RESEARCH PAPER

Taraxacum officinale L.: Bridging Traditional Food, Ethnomedicine and Pharmacological Research—A Narrative Review

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Abstract

Taraxacum officinale L., commonly known as dandelion, is a perennial member of the Asteraceae family that occupies a distinctive position at the interface of traditional food, ethnomedicine, and contemporary pharmacological research. Unlike many medicinal plants that are used exclusively as herbal remedies, dandelion is an edible plant in which leaves, roots, flowers and other aerial parts have historically been consumed as food or prepared as traditional remedies. Its nutritional and medicinal relevance is associated with a chemically diverse profile comprising phenolic acids, flavonoids, sesquiterpene lactones, triterpenoids, phytosterols, polysaccharides, carotenoids, coumarins and other secondary metabolites. Contemporary investigations have reported antioxidant, anti-inflammatory, hepatoprotective, antidiabetic, antimicrobial, immunomodulatory, cardioprotective and anticancer activities of *T. officinale* preparations and individual constituents. Mechanistic studies suggest involvement of nuclear factor erythroid 2-related factor 2/heme oxygenase-1 (Nrf2/HO-1), nuclear factor kappa-B (NF-κB), phosphatidylinositol-3-kinase/protein kinase B (PI3K/Akt), signal transducer and activator of transcription 3 (STAT3), mitochondrial apoptotic and oxidative-stress pathways. Recent food-oriented research further supports the potential of dandelion as a functional-food ingredient because of its phenolic, flavonoid, carotenoid, mineral and fiber content. However, considerable heterogeneity exists among studies because of differences in plant organ, geographical origin, harvesting stage, extraction solvent, processing conditions and chemical standardization. Moreover, much of the pharmacological evidence remains derived from in vitro and animal models, while human clinical evidence is comparatively limited. This narrative review summarizes the recent literature on the botanical characteristics, traditional food and ethnomedicinal uses, phytochemical composition, pharmacological activities, mechanisms of action, safety, quality-control requirements and future research priorities of *T. officinale*. Particular attention is given to the translational gap between traditional knowledge and experimentally demonstrated pharmacological effects.

Keywords: *Taraxacum officinale*; dandelion; traditional food; ethnomedicine; phytochemistry; antioxidant; anti-inflammatory; hepatoprotective; antidiabetic; anticancer; functional food; medicinal plant.

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1. Introduction

Medicinal plants have historically served dual roles as sources of nourishment and therapeutic agents. This food–medicine continuum is particularly evident in *Taraxacum officinale* L., commonly known as dandelion. The species is a perennial herb of the Asteraceae family and is widely distributed across temperate and subtropical regions. Although frequently regarded as a common weed, dandelion has a long history of use as an edible vegetable and traditional medicinal plant. [1, 3, 6, 7]

Recent reviews have emphasized that the genus *Taraxacum* contains substantial chemical and pharmacological diversity. A 2024 review described *T. officinale* as a representative species containing sesquiterpenes, triterpenes, steroids, flavonoids, sugars and their derivatives, phenolic acids and fatty acids, with reported antimicrobial, anti-inflammatory, antioxidant, hepatoprotective, antitumor and metabolic effects. [1]

The scientific interest in dandelion is particularly relevant because its traditional applications overlap with several areas of modern pharmacological research. Traditionally, different preparations have been used as digestive aids, diuretics, anti-inflammatory remedies and agents for hepatobiliary complaints. Modern investigations have subsequently examined antioxidant, anti-inflammatory, hepatoprotective, antidiabetic and anticancer properties. [1, 6, 7, 10–13, 15]

Dandelion is also unusual in that virtually the entire plant has potential food or medicinal value. Young leaves may be consumed raw or cooked, roots may be cooked or roasted, and flowers may be incorporated into traditional preparations. Recent food-science research has demonstrated substantial

phytochemical content in edible dandelion and has proposed its incorporation into functional foods. [2, 3]

Nevertheless, the increasing number of experimental publications should not be interpreted as evidence that all traditional claims have been clinically validated. A major challenge is the heterogeneity of dandelion preparations. Extracts derived from roots, leaves, flowers or whole plants can differ substantially in chemical composition and biological activity. A 2026 systematic review of 55 *Taraxacum* species highlighted both the extensive chemodiversity of the genus and the importance of distinguishing species-specific evidence. [4]

The objective of this narrative review is therefore to bridge three interconnected domains—traditional food, ethnomedicine and pharmacological research—and to critically evaluate how contemporary scientific evidence supports or challenges the traditional relevance of *T. officinale*.

