Phytochemical and biological studies on *Launaea* Cass. genus (Asteraceae) from Algerian Sahara

Abdelkrim Cheriti¹,*, Mebarka Belboukhari¹, Nasser Belboukhari² and Houria Djeradi¹

¹Phytochemistry and Organic Synthesis Laboratory, ²Bioactive Molecules and Chiral Separation Laboratory, University of Bechar, Bechar, 08000, Algeria

**ABSTRACT**

Traditional remedies have been employed for the treatment and management of various ailments since the beginning of human civilization. *Launaea* Cass. is a small genus of the family Asteraceae (tribe Lactuceae, subtribe Sonchinae), consisting of 54 species, of which 9 are presented in the flora of Algeria and is mainly distributed in the South Mediterranean, Africa and SW Asia. Plants in the *Launaea* genus have been used ethnomedicinally as bitter stomachic, for treating diarrhea, gastrointestinal tracts, as anti-inflammatory, for skin diseases, treatment of infected wounds, hepatic pains, children fever, as soporific, lactagogue, diuretic and as insecticidal. The aim of this review is to present as much information as was established from the available scientific literature. The review covers the ethnomedical, biological activity related and phytochemical information on the species from genus *Launaea*, especially those growing in Algerian Sahara and used as medicinal plants.

**KEYWORDS:** Asteraceae, *Launaea* Cass., ethnopharmacological, biological activities, phytochemical, Sahara

**INTRODUCTION**

The World Health Organization (WHO) has recognized the potential utility of traditional remedies and strives to preserve the primary health care involving medicinal plants. Thus, there is ample archaeological evidence indicating that medicinal plants were regularly employed by people in prehistoric times. In several ancient cultures botanical products were ingested for biomedically curative and psychotherapeutic purposes [1]. Plants have formed the basis of Traditional Medicine (TM) systems that have been in existence for thousands of years and continue to provide mankind with new remedies, such as, the oldest known medicinal systems of the world: Ayurveda, Arabian medicine, Chinese and Kempo medicine. Although some of the therapeutic properties attributed to plants have proven to be erroneous, medicinal plant therapy is based on the empirical findings of hundreds and thousands of years [2]. One of the most efficient ways of finding new bioactive compounds is collecting data on the use of medicinal plants in traditional pharmacopeia. Nearly 50,000 species of higher plants have been used for medicinal purposes. They are also used in food, cleaning, personal care and perfumery. In systems of traditional healing, major pharmaceutical drugs have been either derived from or patterned after compounds from biological diversity [3]. Natural products have made enormous contributions to human health through compounds such as quinine, morphine, aspirin (a natural product analog), digitoxin and many others. Thus natural products are very important to conduct research on and they can be a source of new compounds [4]. A trend in phytomedicine is the use of new plant origin bioactive compounds with the potential for chemical modification, which will broaden phytomedical

*karimcheriti@yahoo.com*
importance. Molecular biology is also being used in this process and the pharmacological profiles of these compounds are screened using new research equipment and new technology [5-8]. Natural products and their derivatives represent more than 50% of all the drugs in clinical use in the world and in which higher plants contribute to no less than 25% [2].

A dozen potent drugs have been derived from plants including: derived diosgenin; reserpine and pilocarpine. Other natural products are metabolites from fungi, bacteria, algae, and marine organisms. So, the diversity of structures obtained and the different therapeutic activities shown by the natural products make the isolation, identification, synthesis and biosynthesis of new natural compounds a field of enormous interest. Only a small part of the 400,000 vegetable species known have so far been investigated for their phytochemical and pharmacological aspects, and each species could contain up to several thousands of different components [9].

The plant family Asteraceae (Compositae) comprises of a large number of species that have been and are still used as medicinal plants, particularly in folk medicine and used as a food.

