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MINI REVIEW

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Ethnopharmacognosy of *Echinops spinosus* L. in North Africa: a mini review

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ABSTRACT

Background: The genus *Echinops* (Asteraceae family, Echinopeae class) consists of ca. 120 species and is native to Africa, the Middle East, Europe, and Asia. In Algeria, this genus is represented by the very common species *Echinops spinosus* L. also known as "*tesskra,"* which is used as a diuretic, hypoglycemic, for stomachic effects, liver disorders, and post-partum care.

Objective: The aim of this presentation is to provide an overview of the ethnopharmacognosy studies conducted on *E. spinosus* in North Africa. Data on ethnomedicinal uses, chemical constituents, and pharmacological activity were systematically compiled.

Methods: Several popular search databases, including PubMed, ScienceDirect, Scopus, Web of Science, and Stanford libraries were scrutinised to extract relevant information. The research focused only on English-written papers published between 1980 and 2017.

Results: *Echinops spinosus* L. is traditionally used in North Africa, and it was found that the most ethnomedicinal use reports were from Morocco and Algeria. Promising results have been reported regarding its phytochemistry and pharmacological activity. Forty-three compounds were isolated from different parts of this species. No studies have been conducted to highlight the toxicity and clinical safety of this species.

Conclusion: This review highlights the therapeutic potential of *E. spinosus* used in traditional medicine. Furthermore, clinical trials on standardized preparations are necessary to explore the full safety and efficacy of *E. spinosus* in North Africa.

ARTICLE HISTORY

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KEYWORDS

Echinops species; Algeria; *E. spinosus*; ethnomedical properties; pharmacology

Introduction

The genus *Echinops*, belongs to the family Asteraceae (formerly Compositae) and comprises ca. 120 species distributed throughout the Mediterranean region, in central Asia, and in tropical Africa [1]. In Algeria, this genus is represented by the very common species *Echinops spinosus* L. According the African Plant Database, as well as the Plant List database, this name is synonymous with *E. spinosissimus* Turra [2–4]. It thrives in arid desert conditions with an annual rainfall varying between 20 and 100 mm, and has a wide ecological range for soil, including coastal, calcareous dunes, sandy, and gravelly to rocky surfaces [5]. Botanical classifications have subdivided *Echinops spinosus* L. into two subspecies [6,7]:

E. spinosus ssp. eu. *spinosus* Maire (var. *chaetocephalus* Pomel) and *E. spinosus* ssp. *bovei* (Boiss.) Maire (var. *pallens* Maire.), which is also known as *E. bovei* Boiss [8]. Recent data provided by synonymic survey of the Cardueae (Compositae) genera database, validated the scientific name of *E. spinosissimus* subsp. *bovei* (Boiss.) Greuter ≡ *E. bovei* Boiss [9].

Three other species have been reported in Algeria, but appear to be not very common: a) *E. ritro* L., known under the name of "*oursin bleu*" or "echinops" in French, has a southern European distribution, and occurs in southern Europe, western Asia, and even Siberia; b) *E. sphaerocephalus* L. is a mountainous species; and c) *E. strigosus* L.

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is distributed in the Iberian and North Africa area, especially in southern Spain and Algeria, and is widespread in the most western part of the Tell, from Tenes to the Moroccan border [6]. The literature reveals that 24 species of the genus *Echinops* have been subjected to varying degrees of scientific investigation [10]. Conversely, very little is known about *E. spinosus* [11,12]. Therefore, the objective of this review is to provide a detailed comparison of the chemical composition and pharmacological properties displayed by *E. spinosus* in North Africa with the widely studied species. Several search databases, including PubMed, ScienceDirect, Scopus, and Web of Science, were probed to extract information between 1980 and 2017.

Figure 1. Morphological aspect of *Echinops spinosus*

Vernacular names

In Algeria, *E. spinosus* L. is known in the Berber language under the names *"Taskra," "Teskera," "Taskra" Ameskelit T,* and *Sarsor,* and in Arabic by the names: *"fouga el djemel," "chouk el djemel," "suk ej-jmal," Kachir, Ikchir, Chouk el Hamir, Chicaou,* and *Sorr* [13–15]. In the Tamahaq language, this species is called Téfariast [16].

The Arabic name of "*qounfoudzia*" (de hérisson), is the transcription in Greek of "*Ekhinos.*" The vernacular name of "*ri ayi el-ibil*" has the meaning "Camel Pasture" [14]. In Morocco, this species is known under the names of "*tasekra, asekra, teskra, chouk el hamir, suk al-himar,* and *tîmat*" [17].

Botanical description and habitat

E. spinosus is a perennial herb growing to 1 m and more, with erect brownish to reddish stems, few long leaves from 10 to 15 cm, hairy, arachnoids, and with very long spines. The inflorescence is often a single hemispherical globe up to 5 cm in diameter during the flowering period. It is surrounded with numerous long spines (Figure 1). The small hermaphroditic flowers that compose the dense head are tubular, turning from green to white and yellowish when in full bloom. The fruits are small achenes topped by membranous scales to ease dispersion [18].

In Algeria, two very polymorphous subspecies have been described: 1) **ssp. *bovei* (Boiss.) Maire**: stems pubescent, not glandular. The achenes are composed into distinct pieces at the base. The leaves are whitish and woolly on both sides. *E. bovei* is a Southern Mediterranean-Saharan taxon, and is widespread in Algeria [19,20]; and 2) **ssp. eu. *spinosus* Maire**: annual plant, upright and firm stems, from 40 to 60 cm. The distribution of *E.* eu *spinosus* is limited to the pre-desert regions in septentrional and central Sahara and is considered as a Saharo-Sindian taxon [6,7].

Phytochemistry

The genus *Echinops* is one of the taxa with characterized alkaloids within the Asteraceae family [21]. An overview of the literature on *E. spinosus* showed that reports concerning the phytochemistry of the Algerian species are very limited, with only two studies undertaken [11,12]. Preliminary qualitative phytochemical screening of various secondary metabolites by specific chemical tests was carried out on extracts of the aerial parts and roots, which indicated that the aqueous extract contained alkaloids, tannins, flavonoids, quinones, reducing sugars, and starch [11].

