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A REVIEW OF CHEMICAL CONSTITUENTS AND PHARMACOLOGICAL EFFECTS OF TARAXACUM OFFICINALE

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Abstract: Taraxacum officinale (dandelion) is a widely distributed medicinal plant that has long been used in traditional medicine for the treatment of various diseases. This review summarizes current knowledge on the **chemical constituents** and **pharmacological activities** of T. officinale. Phytochemical studies reveal that the plant is rich in **phenolic compounds, flavonoids, sesquiterpene lactones, triterpenes, sterols, polysaccharides, and inulin**, with different plant parts (roots, leaves, flowers) exhibiting distinct chemical profiles. Pharmacological investigations demonstrate that T. officinale possesses a wide range of biological activities, including **antioxidant, anti-inflammatory, hepatoprotective, antidiabetic, antimicrobial, anticancer, and diuretic effects**. These activities are mainly attributed to its polyphenols, flavonoids, and triterpenoid compounds. In addition, recent studies suggest that in vitro cultures, particularly root and callus cultures, can serve as alternative sources for the production of bioactive compounds. Overall, T. officinale represents a promising medicinal plant with significant therapeutic potential, supporting its further investigation and application in pharmaceutical and biotechnological fields.

1. Introduction.

Dandelion (Taraxacum genus), named “Pugongying” in China, is a perennial plant belonging to the Asteraceae family. It has a complex classification, comprising over three hundred species. [1] In Asia, the Taraxacum genus is widely cultivated and also found wild in most parts of China, North Korea, Mongolia, and Russia. [2] Dandelion was distributed widely in many countries. There are more than 2000 kinds of varieties of dandelion; about 70 kinds of varieties are distributed in various provinces in China. [3]

The plant is about 40 cm tall and is characterized by yellow to orange flowers and jagged leaves (Fig. 1). The name "Taraxacum" comes from the Greek words "taraxos" (disorder) and "akos" (remedy). The word "officinale" denotes a plant having medicinal properties. It is noteworthy that this herb has been used as a medicinal plant from ancient times. The root and the young tops are mainly used for medicinal purposes. [4] However, roots 60–100cm in length are also found. The roots are capable of producing new plants even when the plant is cut at or below the soil surface. The large, light to dark green leaves (5–40cm long) are clustered in a rosette at the base of the plant and are deeply serrated. The flowering stalks are upstanding, 5–40cm long and carrying a solitary, terminal inflorescence. On average, each plant is developing 5–10 flowers. The florescence ranges from 7 to 15mm in diameter and is composed of 140–400 yellow, ligulate florets [5]

The entire dandelion plant, including flowers, leaves, stems and roots, is edible and composed of biological active substances. An array of secondary metabolites were found and isolated such as sesquiterpenes and triterpenes, phenolic compounds, and phytosterols. [6] Several studies show that dandelion is also a rich source of vitamins (A, C, D, E, and B), choline, inositol, lecithin, minerals, and oligoelements (calcium, sodium, magnesium, iron, silicon, copper, phosphorus, zinc, manganese). [7,8]

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Figure 1. The morphology of Taraxacum officinale.

Taraxacum can be used as diuretics, antioxidants, bile agents, anti-inflammatory, analgesic, and anti-cancer agents. Corresponding studies in the 20th century revealed that Taraxacum can be used medicinally, while its inflorescences, leaves, and roots can be processed into different foods. For example, the leaves of cultivated or wild Taraxacum species can be eaten in salads, while roots are baked and used as a coffee. [9]

2. Materials and Methods

The literature survey was conducted using multiple scientific databases, including Web of Science, ScienceDirect, PubMed, Wiley Online Library, Google Scholar, Europe PMC, Baidu Scholar, the American Chemical Society (ACS), and SpringerLink, in addition to authoritative books such as the Chinese Pharmacopoeia and Flora of China. Relevant keywords were applied to retrieve and analyze the available publications.