Launaea Cass. is a small genus of the family Asteraceae (tribe Lactuceae, subtribe Sonchinae). The genus consists of 54 species, of which 9 are presented in the flora of Algeria and is mainly distributed in the South Mediterranean, Africa and SW Asia. They are perennial to annual herbs, small shrubs or sub shrubs. Many of its plants are used in folk medicine as bitter stomachic, for treating diarrhea, gastrointestinal tracts, as anti-inflammatory, for skin diseases, treatment of infected wounds, hepatic pains, children fever, as soporific, lactagogue, diuretic and as insecticidal. Additionally, crude extracts of some species have been reported to exhibit antibacterial, antiparasitic, antioxidant, cytotoxic, neuropharmacological and insecticidal activities. From a chemical point of view, only ten species of the genus Launaea Cass. have been subjected to previous phytochemical investigation, namely, Launaea acanthoclada, L. arborescens, L. aspleniifolia, L. capitata, L. cassiniana, L. mucronata, L. nudicaulis, L. pinnatifida, L. resedifolia and L. tenuiloba. Different secondary metabolites including terpenoids, steroids, triterpenoid saponin, sesquiterpene lactones, coumarins, flavonoids, flavone glycosides and phenolic compounds have been reported.

We attempt to present a review on the ethnopharmacological and phytochemical studies and biological activities of plants from the genus Launaea Cass., especially those growing in Algerian Sahara and used as medicinal plants.

Botanical taxonomy of the genus Launaea Cass.

Asteraceae family (Compositae), known as the aster, daisy or sunflower family, is one of the largest angiosperm families of dicotyledenous flowering plants. It comprises about 1400 genera and more than 25000 species of herbaceous plants, shrubs, and trees, spread throughout the world, and classified over three subfamilies and 17 tribes [10]. Asteraceae plants tend to grow in sunlit places, in temperate and subtropical regions and can share these following characters [11]:

Various members of the aster family are familiar species in natural habitats, while others are cultivated plants in gardens and some are grown as food (Lactuca sativa). Many members of Asteraceae are pollinated by insects, which explain their value in attracting beneficial insects and are major honey plants.

The flowers of this family are of two basic types: tubular actinomorphic corollas and those with strap shaped or radiate zygomorphic corollas, often with the same head. Either type may be bisexual or unisexual.

Leaves and stems very often contain secretory canals with resin or latex (particularly common among the Cichorioideae). The leaves can be alternate, opposite, or whorled. They may be simple, but are often deeply lobed or otherwise incised, and conduplicated or revoluted. The margins can be entire or dentate.

The fruit of Asteraceae is a specialized type of achene sometimes called cypsela. One seed per fruit is formed.

Due to their chemo-diversity, the sesquiterpene lactones are the most suitable class of naturals
products for chemo-systematic studies within the family [12, 13].

The tribe Lactuceae Cass. The tribe Lactuceae (Cichorieae, Asteraceae family) comprises 98 genera and more than 1550 species. The milky latex and the floral structure make the tribe easily distinguishable from all other Asteraceae. The flowering heads are composed of wholly ligulate florets that are usually 5-lobed [10].

According to classification system on flowering plants [14], the classification hierarchy of the genus Launaea can be tracked as follows:

Kingdom : Plantae
Division : Angiosperms
Class : Eudicots
Subclass : Asterids
Order : Asterales
Family : Asteraceae
Subfamily : Cichorioideae
Tribe : Lactuceae (Cichorieae)
Sub-tribe : Sonchinae
Genus : Launaea

The genus Launaea Cass. belongs to the tribe Lactuceae of the Asteraceae family and contains about 54 species, most of which are adapted to dry, saline and sandy habits [15]. Plants of this genus have several rows of stems, hairless leaves incised into lobes that are themselves lined with white teeth, membranous scales on the edges, yellow ligules, and elongated chain, prismatic or slightly flattened.

The genus Launaea is represented in the flora of Algeria by nine species including five endemics of North Africa: L. angustifolia, L. quercifolia, and L. cassiniana are the endemic plants of the North Africa, with limited distribution [15, 16], whereas L. acanthoclada and L. arborescens are two endemic plants of the north-west of Africa. The other four species L. nudicaulis and L. residifolia sprout in Algeria and Tunisia Mediterranean Sea, whereas L. glomerata and L. mucronata grow in the Saharan Atlas [16].

Three of this species are used in Algerian Sahara ethnopharmacopea as medicinal plants, L. nudicaulis, L. residifolia and L. arborescens, which is endemic to south west Algeria and south east Morocco [17].

Launaea arborescens (Batt.) Murb, (syn. Zollikoferia spinosa DC) is an almost leafless, xerophilous, perennial spiny shrub, 40-120 cm. high, with typical zig-zag shaped stems (Figure 1). The young stems are green, glabrous and erect. The older ones become tough spines. The leaves are narrow and dissected in small lobes, evergreen at the base but shed after flowering from the stems. The flowers are yellow, and abundant flowering occurs from March to June, but flowers and achenes are produced throughout the year. The roots are very deep, the leaves and stems have white latex which is similar in appearance to milk (thus the local name “Oum loubina”) [15-18].