Phytochemical investigations of *E. spinosus* from North Africa in Morocco, Algeria, Tunisia, and Egypt led to the isolation and identification of 42 metabolites belonging to the phytochemical classes of quinoline alkaloids (S_1–S_2) [1], sesquiterpenoids (S_3) [22], flavonoids (S_4–S_{26}) [12,23], and sterols (S_{27}–S_{39}) [24]. The names of the isolated compounds and their sources are provided in Table 1 and the chemical structures are depicted in Table 2.

In 2009, the isolation of two sesquiterpenoids with a novel carbon framework was reported and named echinopine A and echinopine B [22]. In 2016, Bouattour et al. [24] identified 13 sterols in *E. spinosus* from Tunisia. The two most abundant compounds were ß-sitosterol (44.97%) followed by stigmasterol (34.95%) [24]. In the same year, the occurrence of flavonoids was reported in the aerial parts of *E. spinosus* from Algeria and Egypt.

Table 1. Phytochemical constituents of *Echinops spinosus*.

Extract	Compound	Structure	Reference
E[a]	Echinopsine	S_1	[1]
	Echinorine	S_2	
E[b]	Echinopine A	S_3	[22]
	Echinopine B		
E[c]	Apigenin	S_4	[12]
	Apigenin-7-*O*-ß-glucopyranoside	S_5	
	Apigenin-7-β-D-*O*-(6”-*O*-*E*-*p*-coumaroyl-glucopyranoside	S_6	
E[d]	Luteolin-6-arabinose-8-glucoside	S_7	[23]
	Luteolin-6-glucose-8-arabinoside	S_8	
	Apigenin-6-arabinose-8-galactoside	S_9	
	Apigenin-6-arabinose-8-glucoside	S_{10}	
	Apigenin-6-glucose-8-rhamnoside	S_{11}	
	Luteolin-7-glucoside	S_{12}	
	Narengin	S_{13}	
	Rutin	S_{14}	
	Hesperidin	S_{15}	
	Quercetin-3-*O*-glucoside	S_{16}	
	Rosmarinic acid	S_{17}	
	Apigenin-7-*O*-neohespiroside	S_{18}	
	Kaempferol-3,7-dirhamnoside	S_{19}	
	Apigenin-7-glucoside	S_5	
	Quercetrin	S_{20}	
	Quercetin	S_{21}	
	Naringenin	S_{22}	
	Hespiritin	S_{23}	
	Kaempferol	S_{24}	
	Rhamnetin	S_{25}	
	Apigenin	S_4	
	Acacetin	S_{26}	
E[e]	β-Sitosterol	S_{27}	[24]
	Stigmasterol	S_{28}	
	Campesterol	S_{29}	
	Brassicasterol	S_{30}	
	Campestanol	S_{31}	
	Δ7-Campesterol	S_{32}	
	Δ5,23-Stigmastadienol	S_{33}	
	Cholesterol	S_{34}	
	Sitostanol	S_{35}	
	Δ5-Avenasterol	S_{36}	
	Δ5,24-Stigmastadienol	S_{37}	
	Δ7-Stigmastenol	S_{38}	
	Δ7-Avenasterol	S_{39}	
E[f]	2,2-Ddimethyl-4 [5’-(prop-1-ynyl)-2,2’-biothiphen-5-yl]-1,3-dioxalane	S_{40}	[25]
E[g]	11-Hydroxyisocom-2-en-5-one	S_{41}	[26]
E[h]	A-neooleana-3(5),12-diene	S_{42}	[27]

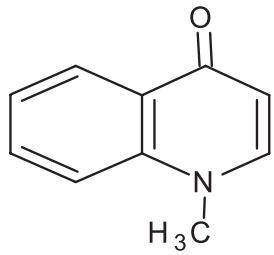
E[a] = chloroform extract prepared from ripe fruits collected in Deltaic coast Egypt, E[b] = methanol extract prepared from root collected in Morocco (2003), E[c] = ethyl acetate extract prepared from aerial parts collected in North Eastern Algeria (April 2009), E[d] = aqueous ethanolic extract prepared from aerial parts collected in Egypt, E[e] = Hexane extract prepared from flower heads in Tunisia, E[f] = dichloromethane extract prepared from roots collected in Morocco, E[g] = dichloromethane extract prepared from roots collected in Morocco, E[h] = crude methanol and ethyl acetate extracts from flowers collected from Sfax, South Tunisia (June 2011).

Twenty-three flavonoids were isolated [12, 23]. One year later, Bouattour et al*.,* isolated a new derivative of apigenin named apigenin-7-*O*-ß-D-glucoside-(4”-*O*-*trans*-*p*-coumaroyl) [27].

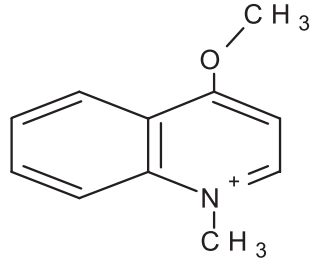
The occurrence of simple quinoline alkaloids in the aerial and/or underground parts was reported in *E. ritro*, *E. echinatus* Roxb [28,29], *E. albicaulis* [30]*,* and *E. niveus* [31]. Furthermore, members of the genus *Echinops* are also reported to contain flavonoids, triterpenoids, and thiophene acetylenes [21,29,30,32–34].

As far as information provided in the literature, thiophenes are a class of heterocyclic compounds which are characteristic secondary

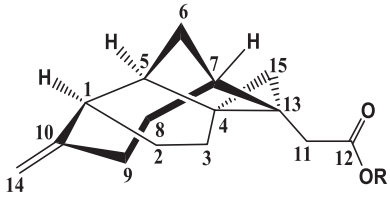
Table 2. Chemical structures of isolated compound extracted from *Echinops spinosus* L.



