REVIEW ARTICLE

RECORDS OF PHARMACEUTICAL AND BIOMEDICAL SCIENCES

Phytochemical Constituents and Biological Activities of *Jasonia montana* (Asteraceae)

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Abstract

Nature has bestowed on people a very rich botanical wealth including a large number of naturally occurring plants in different parts of the world. Natural products from plant resources, including bio-molecules and secondary metabolites, usually exhibit some kind of biological activities in traditional and modern medicine. The Sinai peninsula is considered a repository of indigenous medicinal plants that have been used for hundreds of years for treatment of human ailments. *Jasonia montana* [*Chiliadenus montanus*] belongs to family Asteraceae, one of the largest families of flowering plants. It commonly grows in the Mediterranean region as well as the Sinai Peninsula, locally known as Haneida. The plant has a strong pleasant aromatic odor and is used in folk medicine for diarrhea, stomach-ache and chest diseases. Recent studies suggested that most of the reported biological activities of *J. montana* are due to its rich content of polyphenols, particularly flavonoids. This review highlights the phytochemical constituents of this important plant as well as its different reported biological activities.

Keywords: Asteraceae; *Jasonia*; *Chiliadenus*; Sinai; medicinal plants; polyphenols; flavonoids.

1. Introduction

Jasonia montana is a medicinal flowering plant that belongs to Family Asteraceae, one of the largest families of flowering plants. It grows in the Mediterranean region and adjacent areas, in Palestine, and Arabia. In Egypt, it grows along the Mediterranean coast, in the Eastern desert, and in the hillsides of the Sinai Peninsula. In Sinai, it is popularly known as Haneida and was traditionally used by natives to relieve stomachache and diarrhea (Tackholm, 1974). The current systematic classification of *J. montana* is listed in **Table (1)**.

For hundreds of years, *J. montana* has been recognized as an important medicinal plant. Many studies have been carried out to investigate the phytochemical constituents and medical applications of *J. montana*. A literature survey indicated that the plant contains some mono- and sesquiterpenes (Ahmed and Jakupovic, 1990),

essential oils (Hammerschmidt et al., 1993) and flavonoids, which are particularly abundant in the plant (Ahmed et al., 1989).

Pharmacological studies have shown that *J. montana* possesses various biological activities, including antioxidant (Hussein, 2011), anti-inflammatory (Habib et al, 2020), cytotoxic (Soliman et al., 2009), and antidiabetic activities (Hussein, 2011). Moreover, *J. montana* ethanolic extract was reported to lower fat accumulation, suggesting a beneficial role in patients suffering from obesity (Hussein, 2011). Recent research on its anticholinesterase activity indicated that the plant extract could have a therapeutic application in the treatment of Alzheimer's disease (Ahmed et al., 2013).

Table (1): The systematic classification of *Jasonia montana*

Division	Tracheophyta. (vascular plants)
Class	Magnoliopsida
Superorder	Asteranae
Order	Asterales
Family	Compositae (Asteraceae)
Genus	*Chiliadenus-Jasonia.*
Species	*Montana*

2. Chemical constituents reported from *Jasonia montana*

2.1. Flavonoids

In 2009, Soliman. F and co-workers isolated from *J. montana* eleven flavonoid aglycones from chloroform fraction, three flavonoid glycosides from ethyl acetate fraction, quercetin-3-O-β-D-4C1 galactouronopyranoside, quercetin-3-O-β-D-4C1-glucopyranoside and patuletin-7-O-β-D-4C1-glucopyranoside, while n-butanol fraction yielded two flavonoid glycosides, quercetin-3-O-L-1C4-rhamnopyranoside (Quercitrin) and quercetin-3-O-β-D-4C1 glucuronopyranoside **(table 2**) (Soliman et al., 2009). Hamed and co-workers in 2016 isolated seven methoxylated flavonoids bonanzin, artemitin, chrysosplenetin, centaureidin, chrysosplenol-D, 3,3`,4`-trimethoxy quercetin, 5,4`-Dihydroxy-3,7-dimethoxyflavone **(table 2)** the CH_2Cl_2/MeOH (1:1) extract of air-dried aerial parts of *J. montana* (Hamed et al., 2016).

2.2. Essential Oil constituents

Hammerschmidt and co-workers identified fifty-eight essential oil constituents of *J. montana*, camphor was the major component of this oil followed by borneol, bornyl acetate, chrysanthemol, and 1,8-cineole **(table 3)** (Hammerschmidt et al., 1993).

