Bendifallah et al 2023	*A.campestris*	A. p	Essential oil	Antimicrobial
Neagu et al 2023	*A. vulgaris and A. absinthium*	A. p	Extracts	Antidiabetic and Anti-Inflammatory
Mashraqi et al., 2024	*A. absinthium L.* and A. herba-alba Asso.	Entire plant	Extracts by using variety of solvents	Antimicrobial inhibitor agents.
Milutinović, N. (2024)	*A. absinthium, and A. vulgaris*	Cultivated plant	Essential oil	*A. vulgaris* a strongest antifungal
Giweli et al 2025	*A. herba-alba (Libya)*		Essential oil	Antibacterial activity against (MRSA) and anticancer
Cherfi et al 2025	*A.campestris*	A. parts	Essential oil	Antioxidant, anti-inflammatory, and anticancer properties.
Bou Malhab et al 2025	*A. herba-alba*	A. parts	Ethaolic extract	Anticancer

Anticancer potential of Artemisia

The cytotoxic (*in-vitro* as well as *in-vivo*) activity of different species of Artemisia have been evaluated in different studies against several cell lines, and it has been recognized that the species exhibited distinguished antitumor effects, mostly owing to their various groups of bioactive substances acting by different molecular pathways. These results were widely documented in scientific publications (Gordanian et al 2014)

In early researche, the methanolic extract of the aerial part of *A. arborescens* L., *A. absinthium* L., *A. scoparia* Waldst&Kit, *A. campestris* L., and *A. vulgaris* L were evaluated by (sura et al 2011) for their *invitro* antiproliferative potency. The findings demonstrated a promising activity, particularly against HeLa (cell lines of human cervical cancer), MCF7 (breast cancer cell line) and A549 (human cell line of lung cancer). Furthermore, *A. scoparia* Waldst&Kit exhibited the highest activity against HeLa and MCF7, whereas *A. absinthium* L showed a selective impact against MCF7.

Artemisia absinthium, is one of the reported Libyan Artemisia, has gained notable attention for its promising anticancer potency, explained by its distinct phytochemical profile. These findings are supported by the promoted preclinical studies. (Shafi 2012) evaluated the effectiveness of the crud extract of the aerial part of *A. absinthum* against MCF7. Anti-proliferative activity of the extract was arbitrated to the apoptosis induction in the cells through the modulation of Bcl-2 proteins and the inhibition of MEK/ERK pathway which is over activated in several cancer types.

Other research performed by (Nazeri et al 2020) designed to measure anticancer effect of A. *absinthium* methanolic extract against colorectal cancer cell line by using (MTT) method. The results revealed that the extract has a considerable cytotoxic effect and remarkably activate cell cycle arrest and reduces viability of cells of cancer.

Additional study has also shown that *A. absinthium* leaf the methanolic extract possessed antiproliferative potential against human liver cancer cell lines hepatoma-derived (Huh7) by inducing the transcription level of transforming growth factor-beta (TGF-β1) which lead to asignificant suppression of cell growth activity and accelerate the apoptosis (Sohail et al 2023).

Recently, the synergistic potency of combinining cisplatin with *A.absinthium* extract on Calu-6 human lung cancer cells was evaluated using MTT assay. The finding demonstrated that the combined regimen considerably reduced cell viability and growth, while also promote apoptosis. This enhanced effect could be attributed to the bioactive ingredients of *A. absithium*, such as artemisinin, thujone and may minimize the adverse effects of cisplati(Yazdani et al 2022).

The study of the flavonoids fraction of *A. absinthium* L against the cervical cancer activity showed a promising potency. Furthermore, the results. found that the apoptosis could be promoted in colon cancer cells through the mitochondrial pathway activation as a major mechanism by utilizing the extracts of *A. absinthium* L. moreover, cynaroside and Astragalin displayed a significant dose-dependent increase of the rate of apoptosis in HeLa cells. Additionally, the final finding showed that the apoptotic effect of both Cynaroside and Astragalin may be linked to the overproduction intracellular of ROS in the cancer cells, (He et al (2023).

According to a recent study on oral cancer, particularly the prevalent type (oral squamous cell carcinomas). The in vitro cytotoxic assay of *A. absinthium* extract showed a significant decrease of cancer cells viability by 99% and increase in of caspase 3 and 9 expression with no affect of healthy human periodontal ligament stem cells (tsamesidis et al 2024).Collectively, the anticancer effect of *A. absinthium* might recognized to high concentration of sesquiterpene lactone aremisinin alongside to numerous classes of phenolic compounds including the flavonoids and phenolic acids as well as the essential oils (Hussain et al 2017; Roohnavaz et al 2025).

one of the morphologically distinguished Artemisia species is *Artemisia arborescens* L. which characterized by silver to grey leaves and an essential oil highly enriched chmazuelene and compher with mint and woody odour (Michelakis et al 2016).

Antiproliferative potetial of the aerial parts oil of *A. arborescens* was evaluated using MTT method against various human cancer cell lines. The results indicated that human malignant melanoma and colon carcinoma were prominently affected. The cytotoxic activity of the oil may due to the chief constituents, particularly thujone and chamazulene (Ornano et al 2013).

Moreover. *A. arborescens* essential oil was assayed for its cytotoxic activity against human malignant melanoma cell lines in invitro. As supposed, the antiproliferative effect of the oil manly due to the inhibition of Hsp70 (Heat Shock Protein 70 kDa) expression, the main responsibility of this protein is to arresting apoptosis and promote cancer cells survive (Russo et al 2020).

Antitumor effect of *Artemisia compestris* extracts and essential oil was investigated against a human cell line of colon carcinoma (HT-29). Based on the results, the oil revealed the highest activity and followed by the ethanolic water extract. Myrcene, β-pinene, limonene, α-pinene, and germacrene D, were the principal constituents of the oil, while the activity of ethanolic-water and water infusion extract could be attributed to the phenolic acids and flavonoid contents (Akrout et al 2011).

Other study of Cytotoxicity assays conducted by Limam et al (2024) revealed that both methanolic and ethyl acetate extracts of *A. campestris* L exerted a significant inhibitory impact on multiple myeloma and metastatic breast cancer. By inducing the apoptotic and necrotic cell death and ultimately leading to an S phase cell cycle blockage.\

The in silico molecular docking study revealed that the essential oil of *A. compestris* exhibited asuggested potent anticancer activity against pancreatic cancer and showed a robust binding affinity to phosphoinositide 3-kinase gamma. These findings highlighting its anticancer properties (Cherfi et al 2025).