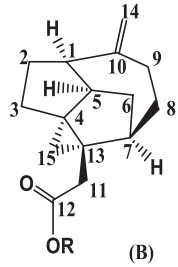
S_1



S_2



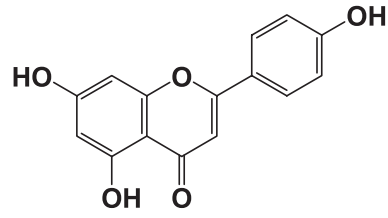
(A)



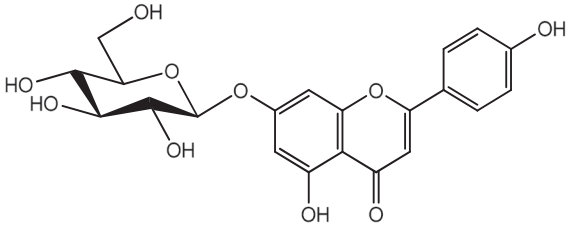
(B)

(A) R = H
(B) R = CH_3

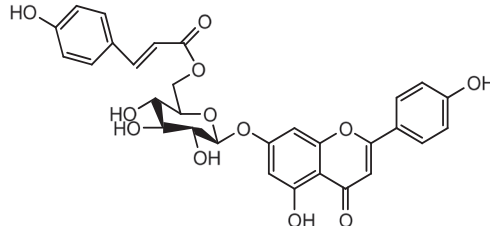
S_3



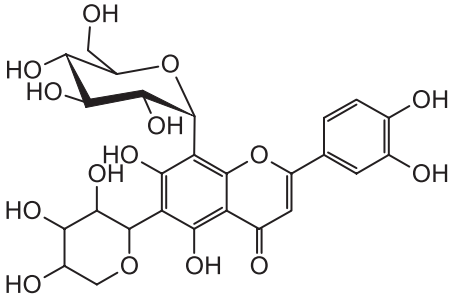
S_4



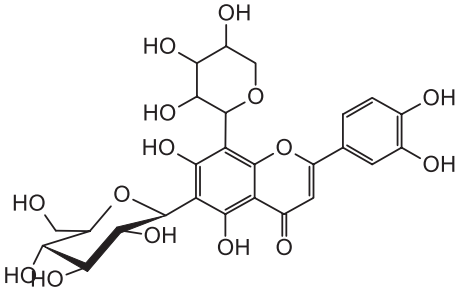
S_5



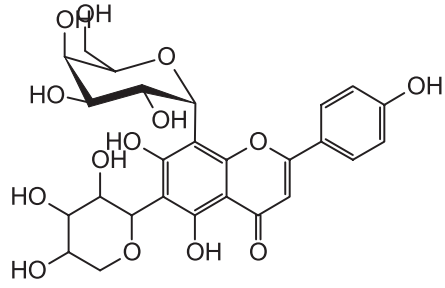
S_6



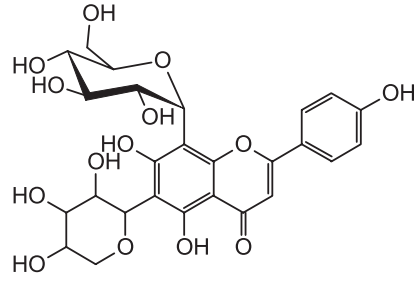
S_7



S_8

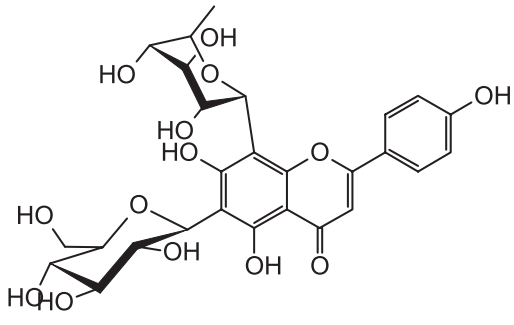


S_9

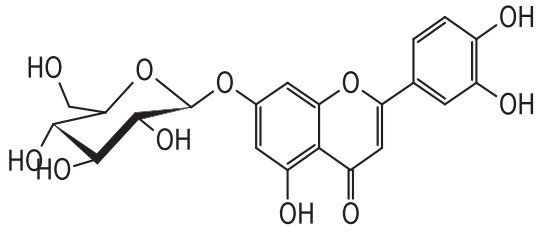


S_{10}

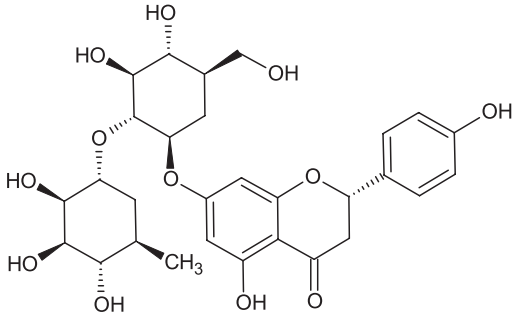
Table 2. Chemical structures of isolated compound extracted from *Echinops spinosus* L. (Continued)