2.3.Terpenes

In 1990, Ahmed and Jakupovic isolated four eudesmanes 5α-hydroxy-β-eudesmol, 5β-hydroxy-β-eudesmo1, Eudesm-4(15), 11(13)-diene-12,5/I-olide, Jasomontanone and 3β-11-Dihydroxyisoiphion-4-one from the aerial parts of *J. montana* **(table 4)** (Ahmed and Jakupovic, 1990).

In 2005, Al-Howiriny, and co-workers isolated three new diterpenes from *J. montana*, namely jasonin-a, jasonin-b, and jasonin-c (Al-Howiriny et al., 2005). In 2007, Mohamed isolated a yellowish oil nor-sesquiterpene for which the name jasonone was chosen **(table 4)** (Mohamed, 2007).

2.4.Acids

Soliman isolated 3, 5-dicaffeoyl-quinic acid and caffeic acid from the n-butanol fraction of *J. montana* **(table 5)** (Soliman et al., 2009).

In 2014, Hegazy and co-workers reported for the first time two free acids from air-dried aerial parts of *J. montana* 3α-acetyl-γ-costic acid and 5α-hydroxy-4α,15 dihydrocostic acid **(table 5)** (Hegazy et al., 2014).

3. Reported biological activities of *Jasonia montana*

3.1. Anti-inflammatory activity

In 2007, triterpenes and sterols were suggested to be responsible for the anti-inflammatory properties of *J. montana* by inhibition of the production of pro-inflammatory cytokines (Mohamed, 2007).

Recently, 5,7,4'-trihydroxy- 3,3'-dimethoxy flavone and 3,5,6,7,4'-pentamethoxy flavone isolated from *J. montana* were found to downregulate LPS-induced expression of inflammatory cytokines, including tumor necrosis factor alpha (TNFα),

interleukin 1β (IL1β), nuclear factor kappa B (NFκB), cyclooxygenase 1 (Cox1), cyclooxygenase 2 (Cox2), and 5-lipoxygenase (5Lox) (Habib, et al, 2020).

3.2. Antioxidant activity

In 2008, Hussein suggested that the *J. montana* extracts may exert antioxidant activities and protect the tissues from lipid peroxidation by scavenging of free radicals thus reducing the risk of diabetic complications (Hussein, 2008). In 2010, Hussein and Farghaly suggested that the aerial parts of *J. montana* extract may effectively normalize the impaired antioxidant status in iron-overloaded rats model experiment. Oral administration of *Jasonia* ethanolic extract significantly prevented the increase in liver, kidney and serum iron, serum ferritin, serum transferrin levels, γ-GT, α-GST and γ-GT activities as well as serum NO and TNF- α level and hepatic MDA level as compared to iron-overload treated rats (Hussein and Farghaly, 2010).

In 2011, Hussein revealed that treatment with *J. montana* significantly prevented the decrease in the levels of hepatic oxidative stress biomarkers; reduced Glutathione (GSH), Glutathione peroxidase (GPx), Glutathione reductase (GR), Superoxide dismutase (SOD) and Catalase (CAT) (Hussein, 2011). *J. montan*a hydroalcoholic extracts exerted a protective action by decreasing cell death and by inhibiting intracellular ROS production (Eissa et al., 2013). In 2014, Shoman and co-workers investigated the potential role of the ethanolic extracts of aerial parts of *Jasonia candican*s and *Jasonia montana* in management of oxidative stress in male rats treated with aluminum chloride ($AlCl_3$). High content of terpenes, sesquiterpenes and flavonoids in the ethanolic extracts of *Jasonia candicans* and *Jasonia montana* were suggested to be responsible for the antioxidative and antigenotoxic action (Shoman et al., 2014).

3.3. Antidiabetic activity

Oral administration of ethanolic and aqueous extracts of *J. montana* in streptozotocin-induced diabetic rats at concentration of 150 mg/kg daily for 30 days showed a significant decrease in fasting blood glucose, hepatic and renal thiobarbituric acid reactive substances and hydroperoxides (Hussein, 2008). *J. montana* ethanolic extract in a dose of 150 and 300 mg/kg was able to lower the blood glucose level partially due to the improvement of insulin resistance index when compared to the high fat diet (HFD) control group (Hussein, 2011).