2. Botanical Description and Taxonomic Considerations

2.1 Botanical characteristics

Taraxacum officinale is a perennial herb characterized by a short vertical rootstock, a prominent taproot, a basal rosette of leaves and leafless hollow flowering stalks. The capitulum consists of numerous yellow ligulate florets. Following flowering, the fruits develop into a characteristic spherical structure consisting of achenes bearing a pappus, facilitating wind dispersal. [6]

The plant is highly adaptable and commonly occurs in meadows, grasslands, agricultural areas, roadsides, gardens and disturbed habitats. Its adaptability has contributed to its widespread availability as a food and traditional medicinal resource. [6]

The root is generally thick and taproot-like, while the leaves are deeply lobed and arranged in a basal rosette. Young leaves are commonly preferred for culinary use because mature leaves can develop a stronger bitter taste. [2, 3]

2.2 Taxonomic complexity

Taxonomic identification is important in interpreting the pharmacological literature. *Taraxacum* is a large and taxonomically complex genus, with numerous species and microspecies. Traditional medicines may use more than one *Taraxacum* species depending on geographical region. [4, 6]

A recent systematic review covering 55 species reported more than 380 identified constituents across the genus and emphasized substantial differences between species. The review specifically identified *T. officinale*, *T. mongolicum* and *T. lacistrum* among species for which relatively favorable safety profiles have been reported. [4]

Consequently, pharmacological results obtained from another *Taraxacum* species should not automatically be attributed to *T. officinale*. Future studies should provide authenticated botanical identification and preferably a voucher specimen. [4]

3. Traditional Food Uses

The food value of *T. officinale* is an important but sometimes overlooked component of its biological significance. [2, 3]

Young leaves are traditionally eaten raw in salads or cooked as vegetables. Roots can be boiled, roasted or processed into beverages, while flowers have been incorporated into traditional food and beverage preparations. The plant contains dietary fiber, minerals, vitamins, carotenoids, phenolic compounds and flavonoids. [2, 3, 5]

Recent research has emphasized that dandelion is entirely edible and nutritionally rich. Masciulli et al. investigated edible *T. officinale* and identified a complex phytochemical profile associated with antioxidant and other biological activities, supporting its potential use in brain-health-oriented functional foods. [2]

Similarly, Laila et al. reviewed dandelion as a potential nutritional and therapeutic resource, highlighting its phenolics, flavonoids, sesquiterpene lactones, saponins and other constituents. [3]

A study of fresh and shade-dried leaves found appreciable quantities of phenolic compounds, flavonoids, ascorbic acid and β-carotene. Shade-dried leaves also demonstrated in vitro inhibition of α-amylase and α-glucosidase, suggesting possible functional-food applications relevant to postprandial glucose control. [5]

However, processing may substantially modify phytochemical composition. Drying temperature, cooking, fermentation and extraction can alter phenolic stability and bioavailability. Therefore, nutritional composition should ideally be evaluated in the form in which the plant is intended to be consumed. [2, 3, 8, 9]

4. Ethnomedicinal Uses

Dandelion has been used traditionally across Europe, Asia and other regions. Traditional indications include digestive complaints, poor appetite, urinary disorders, inflammatory conditions and hepatobiliary complaints. [1, 3, 6]

In traditional Chinese medicine, *Taraxacum* species are represented by *Taraxaci Herba*, which has been documented for centuries. Traditional indications include inflammatory conditions, sore throat, conjunctival disorders, abscesses and certain hepatobiliary complaints. A 2024 comprehensive review documented the historical use and pharmacological development of *Taraxaci Herba* and identified flavonoids, phenolic acids and terpenoids as important classes of constituents. [6]

The historical use of dandelion as a diuretic and digestive aid is particularly relevant to its modern investigation. However, ethnomedicinal evidence

should be interpreted as a basis for hypothesis generation rather than as direct clinical proof. [1, 6]

The traditional use of a plant preparation can involve complex mixtures, preparation-specific doses and dietary patterns that are not reproduced by modern concentrated extracts. Therefore, pharmacological research should attempt to identify which traditional preparations and exposure levels correspond most closely to experimentally investigated products. [2, 3, 6]

5. Phytochemical Profile

The pharmacological potential of *T. officinale* is closely related to its diverse phytochemical composition. [1, 6–9]

Major reported classes include:

- phenolic acids;
- flavonoids;
- sesquiterpene lactones;
- triterpenoids;
- phytosterols;
- polysaccharides;
- coumarins;
- carotenoids;
- fatty acids;
- volatile compounds; and
- other secondary metabolites.