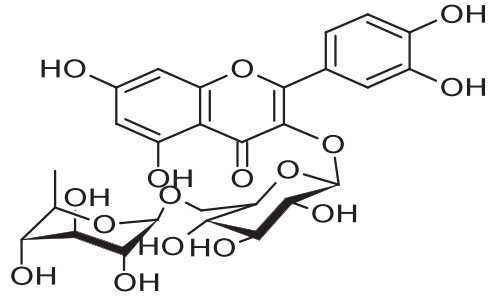
S_{11}



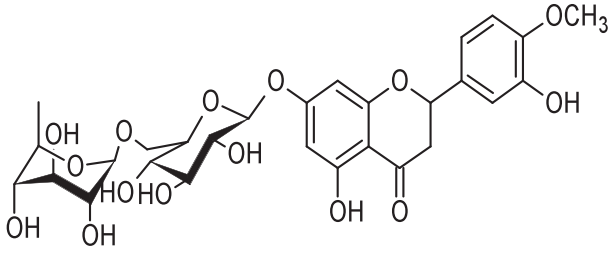
S_{12}



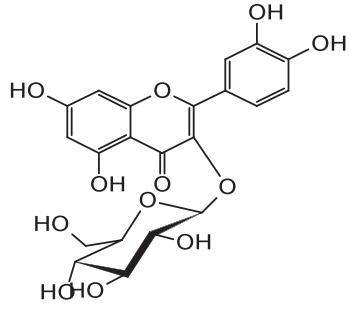
S_{13}



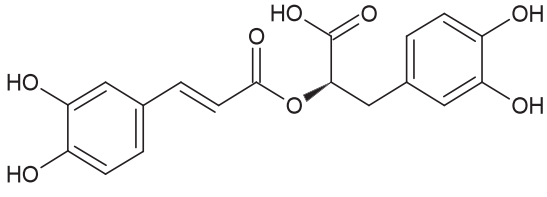
S_{14}



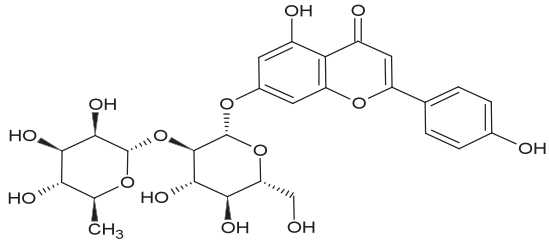
S_{15}



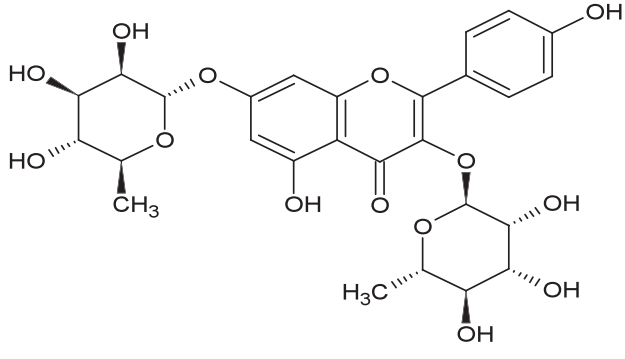
S_{16}



S_{17}

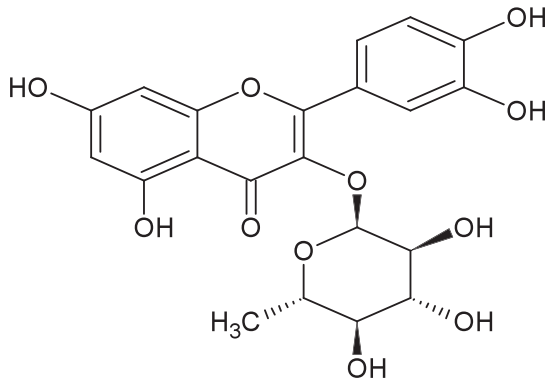


S_{18}

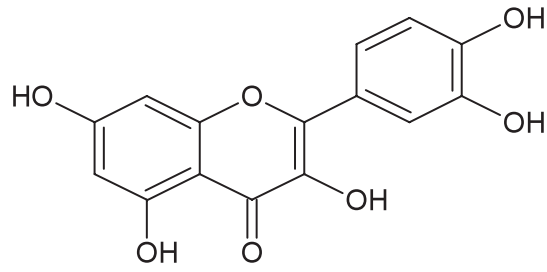


S_{19}

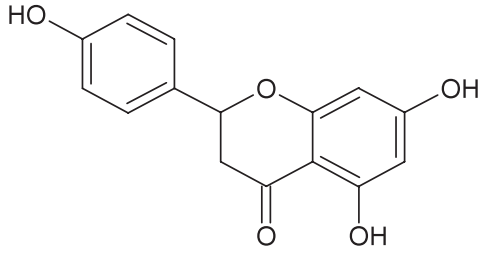
Table 2. Chemical structures of isolated compound extracted from *Echinops spinosus* L. (Continued)