3.4. Anti-Obesity activity

J. montana ethanolic extract was found to significantly suppress increases in plasma lipids content and lowered fat accumulation by suppressing TG, TC, HDL-C, LDL-C, vLDL-C and free fatty acids (Hussein, 2011). In 2014, Helal and co-workers investigated daily management of alloxan-induced diabetic rats with aqueous extract of *J. montana*. The results showed significant improvement in serum insulin, body weight, total proteins, albumin, globulin and HDL accompanied with marked elevation in the levels of fasting blood glucose, levels of HOMA_IR, AST, ALT, GGT, urea, creatinine, uric acid, serum TC, TG, LDL, VLDL and ratios of TC/HDL and LDL/HDL (risk factors) in diabetic rats in comparison with the control group. Treatment with the extract improved the morphological changes that were observed in diabetic groups in liver, kidney and pancreatic tissues in comparison to the control group (Helal et al., 2014).

3.5. Antimicrobial Activity

Al-Howiriny and coworkers reported that the petroleum ether extract of the aerial parts of *J. montana* exhibited activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Mycobacterium smegmatis*, and *Candida albicans*, whereas the chloroform extract displayed activity only against *B. subtilis* and *S. aureus* (Al-Howiriny, T., et al 2005).

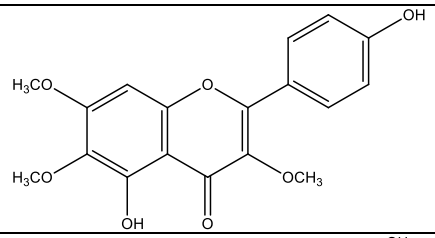
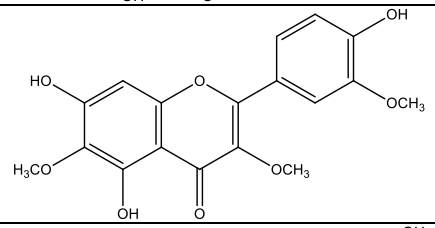
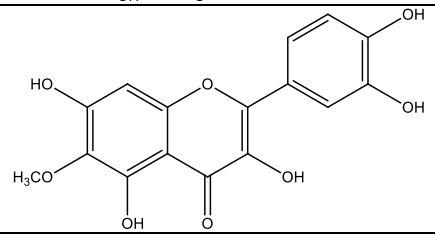
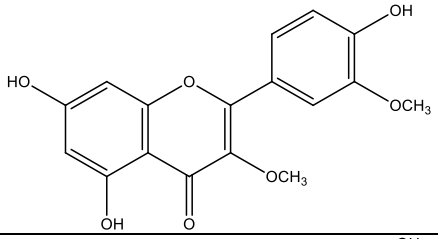
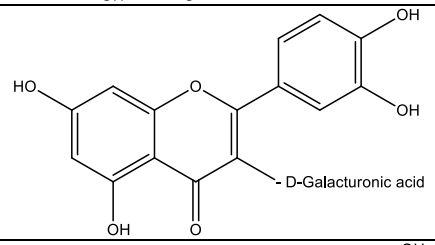
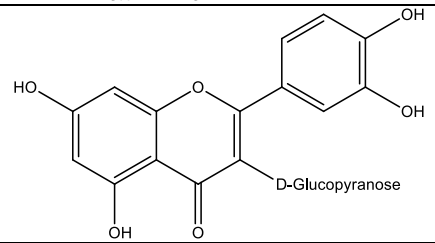
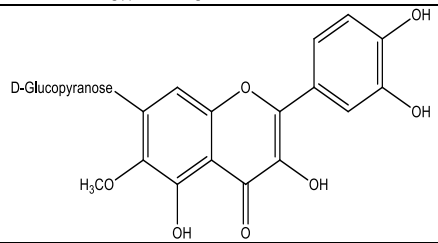
3.6. Cytotoxic Activity