Ethnopharmacology and bioactivity of the genus Launaea Cass.

It is well known that species from Asteraceae family are used as natural remedies such as: Anthemis arvensis L. (anti-inflammatory, emetic, sedative), Artemisia arborescens L. (digestive, stimulant, expectorant), Calendula arvensis (antispasmodic, burns, diuretic, disinfectant and vulnerary), Cichorium intybus L. (blood purification, arteriosclerosis, anti-arthritis, anti-spasmodic, digestive, hypotensive, aperitif and laxative) and Helichrysum microphyllum Willd. (expectorant).
Algeria with its large area and diversified climate has a varied flora, which is a source of rich and abundant medical matter and, in particular, Sahara part constitutes an important reservoir of many plants which have not been investigated until today. Among this flora, some Launaea plants have been used in the traditional medicine [17-19]. Species of the genus Launaea are widely applied in traditional folk medicine throughout their areas of distribution. Many of them are used in folk medicine as bitter stomachic, anti-tumour, insecticides and against skin diseases.

*Launaea residifolia* (Vernacular name: Lemkar) is a medicinal plant used in folkloric medicine mainly for the treatment of hepatic pains.

*Launaea nudicaulis* (Vernacular name: Reghama) is used in the traditional medicine to treat gastric burns, pain of stomach, constipation, to relieve fever in children, in the treatment of itches of skin and eczema.

*Launaea arborescens* (Batt) (Vernacular name: Oum Lbina) commonly used in popular medicine as an antidiarrhoic and antispasmodic, to relieve fever, and as a vermifuge in children. The latex is applied locally to cure sore throats and in the treatment of furuncles. The powdered root mixed with *Artemisia herba-alba* is taken for diabetes. The plant is appreciated by livestock, mainly by camel [17-21].

Many phytochemicals are potent effectors of biologic processes and have the capacity to influence disease risk via several complementary and overlapping mechanisms [22].

More than 4000 sesquiterpenoids structures with around 30 different skeletal types have so far been reported from several tribes of Asteraceae family including the Cichorieae tribe. These natural compounds are responsible for allergic contact dermatitis and exhibit a wide range of bioactivities which include plant growth regulation and antimicrobial activity. Also they are used as schistosomicidal and insect feeding-deterrent agents. In addition, they provoke the toxicity for certain cancer cell lines by inhibition of nuclear DNA synthesis, especially the enzymatic activity in tumour cells of DNA polymerase and thymidylate synthetase [12, 23, 24].

On the other hand, triterpenoids and flavonoids chemio-characteristic of Asteraceae family, including the *Launaea* genus, have been reported to have anti-inflammatory activities, anti-hyperlipidemia, hepatoprotection, antioxidant, cytoprotective, giving protection against cardiovascular disease, and certain forms of cancer [25, 26]. Antibacterial, antifungal and allelopathic potential activities have been proven for many species of *Launaea*. In an antibacterial assay against *Bacillus subtilis* the extracts of *L. nudicaulis* and *L. residifolia* showed 18.5 and 20.5 mm zones of inhibition, respectively, as determined by the disc diffusion method. The antifungal activity against *Aspergillus* spp. was determined by measuring the linear growth in slants on 4th day of incubation. Methanol extracts of *L. nudicaulis* and *L. residifolia* were active at 0.209 mg/ml levels exhibiting 45 ± 6 mm and 37 ± 6 mm linear growth which decreased to 22 ± 5 mm and 28 ± 4 mm, respectively, at 0.838 mg/ml concentration [27].

As a part of our works on medicinal plants of Algerian Sahara, recently we have reported the antibacterial activity of extracts from *Launaea Arborescens* and *L. nudicaulis* which are widely distributed in the south west of Algeria. The methanol extract of the aerial part of *L. nudicaulis* showed high activities against *Candida albicans*, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. The highest inhibition observed in *S. aureus*, a human pathogen, explains the use of this plant against a number of infections for generations. Very interesting antifungal activity against *Candida albicans*, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* and *Klebsiella enterococcus* have been reported for the methanol extract of *Launaea Arborescens* [18, 28].