Bou Malhab et al (2025) showed that the methanolic extract of *A. herba-alba* exhibited cytotoxicity against colorectal cancer cell line (CRC) via multiple mechanisms. It stimulated apoptosis and significantly arrested cell cycle (phase G2-M) in CRC cells, with reducing the expression of both Cyclin B1 and CDK1. Additionally, it also inhibited the signals of PI3K/AKT/mTOR pathway involved in cancer progression. Based on these consequences, *A. herba-alba* can be considered as the promising and a valuable natural resource of anticancer treatments.

Recent study revealed that the methanolic extract of the shoots of *A. judaica* has a considerable cytotoxic potency against different types of cell lines of cancer, such as liver, colon and breast cancer compared with vinblastine as a reference drug. The results reported that the maximum activity was showed against liver HepG2 cells, specifically through several pathways including caspase pathway activation and inducing apotosis. Moreover, the plant extract demonstrated more selectivity the cancer cells than normal cells (Younes et al 2022).

Cytotoxic evaluation of the essential oils obtained from the leaves of *A. judaica* displayed dose-dependent activity on cervical adenocarcinoma and liver cancer cells. The anticancer potency of the oil may be linked to the major costituents artemisia ketoe, artemisia triene and piperitone (Qneibi et al 2025).

Similarly, other in vivo study published recently (Zidane et al 2025) examined the impact of the combination of *A. judaica* extract with triazole derivative against lung cancer in mice. Immunohistochemical examination revealed a synergistic potential using both *A. Judaica* and 1,2,4-triazole derivatives (TRI) through promoting apoptosis mechanism and regulating caspase-3 and caspase-7 activity. Additionally, they elevate ROS level which induce mitochondrial trigger mitochondrial damage and apoptosis and significantly decrease in TNF-α expression.

Artemisia inculta Delile is another Artemisia species native to Libya. The researches of this species with in Libya is completely absent, mostly because it was registered in the flora of Libya encyclopedia as *Artemisia herba-alba* and recently classified as *Artemisia herba-alba* var. densiflora Boiss according to POWO (Royal Botanic Gardens, Kew, 2024).which is heterotypic synonum of *A. inculta* Delile. As a result of this change, the puplished for its data anticancer potential from Libya appear to be absent or not recognized to the present.

Additionally, regarding the anticancer potency of Artemisia essential oil, another species found in Libya, *A. monosperma*, has also reported to display remarkable cytotoxic activity against human promyelocytic leukaemia cell lines (Romeilah et al 2021).

Recent study conducted (Farshori et al 2023) displayed that the chloroform extract *A, mnosperma* showing a significant reduction of cell viability of human colorectal carcinoma and induced apoptotic pathway by down regulating antiapoptic genes and upregulate proapoptic genes.

As well, the cultivated Artemisia species showed a notable anticancer potency. Among the different parts of *A. vulgaris*, the flower methanolic extract displayed the highest cytotoxic activity in the breast cancer cell line (MCF7) (gordanian et al 2014).

Other study showed that the aqueos extract of *A. vulgaris* exhibited a significant cytotoxic activity on colorectal cancer cells only after long-term exposure via apoptosis induction and demonstrated a synergestic activity when it combined with mitomycin C (Jakovljević et al 2023).

Finally, one of the most famous taxa of genus Artemisia is *Artemisia annua* L. which has been extensively studied over several decades for it chemistry and biological activity. To date, more than 600 compounds were completely isolated and identified from all parts of the plant, moreover some of them showed a potent anticancer effect and deserve further analysis for their mechanism of action and pharmacokinetic pattern (Sun et al 2025). Artemisinin is a lead component among the bioactive ingredients of *A. annua* L.. Advanced researches was performed on this remarkable molecule, leading to the development of a several derivatives including DHA, artesunate and artemether (Marwa et al 2022). It is essential to note that the anticancer activity of these group of compounds due to the structure similarity (The endoperoxide bridge) responsible for over production of ROS. The accumulation of ROS lead to cell cycle arrest, apoptotic and non-apoptotic cell death induction and angiogenesis inhibition, (Sun et al 2025).

Recent study approved this theory and demonstrated a direct correlation between the endoperoxide bridge of artimisinin and its anticancer activity in breast cancer cell lines MCF-7 (Shao 2021). Regrettably, despite the notable antitumor potency of *A. annua* components, the clinical trials have observed that prolonged oral administration of *A. annua* may be associated with an increase in prostate specific antigens PSA in patient with prostate cancer. This finding suggests the development of drug resistance in cancer cells toward *A. annua* treatments. Moreover, the anticancer activity of *A. annua* faced another challenges of insufficient pharmacotoxicological data on chronic exposure, in addition to pharmacokinetic and toxicological data, concerning the short-term effects of high doses also required to cover importantly (Kolesar et al 2022).

Conclusion

Numerous ailments including cancer, have been conventionally and ethnopharmacologically addressed with Artemisia and its associated phytochemicals. Artemisia represent a valuable source of natural bioactive compounds, such as polyphenols, lactones, coumarins and essential oils. The biological studies indicate that Artemisia species exhibit a wide range of pharmacological activities, including antineoplastic, antimalarial, antispasmodic, anti-inflammatory, antioxidant, antibacterial, antifungal, antiepileptic, and analgesic properties. Although, chronic use of the plant may associated with adverse effects, whereas acute toxicity studies generally indicate that the plant is nontoxic or minimally toxic.

Important to know, Despite the promising results, the translation of *Artemisia*-based products into clinically approved anticancer therapies faces a several gabs. Limitations related to how to achieve the standard dose with optimum bioavailability. Furthermore, the study of the toxicity associated with long-term use has not adequately investigated. Therefore, future research should focus on comprehensive pharmacological characterization, mechanistic elucidation, safety evaluation, and well-designed clinical investigations to validate the efficacy and safety of *Artemisia*-derived compounds. Addressing these limitations is essential for the rational integration of *Artemisia* constituents into evidence-based cancer therapeutic

REFERENCES

Abdallah, I. I., Mahmoud, H. A., El-Sebakhy, N. A., & Mahgoub, Y. A. (2025). Comparative phytochemical profiling and authentication of four Artemisia species using integrated GC-MS, HPTLC and NIR spectroscopy approach. *BMC chemistry*, *19*(1), 100.

Abuhadra, M. N., MAKHLOUF, M., & ESSOKNE, R. (2017). A new record Artemisia vulgaris L.(Asteraceae) for the flora of Libya. *American Journal of Life Science Researches*, *5*(3), 83-88.