Recent reviews have confirmed that these chemical groups contribute to the broad biological profile attributed to dandelion. [1, 6, 7]

5.1 Phenolic acids

Phenolic acids are among the best characterized constituents. Chlorogenic acid and chicoric acid are particularly relevant. These compounds possess antioxidant properties and have been investigated for anti-inflammatory and metabolic effects. [6–9]

Hydroxycinnamic acids were prominent in detailed chemical studies of dandelion root preparations. Jedrejek et al. reported approximately 100 phytochemicals across different root preparations and demonstrated substantial differences in chemical composition and radical-scavenging capacity among preparations. [8]

5.2 Flavonoids

Flavonoids identified in dandelion include luteolin derivatives, quercetin-related compounds and other glycosylated flavonoids. These compounds may contribute to antioxidant, anti-inflammatory and cytoprotective effects. [6, 9]

Miłek et al. found flavonoids, particularly luteolin derivatives, together with phenolic acids among the predominant polyphenols in leaf and flower extracts. [9]

5.3 Triterpenoids

Triterpenoids, including taraxasterol and related pentacyclic compounds, are important constituents of *T. officinale*. Taraxasterol has attracted attention in studies examining inflammatory, hepatic and anticancer pathways. [6, 10, 15]

A 2025 hepatoprotective review identified taraxasterol as one of the relevant bioactive constituents associated with modulation of oxidative-stress and inflammatory pathways. [10]

5.4 Sesquiterpene lactones

Sesquiterpene lactones contribute to the characteristic bitterness of dandelion and have been investigated for anti-inflammatory and cytotoxic activities. Their biological effects may involve interactions with cellular signaling and oxidative-stress pathways. [1, 6, 7]

5.5 Polysaccharides and inulin

Dandelion roots contain polysaccharides and inulin-type carbohydrates. These compounds may contribute to the plant's nutritional value and have been investigated for metabolic and gastrointestinal relevance. [3, 6]

5.6 Carotenoids and vitamins

Leaves contain carotenoids, including β-carotene, together with vitamin-related nutritional compounds. Their presence strengthens the argument for considering dandelion as a food-derived source of bioactive compounds rather than solely as an herbal medicine. [2, 3, 5]

Table 1. Major phytochemical classes reported in *T. officinale*

Phytochemical class	Representative compounds	Major reported relevance
Phenolic acids	Chlorogenic acid, chicoric acid	Antioxidant, anti-inflammatory, metabolic effects
Flavonoids	Luteolin derivatives, quercetin-related compounds	Antioxidant, anti-inflammatory, cytoprotective
Triterpenoids	Taraxasterol and related compounds	Anti-inflammatory, hepatoprotective, anticancer potential
Sesquiterpene lactones	Taraxinic-acid-related compounds and others	Anti-inflammatory, cytotoxic potential
Phytosterols	β-Sitosterol and related sterols	Metabolic and membrane-

Phytochemical class	Representative compounds	Major reported relevance associated effects
Polysaccharides	Water-soluble polysaccharides, inulin	Nutritional, metabolic and possible prebiotic effects
Carotenoids	β-Carotene and related pigments	Antioxidant and nutritional effects
Coumarins	Various coumarin derivatives	Antioxidant and pharmacological potential
Volatile compounds	Terpenoid and other volatile constituents	Antioxidant and antimicrobial potential

6. Pharmacological Activities

6.1 Antioxidant activity

Oxidative stress is a common pathological component of metabolic, inflammatory, cardiovascular and neurodegenerative diseases. Dandelion extracts have demonstrated antioxidant activity in chemical assays and experimental biological systems. [8, 9, 19, 20]

Root preparations rich in hydroxycinnamic acids showed substantial free-radical-scavenging capacity, demonstrating the importance of extraction-dependent phytochemical composition. [8]

Similarly, studies of dandelion leaves and flowers have demonstrated antioxidant activity associated with their phenolic and flavonoid content. [9]

However, antioxidant activity measured by DPPH, ABTS, FRAP or related chemical assays should not be interpreted as direct evidence of antioxidant efficacy in humans. In vivo activity depends on absorption, metabolism, tissue distribution and interaction with endogenous antioxidant systems. [8, 9, 19, 20]

6.2 Anti-inflammatory activity

Anti-inflammatory effects are among the best-supported experimental properties of *T. officinale*. [1, 7, 11]

Dong et al. demonstrated that ethanol extract of *T. officinale* attenuated inflammatory responses in lipopolysaccharide-stimulated microglial cells and mouse hippocampus. The extract inhibited NF-κB p65 nuclear translocation and increased Nrf2-associated HO-1 expression. Knockdown of HO-1 partially reversed the anti-inflammatory effects, providing mechanistic evidence for involvement of the Nrf2/HO-1 pathway. [11]

These findings provide a mechanistic explanation for some traditional anti-inflammatory applications. [11]

Potential anti-inflammatory mechanisms include:

- suppression of NF-κB activation;
- enhancement of Nrf2/HO-1 signaling;
- reduction of oxidative stress;
- modulation of inflammatory cytokines;
- inhibition of inflammatory mediator production; and
- regulation of macrophage or microglial responses.

