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Evaluation of the Phytochemical Contents and Biological Activities of 'Dandelion' (*Taraxacum officinale* F.H.Wigg.): A Review

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Abstract

Taraxacum officinale F.H.Wigg. commonly known as the dandelion, is a plant that is widely distributed across the globe and can easily thrive in gardens, lawns, and along roadways. This paper aims to compile studies on this readily available plant's pharmacological properties and phytochemical composition. Dandelion is recognized worldwide for its gastrointestinal benefits, supporting digestion and liver functions, and it is known to possess numerous pharmacological activities. These activities are attributed to its rich phytochemical profile. The primary effects of plants with varied components are typically linked to compounds such as taraxol, taraxerol, and sesquiterpene lactones.

Furthermore, dandelion roots are rich in inulin, making the plant versatile for various applications in daily life. The scientific literature shows no reports of dandelion toxicity or serious adverse effects in humans. The potential value of dandelion increases due to its ease of cultivation, diverse pharmacological activities stemming from its rich phytochemical content, and low toxicity profile.

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1. Introduction

Medicinal plants have been used since the dawn of humanity to prevent and treat diseases. In the past, they were commonly utilized for basic needs such as nutrition and health. However, they are often chosen under the mistaken belief that "natural is harmless." In reality, plants contain many primary and secondary metabolites, which can have unintended effects. These effects and interactions between plant metabolites and drugs or nutrients may lead to adverse outcomes. To safeguard public health, it is essential to have reliable sources of information about plants and individuals who are well-informed. Therefore, it is crucial to access the right plant for the intended benefit and use it responsibly. This study aims to provide a comprehensive summary of the dandelion, including general information, its chemical structure, pharmacological effects, toxicity, and essential details for its proper use.

2. General Information

Dandelion (*Taraxacum officinale* F.H. Wigg), a member of the Asteraceae family, is widespread in every part of the world. Still, it grows most commonly in Europe, North Africa, and West Asia. The perennial herbaceous plant does not rise very high from the ground. Dandelion is included in many Monographs and Pharmacopoeias due to its medicinal effects (Kayıran et al., 2020). The European Scientific Cooperative on Phytotherapy (ESCOP) stated that dandelion roots can be used to treat dyspepsia and restore hepatic and biliary functions. According to the German Commission E, the dandelion roots can also be used for biliary abnormalities, appetite loss, dyspepsia, and stimulation of diuresis (Cheema & Singh, 2021).

2.1. Botanical information

It has long and toothed rosette leaves, single yellow flowers rising from the middle, and a thick taproot. Its fruit consists of numerous seeds with parachute-like feather-like tips. The seeds of the spherical fruits are dispersed by the wind and spread far away. When the leaves and stem of the plant are cut, the bitter milk-like ‘latex’ is released (Başer, 2016).

3. Traditioanal Usage of *Taraxacum officinale*

Dandelion, an edible medicinal plant, and vegetable, has long been used in traditional medicine and folk remedies to treat various diseases in many countries (Fan et al., 2023). In traditional use, findings have been recorded that dandelion was used in the 10^{th} and 11^{th} centuries to treat disorders such as indigestion, heartburn, hepatitis, anorexia, gout, and diarrhea. In traditional Chinese medicine, dandelion is recorded to be used as an immune booster against hepatitis, upper respiratory tract infections, bronchitis, and pneumonia and as a topical compress to treat mastitis. In addition, dandelion roots and leaves are used to treat stomach problems, appendicitis, anemia, jaundice, high fever, eye problems, gastrointestinal problems, eczema, uterine and breast cancer, and to improve the function of the digestive system. Native Americans use dandelion as a diuretic in the treatment of kidney diseases and stomach disorders. In Indian and Russian folk medicine, dandelion is known as a liver tonic. In Iran, it is used for liver and kidney diseases (Jalili et al., 2020). In traditional Indian medicine, it is used to

treat chronic ulcers, tuberculosis, bloating, colic, kidney disorders, gout, jaundice, and gallstone disorders. In Europe, it is used to treat high fever, urinary tract infections, eye problems, diabetes, and diarrhea. It has also been used in traditional medicine to treat eczema and various skin diseases. It is known that dandelion has been an essential component of traditional medicine for at least a thousand years (Kayıran et al., 2020). The plant is used as a mild laxative, diuretic, bile stimulating, and antidiabetic drug in Türkiye (Keçeci, 2011).