3. Chemical Compounds

Taraxacum officinale has many medicinal properties, due to phytochemicals found in flower, leaf and stem and roots of the plant. The main phytochemicals are: carotenoids; flavonoids (e.g., quercetin, chrysoeriol, lute olin-7-glucoside); phenolic acids (e.g., caffeic acid, chlo rogenic acid, chicoric acid); polysaccharides (e.g., inulin); sesquiterpene lactones (e.g., taraxinic acid, taraxacoside, 11β,13-dihydrolactucin, ixerin D, taraxacolide-O-β glucopyranoside); sterols (e.g., taraxasterol, β-sitosterol, stigmasterol); triterpenes. [10,11]

3.1. Constituents of dandelion roots.

Roots of Dandelion are rich in number of sesquiterpenes which contains eudesmaanolides tetrahydoridentin B, taraxacolide-0-β-glucopyranoside, 13-dihydrolactucin, Ixerin D, Germacranolide acid, taraxinic acid, β-glucopyranoside, and ainslioside. These constituents play a significant role in its bitterness and impart anti-inflammatory properties to this plant. [12] Upon analyzing the volatile components of T. officinale using GC–MS, the essential oil components obtained were butyl acetate, 2-methyl-propanol, n-butanol, 4-phenyl-1-butanol, 4-hydroxyl 4-methyl-2-pentanone, acetic acid, 4-terpineol, fluoro-terpineol, and alpha-terpineol. [13] Schütz et al. isolated fructooligosaccharides and fructopolysaccharides from the root of T. officinale WEB. ex Wigg [14] Some studies utilising techniques like HPLC revealed that roots of T. officinale contain high quantities of Taraxasterol [2.96 µg/ml] and Taraxerol [1.69 µg/ml] [15]

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Studies suggested that taraxasterol possesses anticancer and anti-microbial activities due to its effectiveness against cancer cells and Staphylococcus aureus [16]