Nevertheless, most evidence remains experimental rather than clinical. [11]

6.3 Hepatoprotective activity

The liver represents one of the most extensively investigated targets of dandelion research. [10]

Experimental studies have reported protective effects against chemically induced hepatic injury. The proposed mechanisms include reduction of oxidative stress, inhibition of inflammatory signaling and protection of cellular antioxidant systems. [10]

A recent narrative review specifically examining dandelion and liver health concluded that preclinical studies have reported protection against liver damage induced by alcohol, carbon tetrachloride and paracetamol. Taraxasterol was highlighted as a potentially important bioactive constituent. [10]

These observations are compatible with traditional hepatobiliary use but do not establish efficacy for human liver disease. [6, 10]

In particular, dandelion should not presently be regarded as a replacement for evidence-based treatment of viral hepatitis, metabolic dysfunction-associated steatotic liver disease, cirrhosis or other chronic liver diseases.

6.4 Antidiabetic activity

The potential antidiabetic effects of *T. officinale* have been examined through enzyme-inhibition studies, cellular models and animal experiments. [5, 12–14]

A 2021 study found that water extracts of dandelion root inhibited α-glucosidase and α-amylase and demonstrated effects on insulin resistance in HepG2 cells. The authors also reported synergistic activity when dandelion extract was combined with *Astragalus* extract. [12]

Another 2021 study evaluated a combination of *T. officinale* and *Momordica charantia*. The combination showed α-amylase, α-glucosidase and DPP-4 inhibitory activity and improved glucose-related outcomes in diabetic rats. [13]

More recent work comparing dandelion and burdock root extracts identified inulin and other phytochemical constituents and reported α-amylase-

related activity, while emphasizing the need for in vivo validation. [14]

These findings suggest potential metabolic activity but do not establish an appropriate therapeutic dose or clinical efficacy in diabetes. [5, 12–14]

6.5 Antimicrobial activity

Dandelion extracts have demonstrated antimicrobial activity against various microorganisms in laboratory studies. Phenolic compounds, terpenoids and other secondary metabolites may contribute through membrane interactions, oxidative effects or interference with microbial metabolic processes. Recent reviews identify antibacterial, antifungal and broader anti-infective activity among the pharmacological properties investigated within the *Taraxacum* genus. [1, 7]

However, antimicrobial activity in vitro does not necessarily translate into therapeutic activity in humans. Future research should determine minimum inhibitory concentrations using standardized preparations and assess pharmacokinetic feasibility. [1, 7]

6.6 Anticancer activity

Anticancer research involving *T. officinale* has expanded considerably. [15, 16]

Experimental studies have investigated effects on proliferation, apoptosis, oxidative stress, cell-cycle progression and oncogenic signaling. Bioactive compounds of interest include taraxasterol, chlorogenic acid, chicoric acid and taraxinic-acid-related compounds. [15]

Potential mechanisms include:

- mitochondrial membrane disruption;
- increased reactive oxygen species;
- activation of apoptotic pathways;
- cell-cycle arrest;
- PI3K/Akt modulation;
- STAT3 inhibition;
- suppression of inflammatory signaling; and
- modulation of oxidative-stress responses.

A 2025 review concluded that dandelion contains several promising compounds for anticancer research but emphasized the need for additional preclinical and clinical validation. [15]

Research specifically addressing leukemia and lymphoma has also suggested selective cytotoxic and pro-apoptotic effects in experimental systems, while highlighting limitations including inadequate pharmacokinetic data, dose relevance and limited safety profiling. [16]

Thus, *T. officinale* should presently be considered a **source of candidate anticancer compounds**, not an established anticancer therapy. [15, 16]

6.7 Cardioprotective and metabolic effects

Dandelion may have cardiovascular relevance through its antioxidant, anti-inflammatory and metabolic effects. Experimental studies have investigated effects on oxidative stress, lipid metabolism, platelet function and inflammatory signaling. Studies of dandelion fruit flavonoid preparations have also reported antioxidant and antiplatelet properties in laboratory models. [17]

These findings suggest potential cardiovascular relevance, but human clinical evidence remains insufficient to establish preventive or therapeutic efficacy. [17]

6.8 Neuroprotective potential

Neuroinflammation is an emerging area of dandelion research. The 2020 study by Dong et al. demonstrated modulation of inflammatory responses in microglial models through Nrf2/HO-1 and NF-κB signaling. [11]

More recently, edible dandelion has been investigated for its potential incorporation into brain-health-oriented functional foods. The 2025 study by Masciulli et al. specifically highlighted the underexplored relationship between *T. officinale* and neuroinflammation. [2]

