

## AMELIORATIVE EFFECT OF DANDELION (*TARAXACUM OFFICINALE*) ON HEPATIC AND GUT DISORDERS

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### ABSTRACT

Dandelion contains a high content of vitamins, inulin, phytosterols, amino acids, minerals, triterpenes, and polyphenols. This edible flowering plant has choleric, diuretic, hypoglycemic, and anti-inflammatory properties. Dandelion (*Taraxacum officinale*) is a perpetual herbaceous plant that can detoxify the blood, and support liver function as well as treat numerous systemic illnesses. It has been used for a long time in conventional medicines, as well as in different remedial treatments for a wide extent of symptoms, which include gastrointestinal (GI) diseases and digestive ailments as well as other complicated hepatic related issues. Dandelion is also commonly used in the management and prevention of numerous types of liver illnesses. Ascorbic acid, polyphenols, flavonoids, and tannins in dandelion are the active ingredients responsible for their hepato-protective properties. Dandelion shows positive health effects against various diseases like hepatic disorders, and GI disorders such as ulcerative colitis, gallstones, gastritis, GI malignancy, and small intestinal ulcer. Phenolic acid and flavonoids are the primary active substances in dandelion that lead to the reduction in oxidative stress and inflammatory damage. For future research, there is a need to enhance natural ways of treating various illnesses by regular consumption of dandelion against hepatic and GI disorders.

**Keywords:** Dandelion root, GI disorders, Liver diseases, Anti-inflammatory, Anti-oxidative.

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### 1. INTRODUCTION

Dandelion (*Taraxacum officinale*) is a perpetual herbaceous plant that belongs to the *Asteraceae* family. There are 3000 varieties of this plant, which originates in Central Asia and grows all over the world (Li *et al.*, 2022). It's originally from Europe and is widespread in the northern hemisphere's mild temperate zones. Dandelion is considered a safe herb that can be used for the treatment of anti-inflammatory disorders, choleric, diuretic, and anti-rheumatic disorders. Dandelion is a harmless perennial herb that can be used in other food products with its leaves, roots, or flowers. Dandelion contains high levels of minerals, protein, fiber, and vitamins as well as an adequate amount of trace elements (González-Castejón *et al.*, 2012). The choleric, diuretic, hypoglycemic, and anti-inflammatory properties of dandelion flowers are well-known. The intake of extract from dandelion leaves has been shown to improve triacylglyceride levels, and fasting blood glucose accumulation (Mega *et al.*, 2021). As a result of its alleged capability, dandelion is utilized as a medicinal product to detoxify the blood as well as for the maintenance of liver function and treatment of innate illnesses. One of its main active ingredient is taraxasterol for which its has been frequently used in various traditional Chinese medicine therapies (Pfungstgraf *et al.*, 2021). The active components of dandelion can be found in both the roots and leaves. As a result, the large number of naturally occurring compounds found in dandelion roots promotes their nutritional content and overall health benefits. Dandelion leaves are frequently used in salad dressing, the root itself can be used as a substitute for coffee, and dandelion extracts have also been found to enhance the flavor of soft drinks and baked goods.

The essential organ that regulates the metabolism, elimination, storage, as well as excretion of endogenic and extrinsic substances, is the liver. Various environmental aspects such as trace elements and foodstuffs influence the underlying cause of liver disease (Mega *et al.*, 2021). The human liver is the organ responsible for breaking down and removing harmful substances from consumed foods to clean the body. The liver secretes a variety of chemicals that the body needs (Petrescu and Petrescu, 2020). The most common health problem in the world is liver failure, which is a severe burden of liver disease. Global health is greatly affected by the significant increase in mortality and morbidity that results from liver failure. Chronic liver disease (CLD) is still a major global health concern, which causes up to 2.1 million deaths globally, or 2.3-2.6% of worldwide deaths (Hassan and Li, 2022). Hepatic

encephalopathy (HE), which has a high prevalence and significant economic burden is a severe and devastating complication of CLD. There are two stages to it: covert HE, which is preclinical, and overt HE, which is clinically symptomatic. According to studies, 30% of cirrhotic patients have an overt HE episode, and 56% of them develop covert HE (Ning *et al.*, 2017). Reactive oxygen species (ROS) and oxidative stress cause liver damage, which mainly takes a part in initiating as well as progressing liver injury. In addition, the liver is a metabolic organ that metabolizes carbohydrates, lipids, and proteins for energy production. The major causes of oxidative stress in the liver include extrinsic and endogenous factors. Oxidative stress, induced by both extrinsic and endogenous factors, leads to irreversible alterations in DNA, lipids, and proteins within the liver (Mahboubi and Mahboubi, 2020).