4. Phytochemical Contents of *Taraxacum officinale*

Dandelion has a highly diverse phytochemical structure, encompassing both primary and secondary metabolites. One of the most important secondary metabolic groups in the plant is sesquiterpenoids, which impart the plant's characteristic bitter taste. The plant is rich in sesquiterpenoids and lactones, particularly germacrene, eudesmane, and guaiane-type sesquiterpene lactones. Its flowers, leaves, and roots contain significant amounts of phenolic acids, including chlorogenic acid, hydroxycinnamic acid, caffeoylquinic acid, cichoric acid and its isomer, caffeic acid, *p*-coumaric acid, ferulic acid, and quercetin. Dandelion also contains flavonoids such as quercetin, rutin, luteolin, and triterpenoids like taraxasterol and pseudotaraxasterol. It is a rich source of phytosterols, including *β*-sitosterol, stigmasterol, and campesterol, and has been reported to contain various pigments and volatile oils, such as chlorophyll and chrysophanol.

The roots of the dandelion are high in carbohydrates, including fructose, glucose, and sucrose, and contain inulin in amounts ranging from 2% to 40%. Its roots are consumed as bitter dandelion coffee in many countries. The leaves are a rich source of potassium, containing up to 5%, making them a common ingredient in salads and dishes. Dandelion is also an excellent source of vitamins (A, C, E, K, and B), minerals (calcium, sodium, magnesium, iron, copper, silicon, zinc, and manganese), fiber, and protein (Fan et al., 2023; Kayıran et al., 2020; Olas et al., 2022; Yan et al., 2024).

5. Safety of the Taraxacum officinale

Dandelion is highly regarded for its medicinal properties and is considered entirely non-toxic. Additionally, this plant is frequently consumed as food and is classified as safe for general use. The US Food and Drug Administration has listed dandelion as a safe product, even for individuals with rare allergies. According to the PDR monograph, the plant poses no health hazard when used appropriately (Gruenwald et al., 2000; Olas, 2022).

Studies on its biological effects have demonstrated a range of beneficial activities, including anti-inflammatory, antibacterial, antioxidant, hypolipidemic, antihyperglycemic, anticancer, diuretic, choleretic, antiplatelet, prebiotic, hepatoprotective, and gastroprotective effects. In vitro, animal, and clinical studies supporting these activities are reviewed here. The potential value of the dandelion plant is growing, as it can be easily cultivated, offers numerous benefits due to its rich phytochemical content, is not known to be toxic, and is classified as "GRAS" (generally recognized as safe) in the USA (Başer, 2016).

6. Biological Activity Studies

Results from many studies have shown that dandelion has numerous biological potentials, such as anti-inflammatory, antibacterial, antioxidant, hypolipidemic, antihyperglycemic, anticancer, diuretic, kidney-protective, choleretic, antiplatelet, hepatoprotective and gastroprotective, and also exerts a positive effect on gastric motility and *Bifidobacteria*.

6.1. Anti-inflammatory Activity

Kim et al. (2000) investigated changes in tumor necrosis factor-alpha (TNF-α) levels in astrocytes stimulated by substance P and lipopolysaccharide (LPS) in rats. When *Taraxacum officinale* (TO) (100 and 1000 μg/mL) was administered to astrocytes stimulated with LPS and substance P, TNF-α production was significantly reduced, and interleukin-1 (IL-1) production was also significantly decreased. After the study, it was reported that TO could prevent TNF-α production by inhibiting IL-1 production and demonstrated anti-inflammatory activity.