Abu-Shandi K, Al-Soufi H, AI-Marahleh H, (2017) Isolation and charac terization of the phytoconstituents in the aerial parts of wild and home planted artemisia vulgaris by gas chromatography-mass spectrometry. J Chem Pharm Res 9(4):126–133

Abushwereb, H., & Tolba, M. (2016). Gastroprotective activity of Artemisia herba alba aqueous extract on aspirin-induced gastric lesions in Albino rats. *Journal of Pharmaceutical and Applied Chemistry*, *2*(3), 61-65.

Agiel, N., & Mericli, F. (2017). A survey on the aromatic plants of Libya. *Indian J. Pharm. Educ. Res*, *51*(3), S304-S308.

Agrawal, P. K., Agrawal, C., & Blunden, G. (2022). Artemisia Extracts and Artemisinin-Based Antimalarials for COVID-19 Management: Could These Be Effective Antivirals for COVID-19 Treatment?. *Molecules*, *27*(12), 3828.

Akrout, A., Gonzalez, L. A., El Jani, H., & Madrid, P. C. (2011). Antioxidant and antitumor activities of Artemisia campestris and Thymelaea hirsuta from southern Tunisia. *Food and Chemical Toxicology*, *49*(2), 342-347.

Al-Snafi, A. E. (2015). The pharmacological importance of Artemisia campestris-A review. *Asian Journal of Pharmaceutical Research*, *5*(2), 88-92.

Al-Soqeer A (2011). Antioxidant activity and biological evaluation of hot-water extract of *Artemisia monosperma* and *Capparis spinosa* against lead contamination. *Research Journal of Botany*, 6, 11-20.

Al-Wahaibi, L. H. N.; Mahmood, A.; Khan, M.; Alkhathlan, H. Z. Comparative Study on the Essential Oils of Artemisia Judaica and A. Herba-alba from Saudi Arabia. Arab. J. Chem. 2020, 13(1), 2053–2065. DOI: 10.1016/j. arabjc.2018.03.0

Amin, S. M., Hassan, H. M., El Gendy, A. E. N. G., El-Beih, A. A., Mohamed, T. A., Elshamy, A. I., ... & Hegazy, M. E. F. (2019). Comparative chemical study and antimicrobial activity of essential oils of three Artemisia species from Egypt and Saudi **Arabia.** ***Flavour and Fragrance Journal***, *34*(6), 450-459.

Ashgari G, Jalali M, Sadoughi E (2012). Antimicrobial activity and composition of essential oil from the seeds of *Artemisia aucheri* Boiss. *Jundishapur Journal of Natural Pharmaceutical Products*, 7 (1), 11-15.

Azizuddin AMK, Choudhary MI (2012). Secondary metabolites from *Artemisia parviflora* and *Convolvulus seudocantabrica* of Pakistani origin. *Chemistry of Natural Compounds*, 48 (1), 164-165.

Balasubramani, S., Sabapathi, G., Moola, A. K., Solomon, R. V., Venuvanalingam, P., & Bollipo Diana, R. K. (2018). Evaluation of the leaf essential oil from Artemisia vulgaris and its larvicidal and repellent activity against dengue fever vector Aedes aegypti—an experimental and molecular docking investigation. *ACS omega*, *3*(11), 15657-15665.

Batiha, G. E. S., Olatunde, A., El-Mleeh, A., Hetta, H. F., Al-Rejaie, S., Alghamdi, S. & Rivero-Perez, N. (2020). Bioactive compounds, pharmacological actions, and pharmacokinetics of wormwood (Artemisia absinthium). *Antibiotics*, *9*(6), 353.

Bendifallah, L., & Merah, O. (2023). Phytochemical and biocidal properties of Artemisia campestris subsp. campestris L.(Asteraceae) essential oil at the southern region of Algeria. *Journal of Natural Pesticide Research*, *4*, 100035.

Benkhaled, A., Boudjelal, A., Napoli, E., Baali, F., & Ruberto, G. (2020). Phytochemical profile, antioxidant activity and wound healing properties of Artemisia absinthium essential oil. *Asian Pacific Journal of Tropical Biomedicine*, *10*(11), 496.

Bisht, D., Kumar, D., Kumar, D., Dua, K., & Chellappan, D. K. (2021). Phytochemistry and pharmacological activity of the genus artemisia. *Archives of pharmacal research*, *44*(5), 439-474.

Bohlmann F, Ang W, Trinks C, Jakupovic, Huneck S (1985). Dimeric guaianolides from *Artemisia sieversiana*. *Phytochemistry*, 24 (5), 1009-1015.

Bora KS, Sharma A (2011). The genus *Artemisia*: A comprehensive sreview. *Pharmaceutical Biology*, 49, 101-109.

Bou Malhab, L. J., Harb, A. A., Eldohaji, L., Taneera, J., Al-Hroub, H. M., Abuhelwa, A., ... & Bustanji, Y. (2025). Exploring the Anticancer Effect of Artemisia herba-alba on Colorectal Cancer: Insights From Eight Colorectal Cancer Cell Lines. *Food Science & Nutrition*, *13*(1), e4715.

Boulos L (2002). Flora of Egypt, Alhadara Pupishing Cairo, Egypt Vol.3, p. 258-259.

Cala A, Ferreira J, Chagas A, Gonzalez J, Rodrigues R, Foglio M, Oliveira M, Sousa I, Magalhães P, Barioni W (2014). Anthelmintic activity of *Artemisia annua* L. extracts in vitro and the effect of an aqueous extract and artemisinin in sheep naturally infected with gastrointestinal nematodes. *Parasitology Research*, 113 (6), 2345-2353.

Carvalho IS, Cavaco T, Brodelius M (2011). Phenolic composition and antioxidant capacity of six *Artemisia* species. *Industrial Crops and Products*, 33, 382-388.

Cavar S, Maksimovic M, Vidic D, Paric A (2012). Chemical composition, antioxidant and antimicrobial activity of essential oil of *Artemisia annua* L. *Industrial Crops and Products* 37 (1), 479-485.

Chakravarty H (1976). "Plant Wealth in Iraq", Ministry of Agriculture, Iraq, Baghdad. Vol. 1, 43-45.

Chauhan RS, Kitchlu S, Ram G, Kaul MK, Tava A (2010). Chemical composition of capillene chemotype of *Artemisia dracunculus* L. from North-West Himalaya, India. *Industrial Crops and Products* 31, 546-549.

Cherfi, I., Nasma, M., Hasan, G. G., Benaissa, A., Benaissa, Y., Laouini, S. E., ... & Mallick, J. (2025). Therapeutic Potential of Artemisia campestris Essential Oil: Antioxidant, Anti‐Inflammatory, and Anticancer Insights From In Silico Analysis. *Biomedical Chromatography*, *39*(3), e70012.