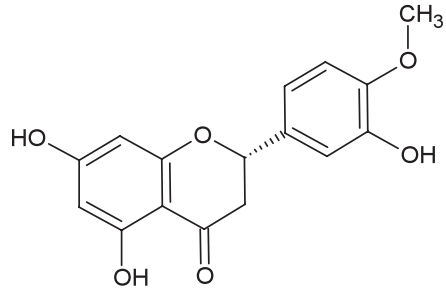
S_{20}



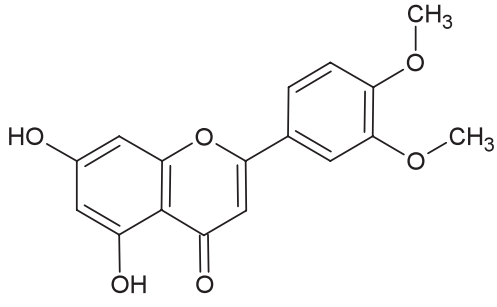
S_{21}



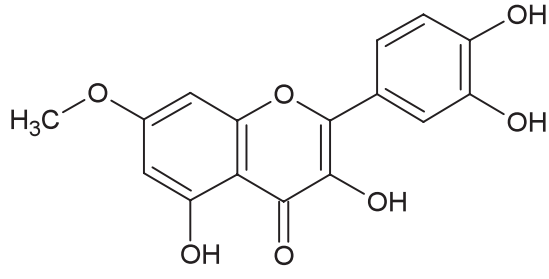
S_{22}



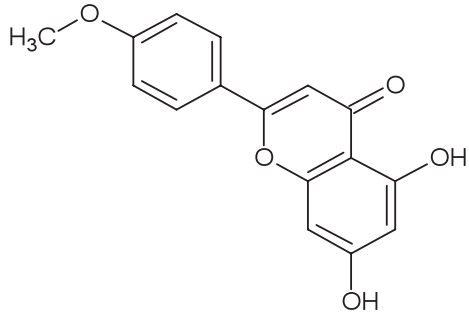
S_{23}



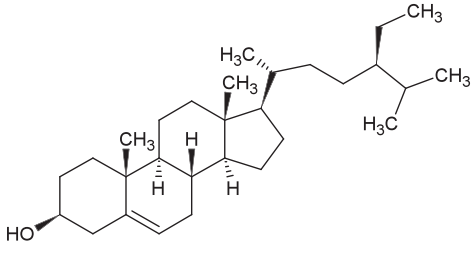
S_{24}



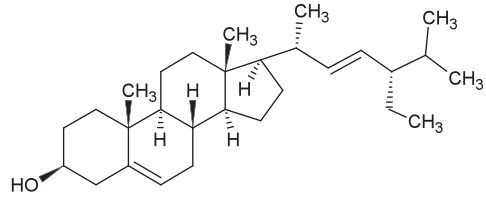
S_{25}



S_{26}

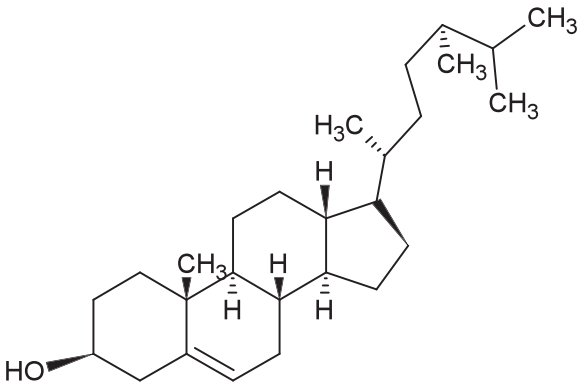


S_{27}

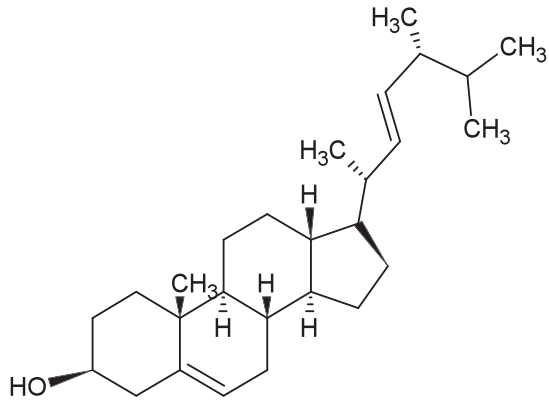


S_{28}

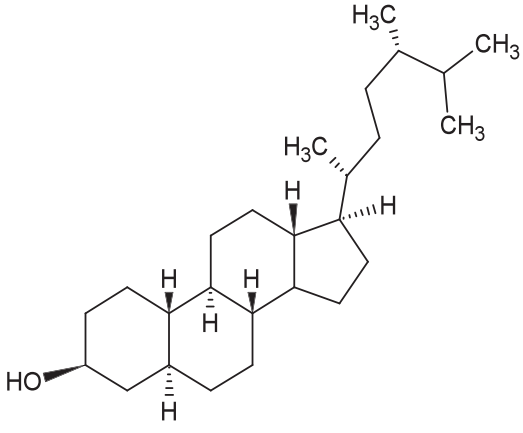
Table 2. Chemical structures of isolated compound extracted from *Echinops spinosus* L. (Continued)