6.2. Anti-Bacterial Activity

In a study by Narkey et al. (2022), the antibacterial activity of extracts obtained through 70% ethanolic and methanolic extractions of fresh *Taraxacum officinale* leaves collected from Ghana was investigated. The antimicrobial activity of the *T. officinale* leaf extract against *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* was evaluated using the agar well diffusion method. The results showed that *Staphylococcus aureus* was resistant to the ethanolic extract of *T. officinale* leaves. However, the ethanolic extract was effective against *E. coli* and *K. pneumoniae*. In contrast, the methanolic extract of *T. officinale* was found to be effective against all three bacteria. The study concluded that the methanolic extract of *T. officinale* leaves exhibited *in vitro* antibacterial activity against *S. aureus, K. pneumoniae*, and *E. coli* (Narkey et al., 2022).

6.3. Antioxidant Activit

Choi et al. (2010) investigated the hypolipidemic and antioxidant activities of dandelion root and leaf in rabbits fed a high-cholesterol diet. Twenty-eight male rabbits were divided into four groups: a normal diet group, a cholesterol diet group, a high-cholesterol diet group supplemented with dandelion root, and a high-cholesterol diet group supplemented with dandelion leaf. Plasma antioxidant enzymes and lipid profiles were assessed. Plasma AST concentrations showed a slight decrease in the dandelion leaf-fed group compared to the control group, while ALT activity was significantly reduced in the dandelion root-fed group. HDL cholesterol levels were significantly increased in the dandelion leaf-fed group, whereas triglyceride and LDL cholesterol levels were significantly decreased. The triglyceride levels in the dandelion root group were significantly lower than those in the control group. GSH activities were significantly higher in both the dandelion-fed groups compared to the control group. Additionally, representative aorta sections stained with hematoxylin-eosin were examined for all four groups. While the aorta sections of the control group rabbits were healthy, those of the high-cholesterol-fed groups showed plaque formation with lipid accumulation, a hallmark of atherosclerosis. Atherosclerosis-related problems were significantly reduced in both

dandelion-fed groups. Overall, the results indicated that antioxidant enzyme activity and lipid profiles improved with dandelion treatment. Therefore, it can be concluded that dandelion has hypolipidemic and antioxidant effects and is protective against the development of atherosclerosis.

6.4. Antihyperglycemic Activity

The effect of ethanol extract from *Taraxacum officinale* collected in Pakistan on insulin secretion was investigated. Air-dried and ground plant material (30 g) was extracted using 80-90% ethanol. The resulting extracts, prepared at concentrations ranging from 1 to 40 μg/mL, were tested for their effects on insulin secretion from INS-1 cells in the presence of glucose. Glibenclamide was used as a control. The results showed promising insulin secretagogue activity in *Taraxacum officinale* at a concentration of 40 μg/mL (Hussain et al., 2004).

Dandelion has also been shown to enhance glucose uptake in the body by stimulating insulin secretion in the pancreas. Taraxasterol (TS) contributes to the anti-hyperglycemic effect by inhibiting α-glucosidase and α-amylase, thus preventing the digestion of carbohydrates (Wirngo et al., 2016).

6.5. Hepatoprotective Activity

Hamza et al. (2020) evaluated the effects of dandelion on liver fibrosis. Liver fibrosis was induced in rats by administering 20% CCl_4 for 8 weeks. It was administered orally to adult male albino rats twice a week. Twenty-four rats were randomly divided into four groups (six rats each). Damaged liver histology was significantly improved by hematoxylin-eosin staining and histopathological scoring methods. Masson staining and hydroxyproline content method also showed that collagen accumulation in the region decreased. mRNA and protein levels of α-smooth muscle actin and collagen 1 and 3 decreased after dandelion treatment compared to the CCl_4 group. In addition, dandelion decreased inflammatory markers such as interleukin-IL-1β, tumor necrosis factor-α, cyclooxygenase-2, and nuclear factor kappa-B. In addition, oxidative stress also decreased myeloperoxidase activity, which is an indicator. The antifibrotic effects of dandelion can be attributed to its ability to scavenge free radicals and reduce the inflammatory process in cells.