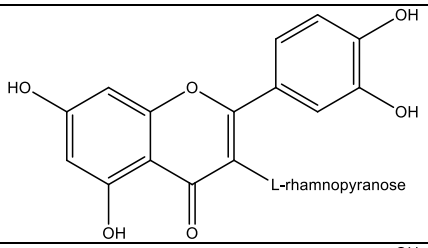
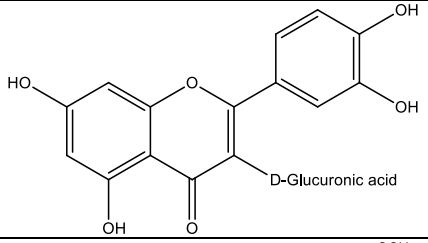
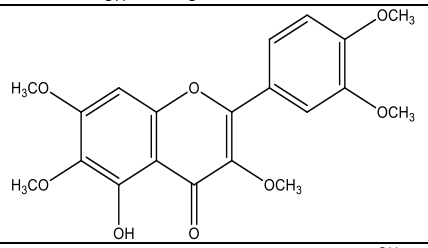
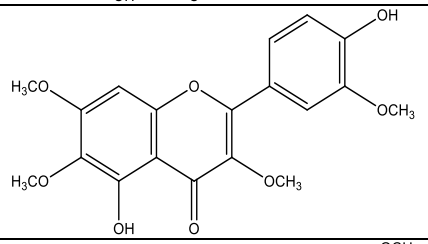
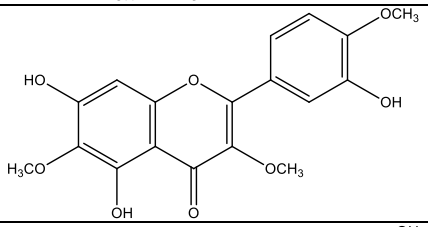
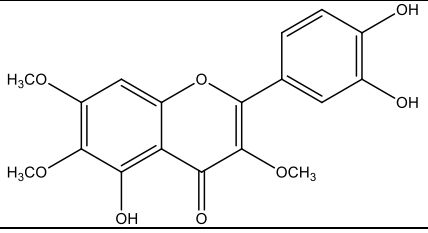
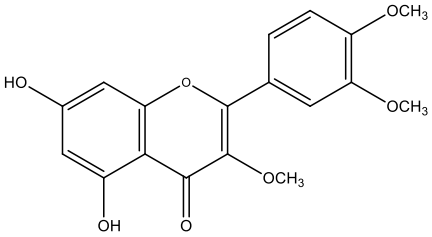
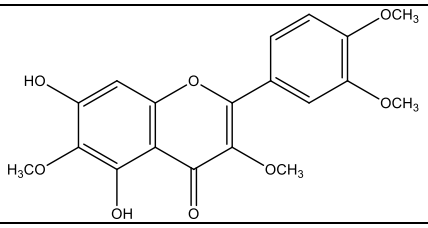
Chrysosplenetin, centaureidin and quercetin-3-O-â-D-4C1-glucopyranoside isolated from the aqueous and ethanolic extracts of *J. montana* herb showed a promising cytotoxic effect against HeLA cervix carcinoma cell line at a concentration of 10 mg/ml (Soliman et al., 2009).

3.7. Anticholinesterase activity

High content of terpenes, sesquiterpenes and flavonoids in the ethanolic extract of the *J. candicans* and *J. montana* were suggested to be responsible for their anticholinesterase activity, decrease TNF-α, TGF-β and 8-OHdG levels, neurotrophic effect as well as anti-amyloidogenic effect. These extracts were suggested to have a potential therapeutic application in the treatment of Alzheimer's disease (Ahmed et al., 2013).

Table (2): Flavonoids isolated from *J. montana* family Asteraceae.

Structure	Name	Reference
	penduletin	**(Ahmed et al., 1989)** **(Soliman et al., 2009)**
	jaceidin	**(Ahmed et al., 1989)** **(Soliman et al., 2009)**
	patuletin	**(Ahmed et al., 1989)** **(Soliman et al., 2009)**
	3,3`-dimethoxyquercetin	**(Ahmed et al., 1989)** **(Soliman et al., 2009)**
	quercetin-3-O-β-D-4C1 galactouronopyranoside	**(Soliman et al., 2009)**
	quercetin-3-O-β-D-4C1-glucopyranoside	**(Soliman et al., 2009)**
	patuletin-7-O-β-D-4C1-glucopyranoside	**(Soliman et al., 2009)**