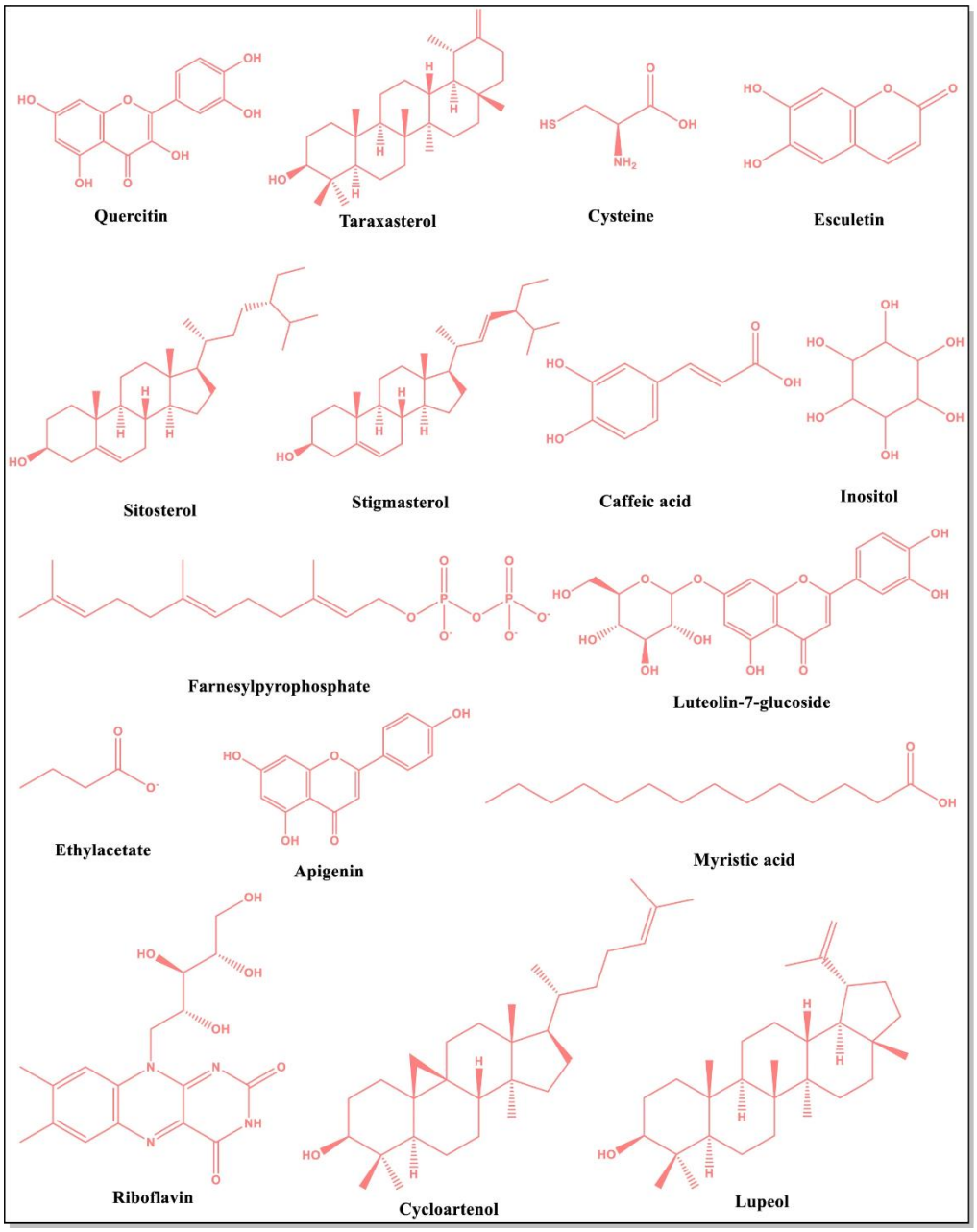

Figure 2. Chemical structure of some chemical constituents present in T. officinale

3.2. Constituents of aerial parts

As in roots, the bitter taste of dandelion leaves has been ascribed to the two sesquiterpenes taraxinic acid-d-gluco pyranoside and 11,13-dihydrotaraxinic-acid-d-glucopyra noside as well as p-hydroxyphenylacetic acid and-sitosterol. [17] The only known sesquiterpene lactone components in this plant are two germacranolides, namely, taraxinic acid and the-glucopyranosyl ester and its 11, 13-dihydroderivative and two eudes manolides (4a (15),11 (13)-tetrahydroridentin B, and taraxacolide-1-O--glucopyranoside), which were isolated from T. officinale. [18]

4. Pharmacological activities

4.1. Antiviral activity

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A study by Han et al. (2011) showed that aqueous Tarax acum officinale extract has antiviral activity in vitro, inhibiting human immunodeficiency virus type 1 (HIV 1) reverse transcription and replication. [19] Taraxasterol helps to treat hepatitis B virus which is studied by Yang et al., and some other studies shows that it has been found that Dandelion shows its activity against dengue virus serotype 2 (DENV2) [20,21]

4.2. Antioxidant activity

Two studies found that polysaccharides from this plant have antioxidant activity in vitro [22,23] Flavonoids and coumaric acid derivatives were extracted from dandelion flowers. In the study of anti-oxidant properties, the extracts had scavenged effects on superoxide and hydroxyl radical-induced damage; meanwhile, the inhibition of hydroxyl radicals was nonspecific. The reduction in the phenolic content of the extract reduced the DPPH capacity and showed a synergistic effect with-tocopherol.[24]

4.3. Antibacterial activity

The increased incidence of bacterial resistance to many antibacterial drugs is a great concern. Medicinal plants have proven as an alternative source to antibacterial agents. Several studies have shown the antibacterial activity of dandelion especially against Staphylococcus aureus and Escherichia coli. [25,26,27]

4.4. Antidiabetic activity

This plant has hypoglycemic properties in an animal model and this effect might be exerted by improving insulin secretion from the β-cells of the pancreatic islets [28]

4.5. Antifungal activity

A recent study by Liang et al. (2020) found that Taraxacum officinale can inhibit Candida albicans by disrupting the cell wall. [29]

4.6. Anti-allergic activity

Desacetylmatricarin which is a guaianolide sesquiterpene isolated from dandelion showed its anti-allergic activity by measuring the release of hexosaminidase from rat basophilic leukemia (RBL-2H3) cells which occurs concomitantly with the release of histamine when mast cells are immunologically activated. [30]

4.7. Hepatoprotective effects

Taraxacum officinale leaves extract is able to prevent and treat non-alcoholic fatty liver disease. [31] One previous study showed that this plant leaf extract has hepatoprotective activity against sodium dichromate-induced liver injury in vivo. [32]

5. Conclusion

This review indicates that twelve medicinal activities of Taraxacum officinale are frequently documented in scientific studies. These include antiviral, antifungal, antibacterial, antioxidant, antidiabetic, antiallergic and effects. Among these, hepatoprotective, antioxidant are the most extensively reported. Taraxacum officinale is therefore considered a promising natural source for the prevention and management of various health disorders. Nevertheless, additional research is required to validate these reported activities and to support the therapeutic use of this plant as a medicinal agent.

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