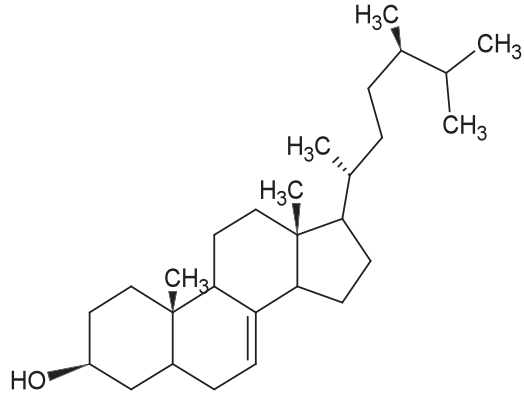
S_{29}



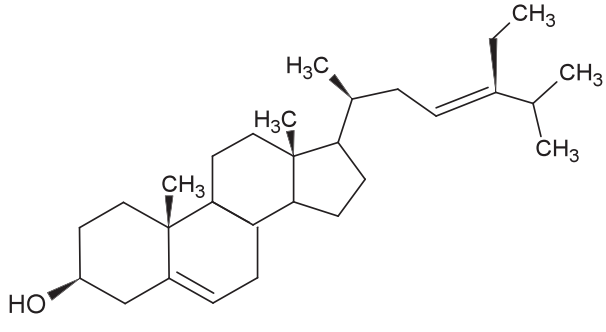
S_{30}



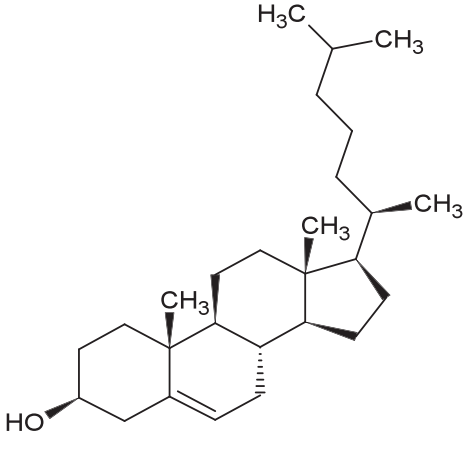
S_{31}



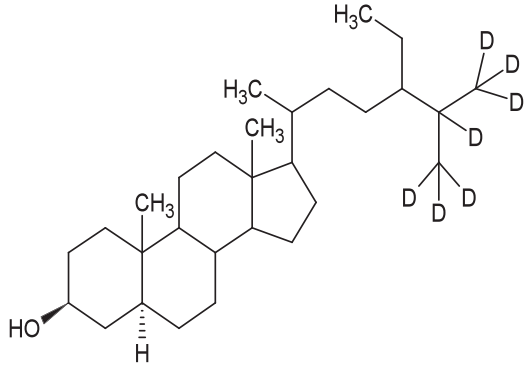
S_{32}



S_{33}

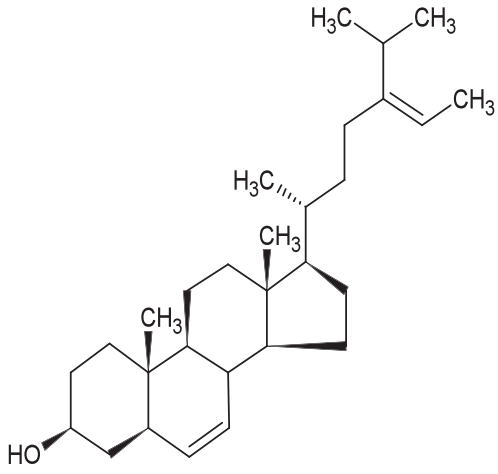


S_{34}

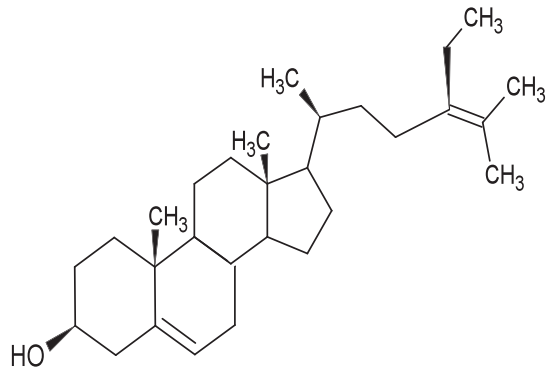


S_{35}

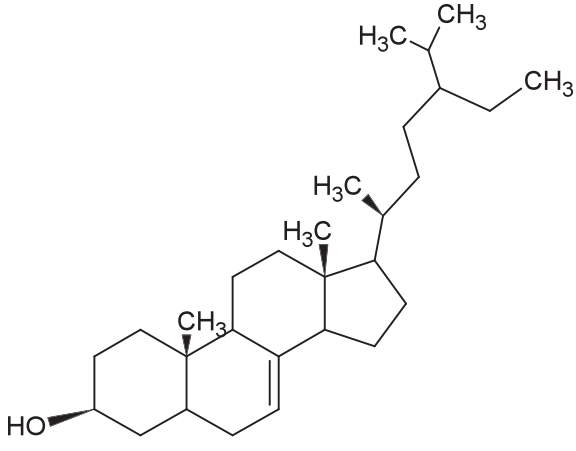
Table 2. Chemical structures of isolated compound extracted from *Echinops spinosus* L. (Continued)



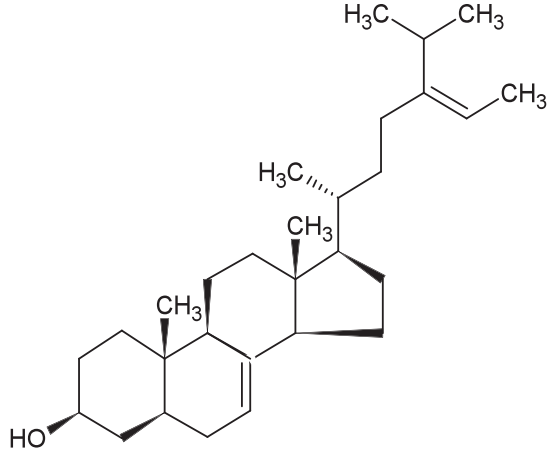
S_{36}



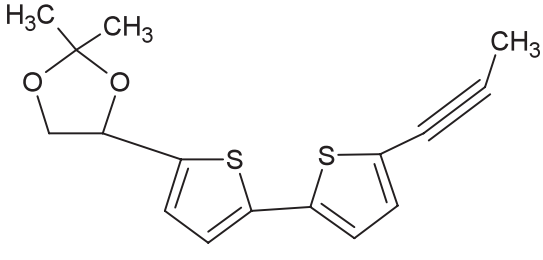
S_{37}



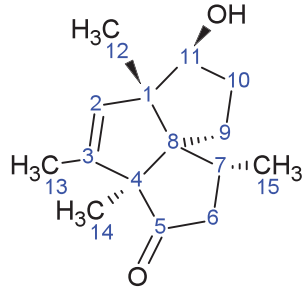
S_{38}



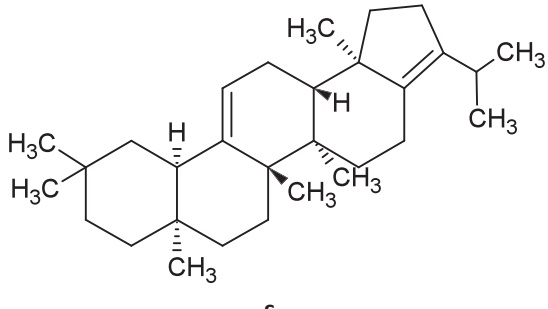
S_{39}



S_{40}



S_{41}



S_{42}

Table 3. Traditional uses and ethnobotanical information on *Echinops spinosus*.

Country	Plant part	Popular name	Geographical distribution	Medicinal uses	Reference
Morocco	Root	*Tassekra*	Spontaneous	Diuretic, hypoglycemic, stomachic, for liver disorders, and post-partum care	[17]
Morocco	Root	*Tassekra, Kherchouf, Chouk al-Himar*	Not indicated	Hypoglycemic, diuretic, post-partum care, liver disorders, appetizing, depurative, and abortive	[38]
Morocco	Not indicated	Not indicated	Not indicated	Against cold, and pain, renal colic, and disinfectant. Warming plant	[39]
Morocco	Root	*Tassekra*	Spontaneous	Obstetric Decoction of roots is administered to women after delivery to expel the placenta and for blood flow	[40]
Morocco	Root and aerial parts Roots and branches Flowers	*Taskra, Bongar*	Hemicryptophyte	Decoction used for colds, kidney, stones disinfectant, diuretic, and hypoglycemic. Decoction: abortifacient, labor pains Tisane: neuralgia, fatigue	[41]
Morocco	Seeds	*Taskra*	Not indicated	Infusion is used as an antidiabetic	[42]
Morocco	Rhizomes	*Taskra*	Not indicated	Decoction: stomachic disorders	[43]
Algeria Mascara	Roots	*Tassekra*	Not indicated	Genital infections (after an abortion), urinary tract infections, inflammation of the kidneys, and blood circulation	[44]
AlgeriaTiaret	Not indicated	*Taskra*	Not indicated	Hygienic agent employed for gynecological reasons	[45]
AlgeriaSetif	Roots and Fruits	Not indicated	Therophyte, southern Mediterranean Sahara	Labor pains, abortion, and neuralgia	[19]
AlgeriaTassili des N'jjers	Aerial Part	*Tefaryast Tassegra*	Saharo-arabic	Infusion in internal use: Eye complaints, trachoma, sore inflammation, digestive diseases, spasms, colic, and fever	[20]