Hydroalcoholic extract from aerial parts of *Launaea arborescens* was evaluated for acute and subacute toxicity in Swiss mice after ingestions of the extract. The LD50 of the extract is higher than 2.75 g/kg and the subacute treatment did not shows any change in corporal weight and haematological parameters, which suggest that the plant seems to be destituted of toxic effects in mice [29].
Phytochemical and biological studies on the Saharan Launaea damage in rats, through antioxidant and free radical scavenging effects of flavonoids and saponins present in this plant, which might be responsible for the elimination of various kidneys insults [34].

Phytochemistry of the genus Launaea Cass.

a. Secondary metabolites from the 2ed group of Lactuceae tribe

The biodiversity of metabolite products isolated from Asteraceae makes this family an important phytochemical and commercial source. Several phytochemical studies of some genera of Lactuceae (Cichorieae) revealed to be rich in secondary metabolites, specifically sesquiterpene lactones exhibiting the eudesmane, germacrane and guaiane carbon framework. A total of 360 sesquiterpene lactones and related compounds have been isolated from 139 taxa belonging to 31 different genera of the Lactuceae. Studies realized for these genera revealed that most sesquiterpenoids within the Cichorieae belong to the guaianolide class, particularly: 92 representatives of costus lactone type, 75 compounds of lactucin type, and 29 representatives of hieracin type [35, 36].

Some phenolic compounds, such as flavonoids and coumarins were also isolated [37-42]. In addition, triterpenes have also been detected [43, 44]. Recently, Sareedenchai and Zidorn indicated that a total of 135 flavonoids have been isolated from 299 species of the Cichorieae (Lactuceae) tribe [45]. Based on the similarity of their sesquiterpene profiles, Zidorn grouped the 31 genera of the Lactuceae into seven main clusters and classified Launaea with the 2ed group characterized by the prevalence of guaianolides, formed by 11 genera, sub-divided into four sub-groups: a) Scorzonerooides; b) Notoseris, Lactua, and Cichorium; c) Launaea, Crepidiastrum, Reichardia, and Cicerbita d) Taraxacum, Helminthotheca, and Hypochaeris [35].

Phytochemical investigation of 2ed group of the Cichorieae tribe resulted in the identification and isolation of different metabolites including:

Aerial part and roots of Launaea arborescens were used to evaluate their extracts for antifungal activity against Fusarium oxysporum f. sp. albedinis Foa. The antifungal test was conducted using disc diffusion technique and relative virulence (RV) test (on potato tuber tissue). For both tests, four extract quantities were used (200, 400, 800 and 1,600 µg). The relative virulence was presented as necrotic tissue weight (mg) of potato tuber tissue. Among all solvents, methanol had the best extraction yield (mean: 6.35%, minimum: 2.27%, maximum: 9.80%) [30].

Coumarins isolated from L. resedifolia showed high antibacterial activity against some Gram-positive bacteria such as Bacillus cereus and Staphylococcus aureus in minimum inhibitory concentrations of 200 and 400 µg/mL. However, they showed no effect on tested Gram-negative bacteria such as Serratia Sp., Pseudomonas Sp. and Escherichia coli [31]. The ethanol extract of L. resedifolia showed neuropharmacological properties in animal models. The extract exhibited an inhibitory effect on the locomotor activity of mice in the open field test, an anti-nociceptive effect by increasing the hot plate reaction time in the hot plate test, and an anti-inflammatory activity in the carrageen-induced paw oedema. This finding has demonstrated that the extract of L. resedifolia possesses sedative, analgesic and anti-inflammatory properties, and some effect on body weight. The anti-inflammatory effect of the plant was found to be as active as the prototype non-steroidal anti-inflammatory drug (NSAID) aspirin [32].

Allelopathic potential effect of aqueous extract of Launaea procumbens was observed in the soil application by a significant retarding effect on wheat growth while shoot spray or root dip treatment had no such effect and methanol and chloroform fraction from this specie exhibited efficient antioxidant scavenging activities, attributed to the phenolic and polyphenolic compounds such as myricetin, catechin, vitexin, orientin, hyperoside and rutin, revealed in HPLC [33].