	Quercitrin	**(Soliman et al., 2009)**
	quercetin-3-O-β-D-4C1 glucuronopyranoside	**(Soliman et al., 2009)**
	Artemitin	**(Soliman et al., 2009)** **(Hamed et al., 2016)**
	Chrysosplenetin	**(Soliman et al., 2009)** **(Hamed et al., 2016)**
	Centaureidin	**(Soliman et al., 2009)** **(Hamed et al., 2016)**
	Chrysosplenol-D	**(Hamed et al., 2016)**
	3,3`,4`-trimethoxy Quercetin	**(Soliman et al., 2009)** **(Hamed et al., 2016)**
	Bonanzin	**(Hamed et al., 2016)**

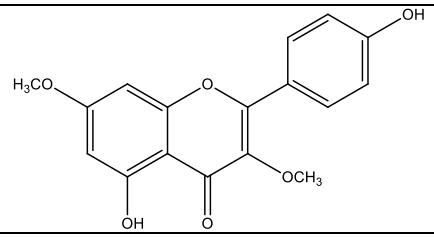
	5,4`-Dihydroxy-3,7-dimethoxyflavone	**(Hamed et al., 2016)**

Table (3): Constituents isolated from essential oil of *J. montana* Family Asteraceae

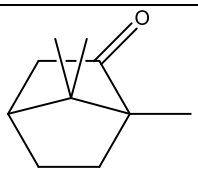
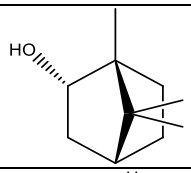
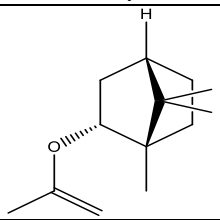
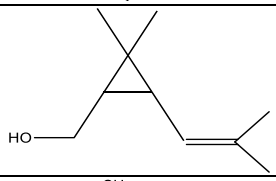
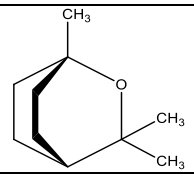
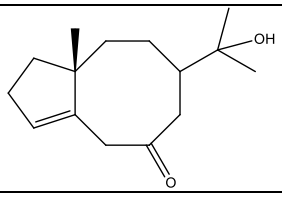
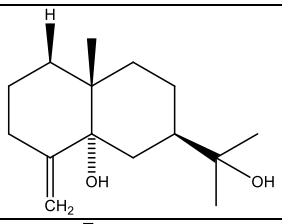
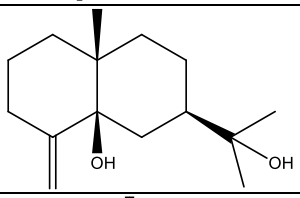
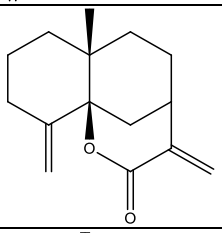
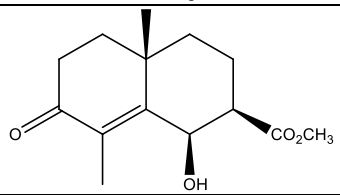
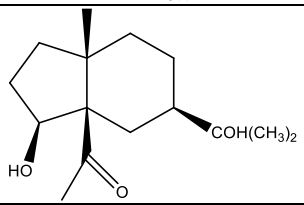
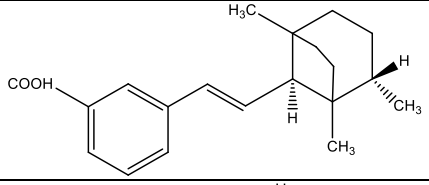
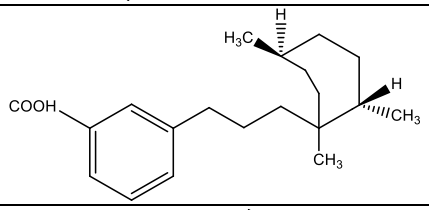
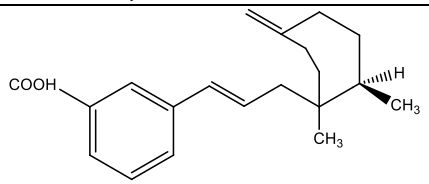
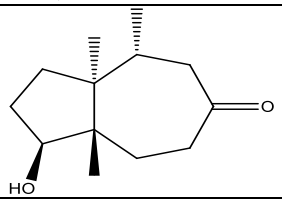
Structure	Name	Reference
	Camphor	**(Hammerschmidt et al., 1993)**
	Borneol	**(Hammerschmidt et al., 1993)**
	Bornyl acetate	**(Hammerschmidt et al., 1993)**
	Chrysanthemol	**(Hammerschmidt et al., 1993)**
	1,8-cineole	**(Hammerschmidt et al., 1993)**