6.6. Gastroprotective Activity

Zanatta et al. (2021) investigated the gastroprotective effects of *Taraxacum officinale* aqueous extract (AETo) in Wistar female rats. Forty rats were randomly divided into five groups, with 8 rats in each group. The dandelion plants were collected from Brazil in October 2019. The study examined the effect of the aqueous extract of dandelion on inflammatory and oxidative stress markers in damaged gastric tissue. Significant damage was observed in the gastric tissue of rats with ethanol-induced ulcers. Ethanol and piroxicam-induced gastric ulceration were treated orally with AETo at concentrations of 3, 30, and 300 mg/kg. The results showed that rats receiving 30 or 300 mg/kg AETo exhibited a significant reduction in the size of the ulcerated area, by 62.1% and 58.7%, respectively, compared to the saline-treated group. In the piroxicam-induced ulcer model, rats showed significant gastric tissue damage, but AETo at 30 and 300 mg/kg resulted in 75.4% and 88.8% reductions in

lesion areas, respectively, compared to the saline-treated group. The gastroprotective effect of AETo is attributed to its ability to reduce oxidative stress and inflammation, as well as to increase mucus content.

6.7. Diuretic Activity

A study investigating the diuretic activity of a hydroethanolic leaf extract of *T. officinale* examined its effects on urinary frequency and volume. Data on urine output and water intake were recorded for two days prior to the application of dandelion extract. Observations were made over a 24-hour period following the administration of the extract (8 mL, three times per day). In the entire study population (n = 17), a significant increase in urination frequency was observed during the 5 hours after the first dose. A similar significant increase in excretion was noted in the 5 hours following the second dose. However, no significant change was observed after the third dose. The study concluded that *T. officinale* increased both the frequency and volume of fluid excretion in healthy humans (Kayıran et al., 2020).

6.8. Prebiotic Activity

The roots of *T. officinale* were collected in Prague in 2003, dried, and ground 30 g of the root was infused in 100 ml of boiling water. After filtering the infusion, it was added to the broth medium at a concentration of 10%. *Bifidobacteria* grown in the Wilkins-Chalgren medium were added to the dandelion root extract medium. All cultures were incubated at 37 °C under anaerobic conditions for 48 h, and the results were recorded. Enzymatic and phenol-sulfuric methods determined the utilization of polysaccharides and glycosides. Dandelion root infusion stimulated the in vitro growth of 14 bifidobacteria (*B. adolescentis* 1, *B. adolescentis* 2, *B. animalis, B. bifidum* 1, *B. bifidum* 2, *B. breve, B. catenulatum, B. infantis, B. longum* 1, *B. longum* 2, *B. longum* 3, *B. longum* 4, *B. longum* 5, *B. pseudolongum)* strains (Trojanova et al. 2004).

6.9. Choleretic Activity

Bile-reducing effect; increases bile volume by increasing the rate of bile excretion from liver cells. This bile passes into the small intestine during digestion. It was recorded that bile secretion increased by 40% when an alcoholic extract obtained from the whole *Taraxacum officinale* plant was administered intraduodenally to rats (Keçeci, 2011).

7. Conclusion

Dandelion has many pharmacological activities that make it a valuable plant due to its low cost, high availability, and no severe toxicity reports. All studies conducted on the plant have shown great potential for use in many diseases due to the available published data on the plant. Studies conducted have generally focused on in vitro and animal experiments. More clinical studies are needed on the absorption, distribution, metabolism, elimination, bioavailability, and safety of the plant for drug and pharmaceutical studies. Studies have generally progressed on certain plant parts such as leaves and roots. In addition, the activities, and mechanisms of action of the effective active ingredients of the plant should be studied further. By combining traditional medicinal plants such as dandelion with today's pharmaceutical sector, more advanced treatment opportunities can be offered to people.

Ethical Statement

There is no need to obtain ethics committee permission for this study for review article reasons. However, the study was conducted in accordance with ethical principles.

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Presentation Information

The findings of this study have not been presented at any conference or journal.

Conflicts of Interest

The authors declare no conflicts of interest regarding this study.

Author Contributions

The contributions of the authors are as follows: R.Ş. wrote the manuscript and H.N.G. made the final revision of the article.

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