Czechowski, T., Rinaldi, M. A., Famodimu, M. T., Van Veelen, M., Larson, T. R., Winzer, T., ... & Graham, I. A. (2019). Flavonoid versus artemisinin anti-malarial activity in Artemisia annua whole-leaf extracts. *Frontiers in plant science*, *10*, 984.

Dabe, N. E., & Kefale, A. T. (2017). Antidiabetic effects of Artemisia species: a systematic review. *Ancient science of life*, *36*(4), 175.

de Souza Chagas AC, Cynthia Sanches Georgetti CS, de Carvalho CO, de Sena Oliveira MC, Rodrigues RA, Foglio MA, de Magalhães PM (2011). In-vitro activity of *Artemisia annua* L. (Asteraceae) extract against *Rhipicephalus (Boophilus) microplus*. *Revista Brasileira de Parasitologia Veterinaria*, 20 (1), 31-35.

El-Barasi, Y. M. M., & Saaed, M. W. B. (2013). Threats to plant diversity in the north eastern part of Libya (El-Jabal El-Akahdar and Marmarica Plateau). Journal of Environmental Science and Engineering. A, 2(1A), 41.

Elgamal M, Ouf S, Hanna A, Yassin F (1997). Phytochemical and mycological investigation of *Artemisia monosperma. Folia Microbiologica*, 42, 203–210.

El-Gohary, A. E., Elsayed, A. A., El-Garf, I. A., Sabry, R. M., Khalid, K. A., & Ahmed, S. S. (2021). Evaluation of Essential Oils in Two Artemisia Species that are Grown Wildly in Eastern Desert of Egypt. *Journal of Essential Oil Bearing Plants*, *24*(2), 186-192.

El-Maggar EB (2012). *Artemisia herba alba* and *Artemisia monosperma:* The Discovery of the first potential Egyptian plant sources for the Pharmaceutical Commercial Production of Artemisinin and Some of Its Related Analogues. *Journal of Applied Pharmaceutical Science*, 02 (07), 77-91.

El-Sohly HN, Croom Jr EM, El-Feraly FS, El-Sherei MM (1990). A large-scale extraction technique of artemisinin from *Artemisia annua*. *Journal of Natural Products*, 53 (6), 1560-1564.

El-Tantawy WH (2015) Biochemical effects, hypolipidemic antiinfammatory activities of Artemisia vulgaris extract in hypercholesterolemic rats. J Clin Biochem Nutr 57(1):33–3

El-Toumy, S. A., Omara, E. A., Brouard, I., Bermejo, J. 2011. Evaluation of hepatoprotective effect of Artemisia monosperma against carbon tetrachloride-induced hepatic damage rat.

Elturbi, J. A., Sufya, N. M., & Ellafi, A. M. 2009, Phytochemical Investigation of Artemisia Herba Alba Asteraceae.

El Zalabani, S. M., Tadros, S. H., El Sayed, A. M., Daboub, A. A., & Sleem, A. A. (2017). Chemical profile and biological activities of essential oil of aerial parts of Artemisia monosperma Del. growing in Libya. *Pharmacognosy Journal*, *9*(4).

European Food Safety Authority (2014). "Outcome of the consultation with Member States and EFSA on: the basic substance application of *Artemisia vulgaris* for use in plant protection as insecticide / repellent on orchards, vineyards and vegetables". EFSA supporting publication 2014: EN-644. 36pp. EFSA, Parma, Italy. **www.efsa.europa.eu/publications**

Farah, R.; El Ouassis Dahmane, H. M.; Rym, E.; Amira, S.; El Houda, H. N.; Selma, B. A.; Nadia, F. Chemical Composition and Biological Effects of Essential Oil of Artemisia Judaica an Endemic Plant from Central Sahara of Algeria Hoggar. Int. J. Biosci. 2017, 10(1), 16–23

Farshori, N. N., Al-Sheddi, E. S., Al-Oqail, M. M., Al-Massarani, S. M., Al-Jassas, E. A., Ahmad, J., ... & Siddiqui, M. A. (2023). Artemisia monosperma induces ROS-mediated cell death in human colorectal carcinoma cells via modulating apoptotic genes. *Journal of King Saud University-Science*, *35*(6), 102763.

Favero FF, Grando R, Nonato FR, Sousa IM, Queiroz NCA, Longato GB, Zafred RRT,

Carvalbo JE, Spindola HM, Foglio MA (2014). *Artemisia annua* L.: Evidence of sesquiterpene lactones' fraction antinociceptive activity. *BMC Complementary and Alternative Medicine.* 14, 266.

Fedhila S, Ben Lazhar W, Jeridi T, Sanchis V, Gohar M, Lereclus D, Ben Hamida J (2015). Peptides extracted from *Artemisia herba-alba* have antimicrobial activity against foodborne pathogenic Gram-Positive bacteria. *African Journal of Traditional, Complementary and Alternative Medicine*, 12 (1), 68-75.

Ferreira JFS, Luthria DL, Sasaki T, Heyerick A (2010). Flavonoids from *Artemisia annua* L. as antioxidants and their potential synergism with artemisin against malaria and cancer-A Review. *Molecules*, 15, 3135-3170.

Foglio MA, Dias PC, Antônio MA , Possenti A, Rodorigues RAF, da Silva EF (2002). Antiulcerogenic activity of some sesquiterpene lactones isolated from *Artemisia annua*. *Planta Medica*, 68 (6), 515–518.

Garnock-Jones PJ, (1986). Floret specialization, seed production and gender in *Artemisia vulgaris* L. (Asteraceae, Anthemideae). *Botanical journal of the Linnean Society*, 92 (4), 285-302.

Giweli, A., Kremid, M., Daw, I., Najjaa, H., Gatran, R., Arfa, A. B., & Kammon, A. (2025). Camphor–Thujone Chemotype and Bioactivities of Artemisia herba-alba Asso Essential Oil from Zintan, Libya: Chemical Composition, Antibacterial, and Antiproliferative Effects. *AlQalam Journal of Medical and Applied Sciences*, 2578-2585.

Goel D, Goel R, Singh V, Ali M, Mallavarapu GR, Kumar S (2007). Composition of the essential oil from the root of *Artemisia annua*. *Journal of Natural Medicines*, 61(4), 458–461.

Gordanian, B., Behbahani, M., Carapetian, J., & Fazilati, M. (2014). In vitro evaluation of cytotoxic activity of flower, leaf, stem and root extracts of five Artemisia species. Research in Pharmaceutical Sciences, 9(2), 91-96.