Other research has shown that extracts from Launaea procumbens provide effective protection for kidneys against the CCL4-induced oxidative damage in rats, through antioxidant and free radical scavenging effects of flavonoids and saponins present in this plant, which might be responsible for the elimination of various kidneys insults [34].
Sesquiterpenoids

Costus lactone type guaianolides such as dehydrocostuslactone 1, ixerisoside B 2, C 3 and D 4, scorzoside 5, zaluzanin C 6, glucozaluzanin C 7, 11 β,13-dihydrozaluzanin C 8, 8β-hydroxy-4 β,15-dihydrozaluzanin C 9 and prenantheside C 10 [38, 39]. Lactucin type guaianolides, Lactucin 11, 8-O-acetate Lactucin 12, Crepidiaside A 13, 11β, 13dihydrolactucin 14, 8-O-acetate, 11β, 13 dihydrolactucin 15 and 8-Deoxylactucin 16. The eudesmane derivatives santamarin 17, ixerisoside E 18, luctuside D 19, sonchuside C 20 and artesin 21 [39, 46], costinolide type germacranolides such as picriside B 22, C 23, sonchuside A 24, B 25 and cichoerioside C 26, [41, 47, 48], and melampolides type, lactulide A 27, lactuside A 28 and B 29 [38, 39, 49, 50] and in some case sesquiterpenoid sulphate, 8-deoxy-15-(3’-hydroxy-2’-methylpropanoyl) lactucin-3’-sulfate 30 [51].
Terpenoids

The majority of these triterpenes are pentacyclic and belong to lupane, oleanane, gammacerane and ursane groups, with some tetracyclic compounds such as β-amyrin 31, β-amyrin acetate 32, taraxerol 33, taraxeryl acetate 34, taraxasterol 35, taraxasterone 36, taraxasteryl acetate 37, ψ-taraxasteryl derivatives 38, 39, α-amyrin derivatives 40, 41, lupeol 42, lupenone 43, and lupenyl acetate 44 [39, 44].
Phenolic compounds

Several phenolic compounds were identified in the aerial parts and roots of some species of the 2nd group of Lactuceae tribe such as small phenolic compounds: $p$-hydroxybenzoic acids, 4-caffeoylquinic, chlorogenic, trans-caffeic, methyl and ethyl $p$-hydroxyphenylacetate, and $p$-coumaric, affeic acids as well as their glycoside derivatives, dihydroconiferin, syringin and dihydroxyringin [38, 39]. In addition this group of Lactuceae tribe contains various flavonoids and flavonoid glycosides such as flavanone type: 7-hydroxyflavanone 45, 7-methoxyflavanone 46, naringenin 47, naringenin 7-methyl ether 48, miscanthoside 49, hesperitin 50, quercetin derivatives:isorhamnetin 51, quercetin 7-O-glucoside 52, quercetin 7-O-gentiobioside 53, hyperin 54, quercetin 3-O-gluconoride 55, quercetin 3-O-rhamnoside 56, quercetin 3-O-rutinoside 57, isorhamnetin 3-O-glucoside 58 and isorhamnetin 3-O-glucuronide 59. Various apigenin, luteolin and isooetin groups were founds in the tribe such as: Apigenin 4'-methyl ether 60, apigenin 4'-O-glucoside 61, apigenin 7-O-glucoside 62, scutellarin A 63, apigenin 7-O-gentiobioside 64, linarin 65, luteolin 66, luteolin 4'-O-glucoside 67, luteolin 7-O-galactoside 68, luteolin 7-O-glucoside 69, luteolin 7-O-rhamnoside 70, luteolin 7-O-gentiobioside 71, luteolin 7-O-rutinoside 72, luteolin 7,4'-O-diglucoside 73, luteolin 7-O-gentiobioside-4'-O-glucoside 74, luteolin 7,3'-O-diglucoside 75 and isooetin glycosides, 7-O-glucoside 76, 7-O-glucoside-2'-O-arabinoside 77, 7-O-glucoside-2'-O-xylloside 78, 7-O-glucoside-2'-O-(4-O-acetyl)-xylloside 79. It is well noted that flavonoids are considered as chemosystematic markers in the tribe Cichorieae of the Asteraceae family. Furthermore, usually coumarin compounds are found in the 2nd group of the Cichorieae tribe such as, umbelliferone 80, scopoletin 81, esculetin 82 [41, 45, 52, 53].
b. Secondary metabolites isolated from the Saharan Launaea genus