Gastrointestinal (GI) diseases encompass conditions affecting the GI tract that contribute to nearly 8 million deaths worldwide each year. Although the etiology, as well as the mechanism of GI problems, are complex and not fully known. For centuries, medicinal plants have been supplemented and substituted with other therapies for the treatment of GI illness. Attempts are being made for the identification of different regulative mechanisms to produce effective herbal medicines in the fight against GI illnesses. Dandelion and its derivatives were used to treat GI-related disorders effectively (Li *et al.*, 2022). Moreover, dandelion is often considered to be a healthy food. Their roots are used to make therapeutic products such as teas, tinctures, capsules, pills, and juices. In some studies, there have been reported that the presence of phenolic components in dandelion root is responsible for its antioxidant properties. As this effect is associated with phenolic content, it was found that dandelion root water, ethanol, and methanol extract have antibacterial effects on *Bacillus cereus*, *Escherichia coli*, and *Staphylococcus aureus*. This edible, medicinal plant's wide distribution along with its roots provides an accessible natural source of inulin and antioxidants that can be used as a commercial crop. The findings of the study showed that the extracts from the root could potentially be used as natural antioxidant preservatives and food additives in the production of functional foods, which could delay oxidative stress and stimulate *bifidobacteria* growth (Petkova *et al.*, 2015).

### 1.1. Nutritional Composition of Dandelion Root

Dandelions are a well-known plant that grows in areas with mild temperatures. Dandelion contains phytonutrients and medicinal components (i.e. phytophenols, polysaccharides, lactones, and terpenoids). Additionally, because of its characteristics of antioxidant, anti-inflammatory, and anti-fibrotic, dandelion has been classified as a natural source of fibers, potassium, iron, vitamin B complex, vitamin C, zinc, as well as calcium (El-Nagar *et al.*, 2022a). In recent times, dandelions have been used to produce a variety of health products that reflect their beneficial health-promoting properties (Li *et al.*, 2022). The nutritional composition of dandelion root is described in Table 1.

**Table 1:** Nutritional Composition of Dandelion root

Dandelion root	Taxonomy	Scientific name	Bioactive components	Nutritional composition	Intake forms
	Family:	<i>Taraxacum officinale</i>	<ul style="list-style-type: none"> <li>• Oligosaccharides</li> <li>• Polysaccharides</li> </ul>	<ul style="list-style-type: none"> <li>• Carbohydrates</li> <li>• Inositol</li> </ul>	<ul style="list-style-type: none"> <li>• Raw material</li> </ul>
	Subfamily:		<ul style="list-style-type: none"> <li>• Peptides</li> <li>• Flavones</li> </ul>	<ul style="list-style-type: none"> <li>• Lecithin</li> <li>• Vitamins A</li> </ul>	<ul style="list-style-type: none"> <li>• Extracts</li> <li>• Infusions</li> </ul>
	<i>Cichorioideae</i>		<ul style="list-style-type: none"> <li>• alkaloids</li> <li>• terpenes</li> </ul>	<ul style="list-style-type: none"> <li>• Vitamin C</li> <li>• Vitamin D</li> </ul>	<ul style="list-style-type: none"> <li>• Further composition such as:</li> </ul>
	<i>e</i>		Phenolic acids such as:	<ul style="list-style-type: none"> <li>• Vitamin E</li> <li>• Vitamin B</li> </ul>	
			<ul style="list-style-type: none"> <li>• Chicoric acid</li> <li>• Caffeic acid</li> <li>• Chlorogenic acids</li> <li>• Cinnamic acid derivatives</li> <li>• Triterpenoids</li> </ul>	<ul style="list-style-type: none"> <li>• Oligo-elements and Minerals such as:</li> <li>• Copper</li> <li>• Phosphorus</li> <li>• Calcium</li> <li>• Sodium</li> <li>• Magnesium</li> <li>• Iron</li> <li>• Silicon</li> <li>• Zinc</li> <li>• manganese</li> <li>• High level of potassium</li> </ul>	<ul style="list-style-type: none"> <li>• Granules</li> <li>• Powder</li> <li>• Tablet</li> <li>• Capsule</li> </ul>
		(Majewski <i>et al.</i> , 2020)	(El-Nagar <i>et al.</i> , 2022b)	(González-Castejón <i>et al.</i> , 2012)	(Li <i>et al.</i> , 2022)