Gulzar AS, Abassi AM, Tayyaba S, Tauheeda R, Siddiqui SZ, Muhammad A, (2011). *In-vitro* assessment of the protection from oxidation from oxidative stress by various fractions of *Artemisia incisa* Pamp. *Journal of the Serbian Chemical Society*, 76, 1379-1386.

H. Ghafoori, R. Sariri, and M. R. Naghavi, (2014) "STudy of effect of extraction conditions on the biochemical composition and antioxidant activity of Artemisia absinthium by HPLC and TLC," Journal of Liquid Chromatography & Related Technologies, vol. 37, no. 11, pp. 1558–1567.

Hammoda HM, Aboul Ela MA, El-Lakany AM, El-Hanbali O, Zaki CS, Ghazy NM (2008). New constituents of *Artemisia monosperma* Del. *Pharmazie*, 63, 611–614.

Han J, Ye M, Qiao X, Xu M, Wang BR, Guo DA (2008). Characterization of phenolic compounds in the Chinese herbal drug *Artemisia annua* by liquid chromatography coupled to electrospray ionization mass spectrometry. *Journal of Pharmaceutical and Biomedical Analysis*, 47(3), 516-525.

He, M., Yasin, K., Yu, S., Li, J., & Xia, L. (2023). Total flavonoids in Artemisia absinthium L. and evaluation of its anticancer activity. *International Journal of Molecular Sciences*, *24*(22), 16348.

Hifnawy MS, Abdel Wahab SM, El-Hawary SS, Karawya MS (1990) Study of essential oil of *Artemisia monosperma* and its larvicidal effects. *International Journal of Crude Drug Research*, 28, 247-251.

Hifnawy MS, Rashwan OA, Rabeh MA (2001). Comparative chemical and biological investigations of certain essential oils belonging to families Asteraceae, Lamiaceae and Graminae. *Bulletin of the Faculty of Pharmacy Cairo University*, 39 (2), 35-53.

Hijazi AM, Salhab AS (2010). Effects of *Artemisia monosperma* ethanolic leaves extract on implantation, mid-term abortion and parturition of pregnant rats. *Journal of Ethnopharmacology*, 128, 446–451.

Houmani M, Houmani Z, Skoula M (2004). Intérêt de *Artemisia herba alba* Asso dans l'alimentation du bétail des steppes algériennes, *Acta Botanica Gallica*, 151 (2), 165-172.

Hussain, M., Raja, N. I., Akram, A., Iftikhar, A., Ashfaq, D., Yasmeen, F., ... & Iqbal, M. (2017). A status review on the pharmacological implications of Artemisia absinthium: A critically endangered plant. *Asian Pac J Trop Dis*, *7*(3), 185-192.

Ivanescu, B., Vlase, L., & Corciova, A. (2013, November). Importance of phytosterols and their determination in herbal medicines. In *2013 E-Health and Bioengineering Conference (EHB)* (pp. 1-4). IEEE.

Ivanescu B, Miron A, Corciova A (2015). Sesquiterpene Lactones from *Artemisia* Genus: Biological Activities and Methods of Analysis. *Journal of Analytical Methods in Chemistry*. Volume 2015, Article ID 247685, 21 pages http://dx.doi.org/10.1155/2015/247685.

Jafri SMH, El-Gadi A (1983). "Flora of Libya". Al Fateh University, Faculty of Science, Department of Botany, Tripoli, p. 107, 179-185.

Janaćković P, Novaković J, Soković M, Vujisić L, Giweli AA, Stevanović ZD, Marin PD (2015). Composition and antimicrobial activity of essential oils of *Artemisia judaica*, *A. herba-alba* and *A. arborescens* From Libya. *Archives of Biological Science, Belgrade*, 67(2), 455-466.

Janaćković, P., Rajčević, N., Gavrilović, M., Novaković, J., Giweli, A., Stešević, D., & Marin, P. D. (2019). Essential oil composition of five Artemisia (Compositae) species in regards to chemophenetics. *Biochemical Systematics and Ecology*, *87*, 103960.

Jakovljević, M. R., Milutinović, M., Djurdjević, P., Todorović, Ž., Stanković, M., & Milošević-Djordjević, O. (2023). Cytotoxic and apoptotic activity of acetone and aqueous Artemisia vulgaris L. and Artemisia alba Turra extracts on colorectal cancer cells. *European Journal of Integrative Medicine*, *57*, 102204.

Jaradat, N., Qneibi, M., Hawash, M., Al-Maharik, N., Qadi, M., Abualhasan, M. N., ... & Bdir, S. (2022). Assessing Artemisia arborescens essential oil compositions, antimicrobial, cytotoxic, anti-inflammatory, and neuroprotective effects gathered from two geographic locations in Palestine. *Industrial Crops and Products*, *176*, 114360.

Joshi RK, Padalia RC, Mathela CS (2010). Phenyl alkynes rich essential oil of *Artemisia scoparia*. *Natural Product Communications*, 5, 815–816.

Judzentiene A, Budiene J, Butkiene R, Kupcinskiene E, Laffont-Schwob I, Masotti V (2010). Caryophyllene oxide-rich essential oils of Lithuanian *Artemisia campestris* ssp. *campestris* and their toxicity. *Natural Products Communications*, 5, 1981–1984.

Khan M, Mousa AA, Syamasundar KV, Alkhathlan HZ (2012). Determination of chemical constituents of leafand stem essential oils of *Artemisia monosperma* from Cental Saudi Arabia. *Natural product communications*, 7 (8), 1079-1082.

Khan S, Mirza B, Miller J E, Manan A, Irum S, Rizvi SSR, Qayyum M (2015). Anthelmintic properties of extracts from *Artemisia* plants against nematodes. *Tropical Biomedicine*, 32 (2), 257-268.

Kolesar, J. M., & Seeberger, P. H. (2022). Anticancer Potential of Artemisia annua. *Frontiers in oncology*, *12*, 853406.

Kordali S, Cakir A, Mavi A, Kilic H, Yildirim A (2005). Screening of chemical composition and antifungal and antioxidant activities of the essential oils from three Turkish *Artemisia* species. *Journal of Agricultural and Food Chemistry*, 53, 1408-1416.

Lantzouraki, D. Z., Amerikanou, C., Karavoltsos, S., Kafourou, V., Sakellari, A., Tagkouli, D., ... & Kaliora, A. C. (2023). Artemisia arborescens and Artemisia inculta from Crete; secondary metabolites, trace metals and in vitro antioxidant activities. *Life*, *13*(6), 1416.