Different secondary metabolites have been identified from the genus *Launaea*. In addition, few sesquiterpene lactones have been reported from various species of this genus and the occurrence of flavones glycosides is remarkable. The first works in phytochemistry on species of the genus *Launaea* was started in 1969 by Prabhu and Venkateswarlu [54], when they isolated from leaves and roots of *launaea pinnatifida* two compounds Taraxasterol 35 and Taraxerly acetate 37. Five year after, in 1974, Bahadur and Sharma [55] reported the presence of palmitic, stearic, oleic and linoleic acids from the roots of *Launaea nudicaulis*. Twenty year ago, in 1989, Gupta et al. [56] investigated *Launaea asplenifolia* and isolated nine compounds namely, taraxasterol, taraxasterone, taraxasteryl acetate and the common compounds stigmasterol, ethypalmitate, ethylstearate, hexacosanol, octacosanol and octacosanoic acid.

*Launaea nudicaulis*

The light petroleum extract of *Launaea nudicaulis* leads to the characterization of some $\Delta^7$ and $\Delta^5$ phytosterols: $\beta$-sitosterol, brassicasterol, campesterol, stigmasterol, fucosterol, 24$\beta$-$\Delta^7$-ergosteren-3$\beta$-ol and stigmasta-7,24(28)-dien-3-ol [57]. Detailed chemical investigation of *Launaea nudicaulis* yielded some
triterpenes such as taraxasterol 35, ψ-taraxasterol 38, β-amyrin 34, 3β-taraxerol 33, α-amyrin 39, and lupeol 41 [58].

Two new ursene type triterpenes, nudicauline A 84, and nudicauline B 85 have been isolated from the aerial parts of this species, along with olean-11,13(18)-diene 86, 3β-hydroxy-13(28)-epoxy-urs-11-ene 87 and 3-keto-13(28)-epoxy-urs-11-ene 88 [59]. Additionally, flavone glycosides were reported from the 70% EtOH extract of fresh sample of *Launaea nudicaulis* and identified as apigenin-7-O-glucoside 62, luteolin-7-O-glucoside 69, luteolin-7-O-rutinoside 72, apigenin-7-O-gentiobioside 64, luteolin-7-O-gentiobioside 71, and three glycosides luteolin-7,3′-diglucoside 75, luteolin-7′,4′-diglucoside 73 and luteolin-7-O-gentiobioside-4′-O-glucoside 74 [60], which are common metabolites within the 2nd group of Lactuceae tribe as indicated above. Moreover, two common coumarins, esculentin 82, and cichorin 83, were also described [61, 62].

Recently, ethyl acetate soluble fraction of methanolic extract of *Launaea nudicaulis* was subjected to chromatographic purification to get four new compounds including a quinic acid derivative Cholistaquinate 89, a pentahydroxy acetylene analog: trideca-12-ene-4,6-diyne-2, 8, 9, 10, 11-pentaol 90, a flavone glycoside Cholistaflaside 91 and a sesquiterpenic lactone nudicholoid 92. Cholistaquinate 89 exhibited significant activity in DPPH free radical scavenging assay with an IC50 value of 60.7 mM, whereas, nudicholoid 92 exhibited a moderate inhibitory activity against the enzyme butyrylcholinesterase with an IC50 value of 88.3 mM [63].
Launaea residifolia (L.)

Chemical study of the plant led to the isolation of triterpenes α-amyrin 40, lupeol 42, lupeol acetate 44 and their epimer moretenol together with the Δ7-stigmasterol. From the aerial parts of Launaea residifolia grown in Algeria, four coumarin compounds, cichorin 83, esculetin 82, scopoletin 81 and its isomere isoscopoletin, were isolated [64].

On the other hand, the chemical composition of essential oils from this species (0.9%) has been identified using the ordinary GC-MS technique. Nineteen compounds of essential oil of L. residifolia L. were identified representing 86.68% of the total oil. The compounds were identified by spectral comparison to be mainly esters, alcohols, ketones, and terpenes. The principal constituents are diocyl phthalate (39.84%), Decanoic acid, decyl ester (12.09%), 11-Octadecenal (11.24%), and Eucalyptol (07.31%) [65].