metabolites derived from plants belonging to the family Asteraceae such as *Echinops*. Based on this, the distribution of thiophenes in different species of the genus *Echinops* has been examined in six species, including: *E. grijissii* Hance, *E. pappii* Chiov, *E. hispidus* Fresen, *E. transiliensis* Golosh, *E. latifolius* Taush, and *E. ritro* L. [34]. Twenty thiophenes have been reported in nine Ethiopian species: *E. amplexicaulis*, *E. papii*, *E. ellenbeckii*, *E. hispidus*, *E. hoehnelii*, *E.kebericho*, *E. longisetus*, *E. macrochaetus*, and *E. giganteus* [10]. In parallel, it should be noted that *E. spinosus* has not been screened for thiophene composition; only one chemical report described the structure of a new thiophene in roots collected from Morocco, which is known as the acetylene 2,2-dimethyl-4 [5'-(prop-1-ynyl)-2,2'-bithiophen-5-yl]-1,3-dioxalane (S_{40}) [26]. Furthermore, a new sesquiterpenoid 11-hydroxyisocom-2-en-5-one (S_{41}) was described for the first time in the dichloromethane extract of the roots of *E. spinosissimus* subsp. *spinosus* Greuter from Morocco [22]. In 2017, Bouattour et al., isolated a C_{30}-pentacyclic triterpadiene A-neooleana-3(5),12-diene (S_{42}), which might be a marker of identification of *E. spinosus* from other species of *Echinops* [27].

Ethnobotanical aspects

Traditional preparations of *E. spinosus* are frequently used in folk medicine as an abortifacient, as a diuretic, and for blood circulation, diabetes, gastric pain, indigestion, and spasmolytic problems [35].

In traditional medicine practices, *E. spinosus* is known in the Chinese [36] and North African traditions [37]; the latter reporting the ethnomedicinal use of the stems, leaves, and roots as a diuretic drug.

In Algeria, the roots or flower heads of *E. spinosus* have been used in the treatment of prostatism and dysmenorrhea. This botanical remedy has also been used as a peripheral vasoconstrictor in the treatment of hemorrhoids, varicose veins, and varicocele, in various venous hemorrhages and in metrorrhagia. It is considered as a hypertensive drug [13,14]. Table 3 presents the diverse ethnomedicinal uses of various parts of *E. spinosus* in North Africa.

Table 4. *In vivo* anti-inflammatory properties of *E. spinosus* and *E. echinatus*.

Species	Extract, Plant Part	Dose: dmi, dma	Inhibition	Inflammation model	Route of administration	Control-dose % of inhibition	Reference
E. spinosus	Aqueous, RH	100 mg/kg	59.5 %*	Carrageenan-induced rat sub-plantar edema	**i.p.**	IMC3 mg/kg	[47]
	Ethanol, RH	100 mg/kg	21.3%*				
	Chloroform, RH	100 mg/kg	67.4%*				
E. spinosus	Aqueous, RH	3 mg/ear	NI	Arachidonic acid-induced mouse ear edema	**i.p.**	IMC1 mg/kg	[47]
	Ethanol, RH	3 mg/ear	51.0%				
	Chloroform, RH	3 mg/ear	56.0%				
E. echinatus	Ethanol, WP	100 mg/kg	i.p.: 38.9%** i.o.: 13.3%**	Carrageenan-induced rat sub-plantar edema	**i.p.** **i.o.**	PBZ5 mg/kg	[51]
		800 mg/kg	i.p.: 67.5%** i.o.: 51.8%**				
E. echinatus	Ethanol, WP	25 mg/kg	a.c: 18.2%*** a.ch: 32.3%**	Formaldehyde-induced acute and chronic reactions in rats	**a.c:** + 4 hours reaction. **a.ch:** + 10 days	PBZ50 mg/kg	[51]
		200 mg/kg	a.c: 50.3%*** a.ch: 54.3%**				
E. echinatus	Ethanol, WP	25 mg/kg	a.c: 23.6%** a.ch: 44.1%**	Adjuvant-induced acute and chronic reactions in rats	**a.c:** + 18 hours reaction. **a.ch:** + 21 days	PBZ50 mg/kg	[51]
		200 mg/kg	a.c: 75.4%** a.ch: 75.6%**				
E. echinatus	TA	12.5 mg/kg	13.79%**	Carrageenan-induced rat sub-plantar edema		PBZ50 mg/kg 46.23%**	[52]
		200 mg/kg	63.25%**				
E. echinatus	TA	10 mg/kg	a.c: 17.72%*** a.ch: 29.70%**	Formaldehyde-induced inflammation	**a.c:** + 4 hours reaction. **a.ch:** + 10 days	PBZ50 mg/kg a.c: 22.69%** a.ch: 56.15%**	[52]
		80 mg/kg	a.c: 50.70%** a.ch: 70.64%**				
E. echinatus	TA	10 mg/kg	a.c: 29.50%** a.ch: 39.62%**	Adjuvant-induced inflammation	**a.c:** + 18 hours reaction. **a.ch:** + 21 days	PBZ50 mg/kg a.c: 34.16%** a.ch: 64.21%**	[52]
		80 mg/kg	a.c: 57.91%** a.ch: 67.47%**				
E. echinatus	Flavanone A	45 mg/kg	34.21%	Carrageenan-induced paw oedema	**i.p.**	ASA30 mg/kg 52.63%	[53]

dmi = minimal dose, dma = maximal dose, RH = rhizome, WP = whole plant, NI = not investigated, i.p. = intraperitoneal administration, i.o. = oral administration, a.c. = acute reaction, a.ch. = chronic reaction,
TA = taraxasterol acetate, Flavanone A = 5,7-dihydroxy-8,4′-dimethoxy-flavanone-5-O-α-L-rhamnopyranosyl-7-O-β-D-arabinopyranosyl-(1→4)-O-β-D-glucopyranoside, IMC = indomethacin, ASA = acetyl salicylic acid.
*$p < 0.02$, **$p < 0.01$, ***$p < 0.05$.