Lee SH, Lee MY, Kang HM, Han DC, Son KH, Yang DC, Sung ND, Lee CW, Kim HM, Kwon BM (2003). Anti-tumor activity of the farnesyl-protein transferase inhibitors arteminolides, isolated from *Artemisia*. *Bioorganic and Medicinal Chemistry*, 11, (21) 4545–4549.

Limam I, Ghali R, Abdelkarim M, Ouni A, Araoud M, Abdelkarim M, Hedhili A, Ben-Aissa Fennira F. (2024). Tunisian Artemisia campestris L.: a potential therapeutic agent against myeloma - phytochemical and pharmacological insights. Plant Methods. May 2;20(1):59.

Ling YR, Humphries CJ, Shultz L (2006). "Asteraceae". In Editorial Committee (Eds.) "Flora of China", Science Press and Missouri Botanical Garden Press. Beiging, St. Louis. Vol. 20.

Mahklouf, M. H., & Sh-hoob, M. (2023). Floristic Study of Al-Orban area in Gharyan District-Libya. *Scientific Journal for Faculty of Science-Sirte University*, *3*(2), 29-43.

Martins A, Mignon R, Bastos M, Batista D, Neng NR, Nogueira J M. F, Vizetto-Duarte C, Custódio L, Varela J, Rauter AP (2014) In vitro antitumoral activity of compounds isolated from *Artemisia gorgonum* Webb. *Phytotherapy Research*, 28 (9), 1329–1334.

Marwa, K., Kapesa, A., Baraka, V., Konje, E., Kidenya, B., Mukonzo, J., ... & Swedberg, G. (2022). Therapeutic efficacy of artemether-lumefantrine, artesunate-amodiaquine and dihydroartemisinin-piperaquine in the treatment of uncomplicated Plasmodium falciparum malaria in Sub-Saharan Africa: A systematic review and meta-analysis. *PloS one*, *17*(3), e0264339.

Mashraqi, A., Al Abboud, M., Sayeed Ismail, K., Modafer, Y., Sharma, M., & El-Shabasy, A. E. (2024). Comparative phytochemical study of Artemisia sp. in the middle east: a focus on antimicrobial activities and GC-MS analysis in A. absinthium L. Jazan, KSA and A. herba-alba Asso Sinai, EGY. *Journal of Medicinal plants and By-products*, *13*(3), 479-503.

Michelakis, E.C.; Evergetis, E.; Koulocheri, S.D.; Haroutounian, S.A.(2016). Exploitation of *Artemisia arborescens* as a renewable source of chamazulene: Seasonal variation and distillation conditions. *Nat. Prod. Commun.* , *10*, 1515–1519.

Militello, M., Settanni, L., Aleo, A., Mammina, C., Moschetti, G., Giammanco, G. M., ... & Carrubba, A. (2011). Chemical composition and antibacterial potential of Artemisia arborescens L. essential oil. *Current microbiology*, *62*, 1274-1281.

Milutinović, N. (2024). In vitro evaluation of antifungal activity of Artemisia species essential oils (A. absinthium, A. dracunculus and A. vulgaris). *Acta herbologica*, *33*(2), 107-115.

Mohamed AH, El-Sayed MA, Hegazy ME, Helaly SE, Esmail AM, Mohamed NS (2010). Chemical Constituents and Biological Activities of *Artemisia* *herba-alba-* A Review. *Records of Natural Products* 4 (1), 1-25.

Mojarrab M, Naderi R, Afshar FH (2015). Screening of Different Extracts from *Artemisia* Species for Their Potential Antimalarial Activity *Iranian Journal of Pharmaceutical Res*earch, 14 (2), 603-608.

Mouton J, Van der Kooy F (2014). Identification of cis- and trans- Melilotoside within an *Artemisia annua* Tea Infusion. *European Journal of Medicinal Plants*, 4 (1), 52-63.

Mucciarelli M, Maffei M (2002). "Introduction to the genus". In: Wright CW (Ed.) "*Artemisia.* Medicinal and aromatic plants-Industrial profiles", Taylor & Francis, London. Vol. 18, p. 1-50.

Natividad G M, Broadley K J, Kariuki B, Kidd E J, Ford W R, Simons C (2011). Actions of *Artemisia vulgaris* extracts and isolated sesquiterpene lactones against receptors mediating contraction of guinea pig ileum and trachea. *Journal of Ethnopharmacology*, 137 (1), 808–816.

Nazeri, M., Mirzaie-Asl, A., Saidijam, M., & Moradi, M. (2020). Methanolic extract of Artemisia absinthium prompts apoptosis, enhancing expression of Bax/Bcl-2 ratio, cell cycle arrest, caspase-3 activation and mitochondrial membrane potential destruction in human colorectal cancer HCT-116 cells. Molecular biology reports, 47(11), 8831-8840.

Neagu, E., Paun, G., Albu, C., Apreutesei, O. T., & Radu, G. L. (2023). In vitro assessment of the antidiabetic and anti-inflammatory potential of Artemisia absinthium, Artemisia vulgaris and Trigonella foenum-graecum extracts processed using membrane technologies. *Molecules*, *28*(20), 7156.

Ornano, L., Venditti, A., Ballero, M., Sanna, C., Quassinti, L., Bramucci, M., ... & Bianco, A. (2013). Chemopreventive and antioxidant activity of the chamazulene-rich essential oil obtained from Artemisia arborescens L. growing on the Isle of La Maddalena, Sardinia, Italy. *Chemistry & biodiversity*, *10*(8), 1464-1474.

Padalia RC, Verma RS, Chauhan A, Chanotiya CS, Yadov A (2011) Variation in the volatile constituents of *Artemisia annua* var. CIM-Arogya during plant ontogeny. *Natural Product Communications*, 6, 239–242.

Poiată A, Tuchiluş C, Ivănescu B, Ionescu A, Lazăr MI (2009). Antibacterial activity of some *Artemisia* species extracts. *Revista medico-chirurgicală a Societăţii de Medici şi Naturalişti din Iaşi*, 113 (3), 911-914.

Pozdnyakov, D., Ayrapetyan, E., & Konovalov, D. (2022). The study of the anti-inflammatory activity of a stomatological gel based on an extract of Artemisia scoparia Waldst. et Kit. *Journal of Research in Pharmacy*, *26*(1), 189-197.

Proksch P (1992). "*Artemisia*". In: Hansel, R. Keller, K. Rimpler, H. Schneider, G. and Hagers G (Eds.), "Hagers Handbuch der Pharmazeutischen Praxis". Springer-Verlag, Berlin, p. 357-377.

Qneibi, M., Jaradat, N., Hamed, O., Hawash, M., Abualhasan, M., Qadi, M., & Bdir, S. (2025). Essential oils from Artemisia judaica, Ruta graveolens and Salvia palaestina with antiradical, cytotoxic and AMPA receptor-modulatory activities. *Scientific Reports*.