Table (4): Terpenes isolated from *J. montana* Family Asteraceae

Structure	Name	Reference
	11-hydroxyjasonione	**(Ahmed and Jakupovic, 1988)**

	5α-Hydroxy-β-eudesmol	**(Ahmed and Jakupovic, 1990)**
	5β-Hydroxy-β-eudesmo1	**(Ahmed and Jakupovic, 1990)**
	Eudesm-4(15),11(13)-diene-12,5/β-oIide	**(Ahmed and Jakupovic, 1990)**
	Jasomontanone	**(Ahmed and Jakupovic, 1990)**
	3β-11-Dihydroxyisoiphion-4-one	**(Ahmed and Jakupovic, 1990)**
	Jasonin-a	**(Al-Howiriny et al., 2005)**
	Jasonin-b	**(Al-Howiriny et al., 2005)**
	Jasonin-c	**(Al-Howiriny et al., 2005)**
	Jasonone	**(Mohamed, 2007)**

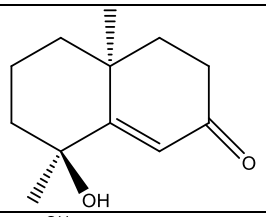
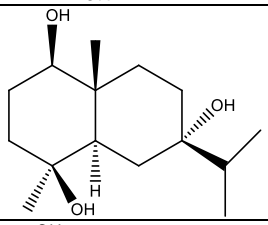
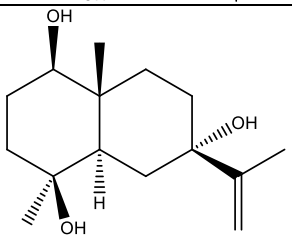
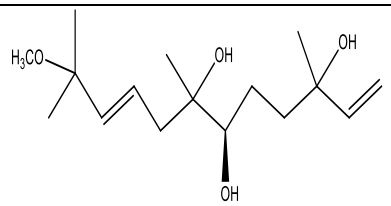
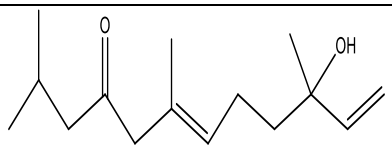
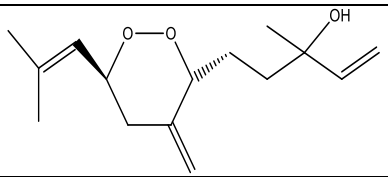
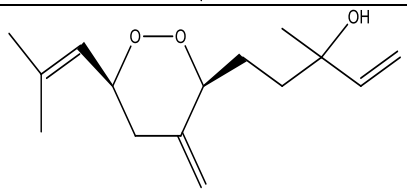
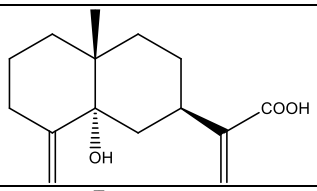
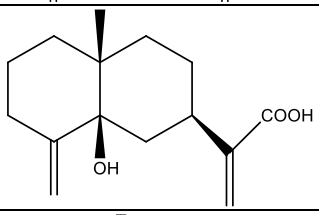
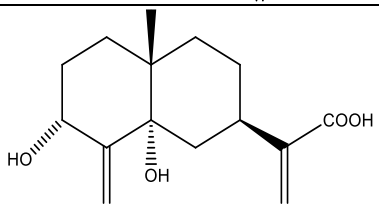
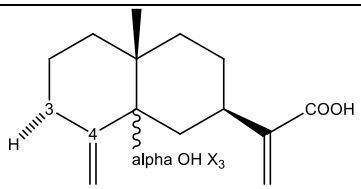
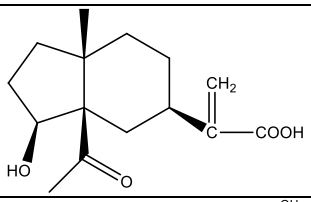
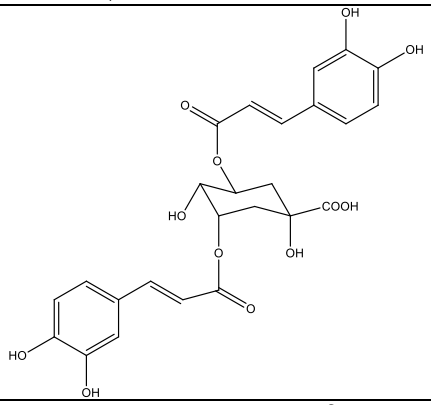
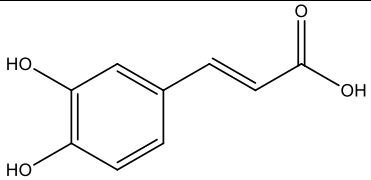
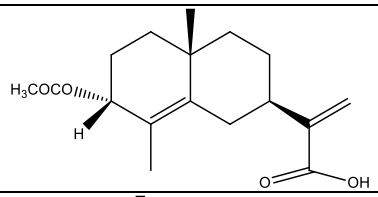
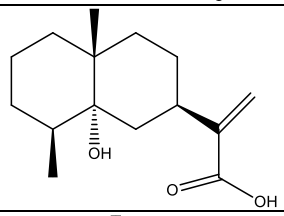
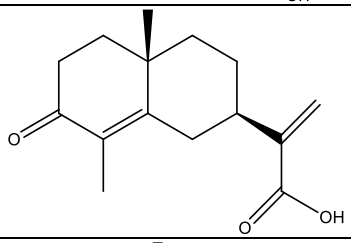
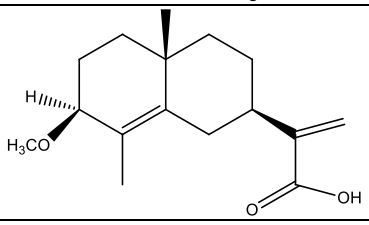
	teuhetenone A	**(Mohamed, 2007)**
	eudesmane-1β,4β,7α-triol	**(Hegazy et al., 2014)**
	Eudesmane-1b,4b,7a-triol-11,13-en	**(Hegazy et al., 2014)**
	Chiliadenol A	**(Hegazy et al., 2014)**
	Chiliadenol B	**(Hegazy et al., 2014)**
	Chiliadenol C	**(Hegazy et al., 2014)**
	Chiliadenol D	**(Hegazy et al., 2014)**