Pharmacological properties

Anti-inflammatory activity

Over a long period of time, many medicinal plants have been used for the treatment and management of various forms of inflammatory conditions by African traditional healers and herbalists. However, most of these plants are not documented as compared to the Chinese or Indian traditional medicines. About 5,000 plant species have used for centuries for the treatment of various diseases, including anti-inflammatory diseases. A few African medicinal plants with demonstrated anti-inflammatory and analgesic properties have been documented in the last two decades [18].

The genus *Echinops* is used traditionally in North Africa for its anti-inflammatory actions [46]. In 1999, Rimbau et al., assessed the anti-inflammatory activities of the aqueous, ethanol, and chloroform extracts from the rhizome of *E. spinosus* [47]. Two experimental methods were used: a) carrageenan-induced rats sub-plantar edema inflammatory

models [48,49] with administered extracts at a dose of 100 mg/kg and the reference group was treated with indomethacin (intraperitoneal administration: i.p., 3 mg/kg), and b) the arachidonic acid-induced mouse ear edema [49,50], where extracts were studied at a dose of 3 mg/ear, and the reference group was treated with indomethacin (1 mg/ear). All of the tested extracts showed significant anti-inflammatory activities in both experimental models. However, the chloroform extract showed higher anti-inflammatory activity for the carrageenan experimental model inhibition in rats, with a mean of percentage inhibition of 67.4%, compared with 32.4% for the reference group. In the experimental model in mice, the percentage inhibition for the chloroform extract was 56.1%, compared with 34% for the reference group. Table 4 summarizes the model of inflammation, the extracts used in the study, and the positive control used.

In parallel, a wide range of anti-inflammatory activity has been shown for *E. echinatus* used in the Indian System of Medicine for the treatment of fever and inflammatory diseases. In 1989, *E. echinatus* L. was extensively studied for its acute anti-inflammatory induced in rats by carrageenan, formaldehyde-induced acute and chronic arthritis, and adjuvant-induced acute and chronic arthritis. Taking in to account the methods described to assess the anti-inflammatory activity of *E. spinosus* [48], it was found that the ethanol extract of the whole plant of *E. echinatus* at a dose of 100 mg/kg was less effective than *E. spinosus*. It is noticeable that the percentage of inhibition in the acute carrageenan paw edema was higher in intraperitoneal (i.p.) than oral (p.o.) dosing, with a percentage of inhibition 38.9% ± 2.5%, *versus* 13.3% ± 5.3%, compared with the reference group treated with Phenylbutazone (PBZ) (5 mg/kg) of 61.3% ± 2.8% (i.p.), *versus* 44.6% ± 4.3% for i.o. administration [51].

Another study isolated a triterpenoid taraxasterol acetate from *E. echinatus* and was reported to have an anti-inflammatory effect in albino rats for carrageenan, formaldehyde, and adjuvant-induced inflammation. The effects were dose dependent, and its efficacy was approximately 0.25–2 times that of the reference drug PBZ administrated per i.p. [52].

Interestingly, a new anti-inflammatory agent has been isolated from the methanolic extract from leaves of *E. echinatus*, 5,7-dihydroxy-8,4'-dimethoxy-flavanone-5-*O*-α-L-rhamnopyranosyl-7-*O*-β-D-arabinopyranosyl-(1⟶4)-*O*-β-D-glucopyranoside carried out with non-immunological carragenan-induced hind paw oedema method, which showed an in i.p. administration an inhibitory effect 0.67 times that of the reference drug (Table 4) [53].

Antioxidant activity

The antioxidant activity of flavonoids and tannin extracts from the aerial part (stems and leaves) and roots of *E. spinosus* from Tlemcen was assessed by two methods: the reduction of ferric reducing antioxidant power (FRAP) and the trapping of free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). This study showed that the tannin-containing ethyl acetate extract of the aerial arts of *E. spinosus* had higher capacity of reducing iron and also free radical scavenging activity in the DPPH test than extracts of the roots. The inhibitory concentration (IC_{50}) in the DPPH method was 8.25 µg/ml for the aerial parts (*vs*. 23 µg/ml for roots), while the FRAP method confirmed the high reduction capacity at a concentration of 2.5 mg/ml (optical density = 2.85) of tannin-containing ethyl acetate extract of aerial parts compared with the root extracts [11]. Similarly, Khedher et al. (2014) showed that the ethanol extract of *E. spinosus* had the greatest ability to reduce DPPH radicals, with an IC_{50} value of 147 µg/ml. As expected, it was reported for the roots of *E. spinosus* that there is a positive correlation between the condensed tannin content and activity in the DPPH assay [35].

Comparatively, high scavenging DPPH activities were shown for the methanolic extract of seeds and leaves of *E. orientalis* [54]. It was shown that the aqueous extract of *E. ritro* is a source of phenolic compounds based on gallic acid, measured by Folin–Ciocalteau methods (92.24 Gallic Acid Equivalents (GAE) mg/100 g), and exhibited higher DPPH scavenging activity compared with a synthetic antioxidant Butylated hydroxytoluene (BHT) [55].

Antimicrobial activity

The antibacterial and the antifungal activities of the unsaponifiable matter, and a fraction isolated from the hexane extract of *E. spinosus*, were evaluated for their antimicrobial potential against eight Gram-positive and Gram-negative bacteria by measuring the diameter of the inhibition zone around the well, and the determination of their minimal inhibitory concentration (MIC) and minimum bactericidal concentration. The activity tests were conducted using the diffusion disc and broth microdilution assays. Very weak antibacterial activity, with MIC values of 125.0 µg/ml against *Staphylococcus aureus*, *Bacillus cereus*, and *Micrococcus luteus* (MIC > 125.0 µg/ml) was shown by this extract. No significant antifungal activity was observed [22].

Conclusions

The present paper summarizes the limited information on *E. spinosus* and highlights the therapeutic potential, which is used mainly as an anti-inflammatory drug in Algeria, as well as in Morocco. To the best of our knowledge, no study has been conducted to describe the toxicological effects of this species. Therefore, further clinical studies, based on standardized extracts from a sustainable source, must be designed to ensure the safety and efficacy of the extracts of this species which is widely used in traditional medicine in North Africa as an abortifacient drug.

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