Quispe-Condori S, Sánchez D, Foglio MA, Rosa PTV, Zetzl C, Brunner MAA (2005). Global yield isotherms and kinetic of artemisinin extraction from *Artemisia annua* L. leaves using supercritical carbon dioxide. *Journal of Supercritical Fluids*, 36 (1), 40–48.

Rahiminejad, Ali, Khosrow Hazrati Tappeh, Shahram Seyyedi, and Peyman Mikaili. (2018). "The In Vitro Effect of Hydroalcoholic Extract of Artemisia absinthium on the Growth of Leishmania major (MRHO/IR/75/ER) in Peritoneal Macrophages from BALB/c Mice." *Jundishapur Journal of Microbiology* 11, no. 11

Rezaeinodehl A, Khangholi S (2008). Chemical composition of the essential oil of *Artemisia absinthium* growing wild in Iran. *Pakistan Journal of Biological Sciences*, 11 (6), 946–949.

Romeilah, R. M., El-Beltagi, H. S., Shalaby, E. A., Younes, K. M., Hani, E. L., Rajendrasozhan, S., & Mohamed, H. (2021). Antioxidant and cytotoxic activities of Artemisia monosperma L. and Tamarix aphylla L. essential oils. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *49*(1), 12233-12233.

Roohnavaz, M., Karimi, F., Saboora, A., & Razavi, K. (2025). Artemisinin and absinthin production in response to exogenous methyl jasmonate and chilling in Artemisia absinthium L. in vitro propagated plantlets. Industrial Crops and Products, 225, 120425.

Russo, A., Bruno, M., Avola, R., Cardile, V., & Rigano, D. (2020). Chamazulene-rich artemisia arborescens essential oils affect the cell growth of human melanoma cells. *Plants*, *9*(8), 1000.

Royal Botanic Gardens, Kew. (2024). Artemisia inculta. Plants of the World Online. https://powo.science.kew.org

Rustaiyan A, Faridchehr A (2014). A Review on Constituents and Biological Activities of Further Iranian *Artemisia* Species. *International Journal of Pharmaceutical Biological and Chemical Sciences*, 3 (3), 6-14.

Saad, K. A., Alsanousi, S. A., & Alkailani, H. A. (2021). Evaluation of the effects of Artemisia herba-alba on intestinal parasite infections in domestic pigeons (Columba livia) in Albeida City, Libya. Scientific Journal of University of Benghazi, 34(2).

Saad, K., & Belteben, A. (2023). A Pharmacognostic Review on Artemisia. spp Growing in Libya. *AlQalam Journal of Medical and Applied Sciences*, 469-475.

Said-Al Ahl HH, Hussein MS, Tkachenko KG, Nkomo M, Mudau F (2016). Essential oil composition of Artemisia vulgaris grown in Egypt. Int J Pharm Pharm Sci 2.07:1–7030

Saleh MA, Belal MH, EL-Baroty G (2006). Fungicidal activity of *Artemisia herba-alba* Asso (Asteraceae). *Journal of Environmental Science and Health. Part B. Pesticides, Food Contaminants, and Agricultural Wastes*, 41 (3), 237-240.

Shafi G et al (2012) Artemisia absinthium (AA): a novel potential complementary and alternative medicine for breast cancer. Mol Biol Rep 39(7):7373–7379

Shehata, E., Loupassaki, S., & Makris, D. P. (2016). Essential oil composition and antiradical activity of two Artemisia species endemic to the island of Crete (Southern Greece). *American Journal of Essential Oils and Natural Products*, *4*(1), 32-35.

Shilin Y, Roberts M F, Phillipson J D (1989). Methoxylated flavones and coumarins from *Artemisia annua*. *Phytochemistry*, 28 (5), 1509-1511.

Shao, Y., Wang, Z., Hao, Y., Zhang, X., Wang, N., Chen, K., ... & Zhang, Z. (2021). Cascade catalytic nanoplatform based on "butterfly effect" for enhanced immunotherapy. *Advanced Healthcare Materials*, *10*(8), 2002171.

Singh, N. B., Devi, M. L., Biona, T., Sharma, N., Das, S., Chakravorty, J., ... & Rajashekar, Y. (2023). Phytochemical Composition and Antimicrobial Activity of Essential Oil from the Leaves of Artemisia vulgaris L. *Molecules*, *28*(5), 2279.

Siwan, D., Nandave, D., & Nandave, M. (2022). Artemisia vulgaris Linn: An updated review on its multiple biological activities. *Future journal of pharmaceutical sciences*, *8*(1), 47.

Slimestad, R.; Johny, A.; Thomsen, M.G.; Karlsen, C.R.; Rosnes, J.T. (2022). Chemical profiling and biological activity of extracts from nine Norwegian medicinal and aromatic plants. *Molecules*, *27*, 7335.

Sohail, J., Zubair, M., Hussain, K., Faisal, M., Ismail, M., Haider, I., ... & Khan, M. A. (2023). Pharmacological activities of Artemisia absinthium and control of hepatic cancer by expression regulation of TGFβ1 and MYC genes. *Plos one*, *18*(4), e0284244.

Soliman MMM (2007). Phytochemical and toxicological studies of *Artemisia* L. (Compositae) essential oil against some insect pests. *Archives of Phytopathology and Plant Protection*, 40, 128-138.

Sura, E., Şenol, S., Kose, F. A., & Ballar, P. (2011). In vitro cytotoxic properties of six Artemisia L. species. *Turkish Journal of Pharmaceutical Sciences*, *8*, 247-252.

Szopa, A., Pajor, J., Klin, P., Rzepiela, A., Elansary, H. O., Al-Mana, F. A., ... & Ekiert, H. (2020). Artemisia absinthium L.—Importance in the history of medicine, the latest advances in phytochemistry and therapeutical, cosmetological and culinary uses. Plants, 9(9), 1063.

Sun, J., Xufeng, J., Qiu, Z., Gao, Q., Zhu, Z., He, J., ... & Sui, X. (2025). Artemisiae Annuae Herba: from anti-malarial legacy to emerging anti-cancer potential. *Theranostics*, *15*(15), 7346.

Talbi M, Ainane T, Boriky D, Bennani L , Blaghen M, Elkouali MH (2015). Antibacterial activity of Eudesmanolide compounds isolated from medicinal plant *Artemisia herba-alba. Journal of Materials and Environmental Science*, 6 (8), 2125-2128.