Launaea arborescens

Chemical data on this species are scarce in literature and few published papers describe phenolic components of the plant. In their studies on Launaea genus from Spain including L. arborescens, Giner et al. [66] isolated common phenolic compounds namely, luteolin 66, luteolin-7-O-glucoside 69, luteolin-7-O-rhamnoside 70, esculetin 82 and its glycoside cichorin 83, and simple compounds, ethyl-caffeoate and ferulic acid. The authors remarked that cichorin 83 was the most abundant compound in all studied species.

We are the first initiators on the phytochemical study of the Algerian sample of L. arborescens collected from the Sahara [67]. From the methanol extract of the aerial parts of this species, we have described the isolation of four compounds, two flavonoids, 3-acetyl-5-methoxy-7,3',4'-trihydroxyflavan-3-ol-8-O-glycoside 93, 5,7,4'-tri-hydroxy-3'-methoxyflavone (chrysoeriol) 94, one lignan, 4,4'-dihydroxy-3,3'-dimethoxy-7,9':7,9'-diepoxylignan 95, and a diterpene, methyl-15,16-epoxy-12-oxo-8(17), 13(16), 14-ent-labdatrien-19-oate 96.

A diversity structure of triterpenes oleanane (3β-hydroxy-11α-ethoxy-olean-12-ene) and sesquiterpenes type guaianolides (9α-hydroxy-11β,13-dihydro-3-epi-zaluzanin C, 9α-hydroxy-4α,15-dihydro-zaluzanin C) and costinolide (3β,14-dihydroxycostunolide-3-O-β-Gluc.,3β, 14-dihydroxycostunolide-3-O-β-Gluc.-14-O-p-hydroxyphenylacetate) together with the lactucin-sulfate 30 were chemically characterised from both the aerial parts and roots of L. arborescens [68]. The hydrodistillation of the aerial part of Launaea arborescens gave a green yellowish oil in an yield of 0.07% from dried material. Seventeen compounds were identified, representing 84.96% of the total oil. The essential oil of L. arborescens was a mixture of different substances, including oxygen-containing monoterpenes, alcohols, aldehydes, and esters. Esters were the dominant group in the oil (58.24%) with diocyl phthalate (38.6%) and
decanoic acid, decyl ester (12.07%) as the main constituents. Alkenes and ketones were the minor constituents of the oil. The terpenoid portion consisted of two oxygenated monoterpenes accounting for 7.24% of the oil. We also found aldehydes in considerable amounts (16.09%) [69].

In a recent study, we were interested in the chiral separation and determination of the diastereomerisation barriers of two flavanone glycosides hesperidin and naringin isolated from the aerial part of *Launaeae arborescens*. The chiral separation HPLC screening of diastereomers of hesperidin and naringin by HPLC methods was accomplished in the normal-phase mode using 11 chiral stationary phases and various n-hexane/alcohol mobile phases. The rate constants and activation energy of diastereomerisation (DG#) of flavanones, naringin and hesperidin were determined, respectively, on Chiralpak IC and Chiralpak IA. Separation of (2R/2S)-flavanone glycosides using the Chiralcel OD-H as CSP indicate that Epimer selectivity values (R) ranged from 1.81 for naringin to 1.16 for hesperidin, Chiralpak IA ranged in different conditions from 1.25 to 1.13 for naringin and hesperidin and Chiralpak AD-H presented a good chiral separation of naringin and hesperidin with a selectivity factor towards 1.28. The ChiralpakAD phase presented only the epimer separation of hesperidin with a selectivity factor towards 1.21. Analogously, the resolution factor (Rs) ranged from 2.27 for naringin to 0.97 for hesperidin. The values of R and Rs obtained for naringin were much better than those obtained using another polysaccharide-derived CSP (Chiralpak AD) and a very similar mobile phase (1.51 and 0.7, respectively) [70].

**CONCLUSION**

The genus *Launaea* has great importance due to its ethnobotanics, phytochemistry and biological activity, and it is a promising source of various secondary metabolites including sequiterpenoids, terpenoids and flavonoids. Some of these isolates compounds have been found to exhibit various biological activities. We have attempted to show the high biodiversity of metabolite products isolated from of the *Launaea* genus as well as their biological significance. This review presents information on the importance of the ethnobotany, phytochemistry and biological activities of the members of this genus, especially the species growing in Algerian Sahara. The given information can be the base for undertaking future research. It is necessary to carry out more studies and to propagate utilization of medicinal plants as a way to diminish the costs of public health programs.

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