The field remains preliminary, and evidence for prevention or treatment of neurodegenerative disease is currently inadequate. [2, 11]

Table 2. Summary of pharmacological evidence for *T. officinale*

Activity	Experimental evidence	Principal mechanisms/targets	Evidence status
Antioxidant	Chemical, cellular and animal studies	Radical scavenging, Nrf2, endogenous antioxidant enzymes	Promising preclinical
Anti-inflammatory	Cellular and animal studies	Nrf2/HO-1, NF-κB, inflammatory mediators	Promising preclinical
Hepatoprotective	Animal models	Oxidative stress, inflammatory pathways, taraxasterol	Promising preclinical
Antidiabetic	Enzyme, cellular and animal studies	α-Amylase, α-glucosidase, DPP-4, glucose metabolism	Preliminary–promising

Activity	Experimental evidence	Principal mechanisms/targets	Evidence status
Antimicrobial	In vitro studies	Membrane/metabolic effects, phytochemical interactions	Preliminary
Anticancer	Mainly cell and animal studies	ROS, apoptosis, PI3K/Akt, STAT3, cell-cycle regulation	Promising but unconfirmed clinically
Cardioprotective	Mainly experimental	Antioxidant, anti-inflammatory, antiplatelet pathways	Preliminary
Neuroprotective	Cellular/preclinical	Nrf2/HO-1, NF-κB and neuroinflammatory pathways	Early-stage
Functional-food potential	Nutritional and food-science studies	Polyphenols, carotenoids, fiber and other nutrients	Promising

7. Mechanisms of Action

The pharmacological effects of *T. officinale* are unlikely to depend on a single compound or pathway. Rather, they probably result from interactions among multiple phytochemical classes. [1, 6, 7]

7.1 Nrf2/HO-1 signaling

Nrf2 is an important regulator of cellular antioxidant defense. Activation of Nrf2 promotes transcription of genes involved in oxidative-stress protection, including HO-1. [11]

Dandelion extract has been shown experimentally to increase Nrf2 nuclear translocation and HO-1 expression while reducing inflammatory signaling. [11]

7.2 NF-κB signaling

NF-κB regulates many inflammatory mediators. Suppression of NF-κB activation provides a plausible molecular explanation for the anti-inflammatory effects observed with dandelion extracts.

Experimental evidence demonstrates inhibition of NF-κB p65 nuclear translocation following *T. officinale* treatment. [11]

7.3 PI3K/Akt and STAT3

These pathways are frequently dysregulated in cancer and inflammatory disease. Recent anticancer literature suggests that selected dandelion constituents may modulate PI3K/Akt and STAT3 signaling, although much of the evidence remains derived from cellular systems. [15, 16]