Teshome, B. (2019). Chemical Composition, Antimicrobial Activity and Antioxidant Property of Essential Oil Extracted from Artemisia absinthium L.(Ariti). *Clinical Biotechnology and Microbiology*, *4*, 11-21.

Trifan, A., Zengin, G., Sinan, K. I., Sieniawska, E., Sawicki, R., Maciejewska-Turska, M., ... & Luca, S. V. (2022). Unveiling the phytochemical profile and biological potential of five Artemisia species. Antioxidants, 11(5), 1017.

Tripathi AK, Prajapati V, Aggarwal KK, Khanuja SP, Kumar S (2000). Repellency and toxicity of oil from *Artemisia annua* to certain stored-product beetles. *Journal of Economic Entomology*, 93 (1), 43-47.

Tsamesidis, I., Papadimitriou-Tsantarliotou, A., Christodoulou, A., Amanatidou, D., Avgeros, C., Stalika, E., ... & Kontonasaki, E. (2024). Investigating the Cytotoxic Effects of Artemisia absinthium Extract on Oral Carcinoma Cell Line. Biomedicines, 12(12), 2674.

Tzeng T-C, Lin Y-L, Jong T-T, Chang C-MJ (2007). Ethanol modified supercritical fluids extraction of scopoletin and artemisinin from *Artemisia annua* L. *Separation and Purification Technology*, 56 (1), 18–24.

Tzenkova R, Kamenarska Z, Draganov A, Atanassov A (2010). Composition of *Artemisia annua* Essential Oil Obtained from Species Growing Wild in Bulgaria″. *Biotechnology and Biotechnological Equipment*, 24 (2), 1833-1835.

Valles J, Suarez M, Seoane JA (1987). Estudio Palinologico de las especies iberico-baearicas de las secciones *Artemisia seriphedium* Bess. del genero *Artemisia* L. *Acta Salmaticensia Ciencias*, 65, 167-174.

Verdian-Rizi M, Sadat-Ebrahimi E, Hadjiakhoondi A, Fazeli MR, Hamdeni MP (2008). Chemical composition and antimicrobial activity of *Artemisia annua* L. essential oil from Iran. *Journal Medicinal Plants,* 7 (4), 58-62.

Vindya NS, Manjunath C, Pallavi N, Tamizhmani T (2015). Davana (*Artemisia pallens*)-A Brief Review on Its Medicinal Importance. *Universal Journal of Pharmacy,* 04 (04), 27-30.

Wani H, Shakeel A, Shah, Javid A, Banday (2014). Chemical composition and antioxidant activity of the leaf essential oil of *Artemisia absinthium* growing wild in Kashmir, India. *The Journal of Phytopharmacology*, 3 (2), 90-94.

Watson L, Bates P, Evans T, Unwin M, Estes J (2002). Molecular phylogeny of subtribe Artemisiinae (Asteraceae), including *Artemisia* and its allied and segregate genera. *BMC Evolutionary Biology*, 2, 17.

WFO,http://www.worldfloraonline.org/organisation/WFO

Williams JD, Saleh AM, Acharya DN (2012). Composition of the essential oil of wild growing *Artemisia vulgaris* from Erie, Pennsylvania. *Natural Product Communications*, 7 (5), 637-640.

Woerdenbag JFJ, Lüers W, Uden N, Pras T.M, Malingré, Alfermann AW (1993). Production of the new antimalarial drug artemisinin in shoot cultures of *Artemisia annua* L. *Plant Cell Tissue and Organ Culture*, 32, 247-257.

www.floraoflibya.services.ly

Yang SL, Roberts MF, O'Neill MJ, Bucar F, Phillipson JD (1995). Flavonoids and chromenes from *Artemisia annua. Phytochemistry* 38 (1), 255-257.

Yazdani, M., Hallaj, A., Salek, F., & Baharara, J. (2022). Potential of the combination of Artemisia absinthium extract and cisplatin in inducing apoptosis cascades through the expression of p53, BAX, caspase 3 ratio, and caspase 9 in lung cancer cells (Calu-6). European Journal of Integrative Medicine, 56, 102193.

Younes, K. M., Bin, M. K., Unissa, R., Almarshdi, A. A., Alharbi, F. M., Alenzi, S. S., ... & Abouzied, A. S. (2022). In-Vitro Evaluation of Anti-Microbial and Cytotoxic Activity of Artemisia judaica Leaves and Stem Extracts via Induction of Caspase Dependent Apoptosis. Indian J. Pharm. Educ. Res, 56, s52-s57.

Zaki M, Mathew KT, Gibson T, Williamson RT, Gibbons S (2004). New constituents of *Artemisia monosperma*. *Journal of Natural Products*, 67, 892-894.

Zayyat, M., Khedr, A. H., & Amer, N. (2018). Phytochemical and antimicrobial activity of two Egyptian xerophytes: Artemisia jaudica L. and Artemisia monosperma Delile. *African Journal of Biological Sciences*, *14*(2), 127-140.

Zengin, H., & Baysal, A. H. (2014). Antibacterial and antioxidant activity of essential oil terpenes against pathogenic and spoilage-forming bacteria and cell structure-activity relationships evaluated by SEM microscopy. *Molecules*, *19*(11), 17773-17798.

Zhang QW, Zhang YX, Zhang Y, Xiao YQ, Wang ZM (2002). Studies on chemical constituents in buds of *Artemisia scoparia*. *Zhongguo Zhongyao Zazhi*, 27 (3), 202-204.

Zhao W , Zhang W, Chen Y, Yang F , Cao Q, Chen W , Liu L , Dai K (2015). Identification and purification of novel chlorogenic acids in *Artemisia annua* L. *Journal of Experimental Biology and Agricultural Sciences*, 3 (5), 415-422.

Zhu XX, Yang LY, Li J, Zhang D, ChenY , Kostecká P, Kmoníèková E, Zídek Z (2013). Effects of sesquiterpene, flavonoid and coumarin types of compounds from *Artemisia annua* L. on production of mediators of angiogenesis. *Pharmacological Reports*, 65 (2), 410–420.

Zidane, A. A., Mahmoud, E. A. R., Hamisa, A., & Mokhamer, E. H. (2025). Molecular and Immunological assessment of anticancer activity of 1, 2, 4-triazolo [4, 3-b][1, 2, 4] triazole derivative in combination with Artemisia Judaica Extract in Murine Lung cancer model. *Journal of Medical and Life Science*, *7*(1), 60-84.

Zinczuk J, Ruveda AEA, Thompson HW, Lalancette RA (2007). (+)- Santonide, a sesquiterpenoid enol lactone derived from *Artemisia*. *Acta crystallographica*, Section E, 63, 1490-1491.