Table (5): Acids isolated from *J. montana* Family Asteraceae

Structure	Name	Reference
	5α-hydroxycostic acid	**(Ahmed and Jakupovic, 1990)** **(Hegazy et al., 2014)**
	5β-hydroxycostic acid	**(Ahmed and Jakupovic, 1990)**
	3α,5α-Dihydroxycostic acid	**(Ahmed and Jakupovic, 1990)**
	5α-Hydroxyisocostic acid	**(Ahmed and Jakupovic, 1990)**
	3β-Hydroxyisoiphion-11(13)-en-12-oic acid	**(Ahmed and Jakupovic, 1990)**
	3,5-dicaffeoyl-quinic acid	**(Soliman et al., 2009)**
	Caffeic acid	**(Soliman et al., 2009)**

	3α-acetyl-γ-costic acid	**(Hegazy et al., 2014)**
	5α-hydroxy-4α,15-dihydrocostic acid	**(Hegazy et al., 2014)**
	3-oxo-γ-costic acid	**(Hegazy et al., 2014)**
	3β-Methoxy isocostic acid	**(Hegazy et al., 2014)**

4. Conclusion

Jasonia montana (Asteraceae), also known as *Chiliadenus montanus*, is an important plant with many pharmacological applications. It contains terpenes, acids, and flavonoids, which are particularly abundant. Popularly known in the Sinai Peninsula as Haneida, the plant was traditionally used by natives to relieve stomachache and diarrhea. Pharmacological studies have shown that the plant extract possesses anti-inflammatory, anti-microbial, cytotoxic and anti-diabetic effects. Moreover, the plant extract showed promising anti-obesity potential by lowering fat accumulation and body weight. Recently, *J. montana* extract was reported to exhibit anti-cholinesterase activity, suggesting a possible application of the extract in treatment of Alzheimer's disease. This plant is therefore a promising source of biologically active natural products that deserves further phytochemical and pharmacological investigation.

5. Conflict of interest

The authors declare no conflict of interest.

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