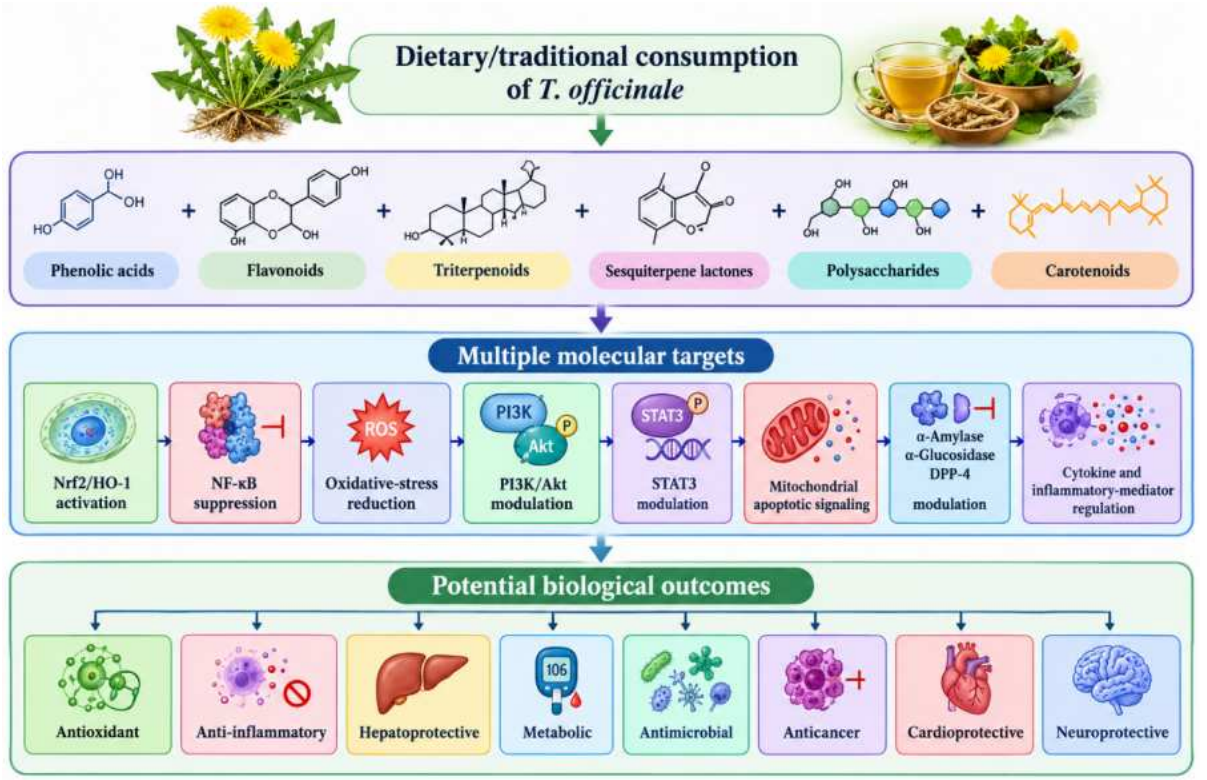
7.4 Mitochondrial apoptosis

Some dandelion extracts and constituents have been associated with mitochondrial dysfunction, ROS generation, caspase activation and apoptosis in cancer-cell models. [15, 16]

7.5 Carbohydrate-metabolizing enzymes

In vitro studies demonstrate inhibition of α-amylase and α-glucosidase by dandelion preparations. Such activity could theoretically reduce carbohydrate digestion and postprandial glucose elevation, although clinical relevance remains to be established. [5, 12]

Figure 1. Proposed integrated mechanism of action



Note: The diagram summarizes mechanisms reported or proposed in preclinical studies and should not be interpreted as proof of clinical efficacy. [11, 15, 16]

8. Food–Medicine Continuum

The distinctive value of *T. officinale* lies in its position between food and medicine. [2, 3, 6]

Traditional consumption exposes individuals to a complex mixture of phytochemicals at dietary concentrations, whereas experimental pharmacology frequently uses concentrated extracts at substantially higher doses. This difference is critical. [2, 3, 8, 20]

A dietary serving of dandelion leaves cannot be considered pharmacologically equivalent to a concentrated ethanolic or methanolic extract. Conversely, demonstrating activity in a concentrated extract does not necessarily establish that ordinary dietary consumption produces the same effect. [8, 20]

This distinction should be central to future research. Studies should compare:

1. concentrations achievable through normal dietary consumption;
2. traditional preparation methods;
3. standardized extracts; and
4. purified individual compounds.

Such an approach could help determine whether the biological effects of dandelion are primarily nutritional, pharmacological or dependent on both mechanisms. [2, 3, 8]

9. Toxicity and Safety

The available evidence generally suggests that *T. officinale* has a relatively favorable safety profile, but the evidence base is not yet sufficient to establish unrestricted long-term therapeutic use. [4, 8]

A 2019 comparative study of different root preparations demonstrated substantial differences in phytochemical composition and biological activity between preparations. This illustrates why safety cannot be generalized from one preparation to another. [8]

Recent systematic evidence across the genus has generally supported a favorable safety profile for *T. officinale*, while also emphasizing species and preparation differences. [4]

Potential safety considerations include:

- hypersensitivity or allergic reactions in susceptible individuals;
- possible interactions with conventional medicines;
- variation in phytochemical concentrations;
- contamination with pesticides or environmental pollutants;
- uncertainty regarding prolonged high-dose supplementation;
- limited pregnancy and lactation data; and
- insufficient pharmacokinetic characterization.

An important emerging issue is environmental contamination. A 2025 assessment of wild food plants from the Deosai region of Pakistan found measurable heavy metals in *T. officinale* leaves, demonstrating that the safety of wild-collected

dandelion may depend on its growing environment. [18]

This finding is especially relevant when dandelion is collected from roadsides, industrial areas, contaminated soils or regions exposed to agricultural chemicals. [18]

10. Quality Control and Standardization

Quality control represents one of the principal challenges in developing *T. officinale* into a reproducible medicinal or functional-food product. [6, 8, 20]

Variability can arise from:

- species and genotype;
- geographical origin;
- soil composition;
- climate;
- harvesting season;
- plant age;
- plant organ;
- drying conditions;
- extraction solvent;
- extraction temperature;
- storage conditions; and
- processing technology.

The 2024 review of *Taraxaci Herba* emphasized the importance of chemical markers and quality-control approaches and identified constituents such as chicoric acid, chlorogenic acid, taraxasterol, taraxasteryl acetate, isorhamnetin and luteolin as relevant chemical markers. [6] Modern analytical strategies should combine:

- botanical authentication;
- voucher-specimen documentation;
- HPLC/UPLC profiling;
- LC-MS/MS;
- GC-MS for volatile fractions;
- DNA-based authentication where appropriate;
- quantitative marker-compound analysis; and
- contaminant testing.

A standardized preparation should ideally specify the plant part, extraction ratio, solvent, marker compounds and acceptable ranges of chemical variation. [6, 8, 20]

11. Research Gaps and Future Perspectives

Despite extensive experimental research, several major gaps remain.

11.1 Lack of clinical evidence

The largest gap is the limited number of well-designed human clinical trials. Most evidence for antioxidant, anti-inflammatory, hepatoprotective, antidiabetic and anticancer effects remains preclinical. [1–4, 10–16]

11.2 Poor standardization

Different studies often use chemically different extracts while referring to them simply as "*T. officinale* extract." This makes cross-study comparison difficult. [8, 20]

11.3 Limited pharmacokinetic information

The absorption, metabolism, tissue distribution and elimination of major dandelion constituents require systematic investigation. [4, 15, 16]

11.4 Dose translation

Effective concentrations reported in cell cultures may be much higher than concentrations achievable through dietary consumption or conventional oral supplementation. [2, 5, 12–16]

11.5 Species confusion

Evidence from other *Taraxacum* species is sometimes combined with evidence for *T. officinale*. Species-specific research is essential. [4, 6]

11.6 Food-processing effects

More research is required to determine how cooking, drying, fermentation, roasting and storage alter the bioavailability of phenolic acids, flavonoids, carotenoids and other compounds. [2, 3, 5, 8, 9]

11.7 Sustainable cultivation

Controlled cultivation, hydroponics, elicitation and environmental manipulation may allow production of plant material with reproducible concentrations of desired compounds. Recent work has specifically proposed horticultural strategies to optimize dandelion material for translational research. [16]

11.8 Safety and drug interactions

Future clinical research should include systematic drug-interaction studies, reproductive toxicity assessment, chronic toxicity testing and pharmacovigilance. [4, 6]

Table 3. Major research gaps and recommended approaches

Research gap	Current limitation	Recommended approach
Clinical efficacy	Few rigorous human trials	Randomized controlled trials
Extract variability	Different solvents and plant parts	Standardized extracts
Taxonomic uncertainty	Species sometimes pooled	Voucher-based authentication
Bioavailability	Limited pharmacokinetic data	ADME and metabolomic studies
Dose translation	Cell-culture doses may be unrealistic	Physiologically relevant concentrations

Research gap	Current limitation	Recommended approach
Safety	Limited long-term human data	Chronic toxicity and pharmacovigilance
Food processing	Bioactive losses poorly characterized	Processing and stability studies
Contamination	Wild plants may accumulate pollutants	Heavy-metal, pesticide and microbial testing
Mechanistic evidence	Some pathways remain hypothetical	Target-validation studies
Functional foods	Limited clinical validation	Human nutrition trials

12. Overall Critical Appraisal

The current evidence supports *T. officinale* as a biologically active plant with substantial nutritional and pharmacological potential. Its traditional food use is particularly important because it provides a culturally established route of exposure and distinguishes dandelion from many medicinal plants that are consumed exclusively as concentrated extracts. [2–4, 6, 7]

The phytochemical literature demonstrates that dandelion contains several classes of compounds capable of influencing oxidative, inflammatory and metabolic pathways. Experimental studies have consequently provided plausible explanations for some traditional applications. [1, 6–11]

However, the strength of evidence varies considerably by indication. [1–18]

The evidence for **antioxidant and anti-inflammatory activity** is relatively extensive at the laboratory level. **Hepatoprotective and antidiabetic effects** are supported mainly by cellular and animal studies. **Anticancer activity** is particularly promising but remains predominantly preclinical. **Cardiovascular and neuroprotective applications** are emerging areas requiring substantially more investigation. [8–17]

Importantly, pharmacological promise should not be confused with clinical efficacy. A plant extract may demonstrate strong activity in a cell line while having poor oral bioavailability in humans. Similarly, a compound may exert a molecular effect at concentrations that cannot realistically be reached through dietary consumption. [2, 8, 12, 15, 16]

Therefore, the future of *T. officinale* research should move from repeated demonstration of broad in vitro activity toward standardized, mechanism-driven and clinically relevant research. [4, 6, 8, 10, 15, 16]

13. Conclusion

Taraxacum officinale L. represents an important example of a plant in which traditional food use, ethnomedicine and modern pharmacological research converge. Its leaves, roots and flowers provide nutritional constituents as well as diverse phytochemicals, including phenolic acids, flavonoids, triterpenoids, sesquiterpene lactones, polysaccharides, carotenoids and phytosterols. [2, 3, 6–9]

Recent research supports a broad range of experimental biological activities, particularly antioxidant, anti-inflammatory, hepatoprotective, antidiabetic, antimicrobial and anticancer effects. Mechanistic studies implicate Nrf2/HO-1, NF-κB, PI3K/Akt, STAT3, mitochondrial and metabolic pathways. [5, 8–17, 19, 20]

The strongest conclusion that can currently be drawn is that *T. officinale* is a **promising edible medicinal plant and source of bioactive compounds**, rather than a clinically established treatment for specific diseases. The translation of traditional knowledge into evidence-based applications requires authenticated plant material, standardized extracts, chemical fingerprinting, pharmacokinetic studies, rigorous toxicology and well-designed clinical trials. [4, 6, 8, 10–18, 20]

Its dual identity as both food and medicinal plant also creates an opportunity for development of functional foods and nutraceutical products. However, such development must be accompanied by appropriate quality control, contaminant testing and evidence-based health claims. [2, 3, 6, 18]

Future research should therefore prioritize the establishment of standardized *T. officinale* preparations, clarification of dose–response relationships, identification of bioavailable active constituents and validation of promising pharmacological effects in human studies. Such an integrated approach could transform dandelion from an underutilized edible plant into a scientifically characterized resource for nutrition, preventive health and pharmaceutical discovery. [4, 6, 8, 10–16, 18, 20]

Graphical Abstract

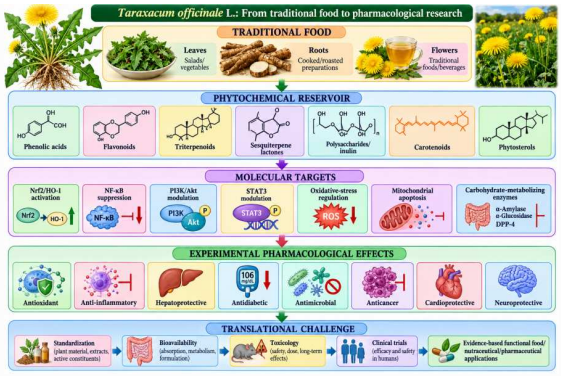


Table 4. Selected recent evidence, 2019–2026

Year	Study focus	Principal finding	Evidence level
2019	Root phytochemistry and antioxidant activity	~100 phytochemicals identified across root preparations; activity differed according to chemical composition	Chemical/preclinical
2020	Neuro inflammation	Nrf2/HO-1 and NF-κB pathways implicated in anti-inflammatory activity	Cellular/animal
2021	Glucose metabolism	Root extract inhibited α-amylase/α-glucosidase and affected insulin-resistance models	In vitro/cellular
2021	Polyherbal antidiabetic activity	*T. officinale* + *M. charantia* showed enhanced metabolic effects	In vitro/animal
2022	Nutritional and antidiabetic potential	Leaves contained phenolics, flavonoids, vitamin C and β-carotene; extracts inhibited carbohydrate-digesting enzymes	Food/in vitro
2022	Essential oil	Antioxidant, antiproliferative and protective	In vitro/animal

Year	Study focus	Principal finding	Evidence level
		effects reported	
2024	Ethnopharmacology and phytochemistry	Broad review of traditional uses, chemical constituents and pharmacology	Review
2024	*Taraxaci Herba*	Detailed review of botanical, phytochemical, pharmacological and quality-control evidence	Review
2024	Phytochemical/pharmacological profile	Updated review of antioxidant, anti-inflammatory, antimicrobial, metabolic and anticancer evidence	Review
2025	Functional-food potential	Edible dandelion investigated for phytochemical and brain-health-related properties	Food/preclinical
2025	Hepatoprotection	Review identified antioxidant/anti-inflammatory and taraxasterol-associated mechanisms	Review/preclinical
2025	Anticancer potential	Review summarized mechanisms involving taraxasterol, chlorogenic acid, chicoric acid and taraxinic acid	Review/preclinical
2025	Leukemia/lymphoma	Preclinical cytotoxic and pro-apoptotic	Review/preclinical

Year	Study focus	Principal finding	Evidence level
		effects reviewed; major translational gaps identified	
2026	Genus-wide systematic review	>380 compounds across 55 *Taraxacum* species; emphasized species-specific pharmacology and safety	Systematic review

Declarations

Author contributions

For a single-author manuscript: **Conceptualization, literature analysis, manuscript preparation, critical revision and final approval were performed by the author.**

For a multi-author manuscript, these statements should be adapted according to the actual contributions of each author.

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Conflicts of interest

The author declares no conflict of interest.

Data availability

No original datasets were generated for this narrative review.

Ethical approval

Not applicable.

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