The nutrient composition of dandelion indicates a significant number of nonorganic substances, and vitamins, as well as a balanced combination of trace elements and macronutrients like proteins, and fiber, which makes it a

great source of trace minerals. Dandelion contains more dietary fiber, proteins, amino acids, and a large number of vitamins and minerals than other plants. Dandelion is composed of 1.5% lipids and a higher content of unsaturated fatty acids including linoleic, oleic, and palmitic acid. Among them,  $\beta$ -carotene is one of the important sources found in dandelion. Numerous studies indicate that dandelion contains high levels of vitamin A, C, D, E and B, choline, inositol, and lecithin as well as minerals and oligo-elements like manganese, calcium, iron, silicon, copper, sodium, magnesium, phosphorus, and zinc. Additionally, dandelion has a high potassium content (González-Castejón *et al.*, 2012, Yang *et al.*, 2020).

## 1.2. Bioactive Components of Dandelion root

Flavonoids and polyphenolic compounds (like taraxasterol, taraxerol, CGA, and chicoric acid, sesquiterpene lactones (SL), Vitamin B, A, C, D, and E, inositol, lecithin, and non-organic substances) are readily available in dandelion (Abdel-Magied *et al.*, 2019). The roots and constituents of dandelion are highly concentrated in flavones, triterpenoids, and derivatives of cinnamic acid, which are polyphenols with anti-bacterial, anti-inflammatory, and anti-cancer properties. In addition, the entire plant is considered to be secure as well as acceptable for human consumption with no reports of adverse reactions. Dandelions are currently a common ingredient of medicines used to treat urinary tract infections, liver disease, and spleen. Because phytochemical components can define a plant's therapeutic significance, their involvement, and effective processes in the elimination of disease. Additionally, the chemical constituents of dandelion extracts are affected by the part of the plant used, such as the entire plant, roots, stem, leaves, and flowers (Lis *et al.*, 2019).

Dandelion flowers and leaves have higher polyphenol concentrations as compared to the roots (Yang and Li, 2015). Dandelions have higher levels of dietary fiber and protein content. Dandelion contains 1.5% lipids and more unsaturated fatty acids such as oleic, linoleic, palmitoleic, and linolenic acids. Dandelion is also a significant source of  $\beta$ -carotene among green vegetables. The main effective component of dandelion is SL, which have anti-inflammatory and anti-cancer properties. There are several phenylpropanoids in dandelion root which exert effects of inflammation-modulation and terpenoids, polysaccharides play a role in platelet anti-aggregation activity, in hepatoprotective effects as well as in immune regulation (González-Castejón *et al.*, 2012). Natural substances, like those found in dandelions, can act as a source of powerful bioactive chemicals that may suppress numerous types of cancer without causing any adverse reactions. Furthermore, the rigorous separation as well as isolation of the active principle found in the various dandelion extracts would be crucial in understanding the anti-proliferative impact of dandelion on cancer cells (Rehman *et al.*, 2017).

In addition, dandelion can be found in a variety of foods and dietary supplements. Polyphenolic compounds, inositol, lecithin, and minerals present in these plants have been showed to be antioxidant, anti-inflammatory, anti-allergic, anti-hyperglycemic, and hypolipidemic, as well as anticoagulants for the prevention of hepatic disease but these mechanisms are still unknown. It is an excellent food source owing to its high content of essential fatty acids (Mahboubi and Mahboubi, 2020). Several studies have examined the phytochemical characteristics and medicinal uses of the various dandelion tissues, including the leaf, root, and flower. The leaves and roots of some species are generally eaten as food and are also used in folk medicine to protect the liver and prevent obesity because of their choleric, diuretic, anti-allergic, anti-carcinogen, antioxidant, anti-inflammatory, and hepatoprotective properties. Dandelion flower extract has been shown to reduce ROS and nitric oxide in vitro, as well as to prevent lipid oxidation. However, there is still little knowledge about the compounds and tyrosinase-inhibitory properties of dandelion leaf and stem extract. The interaction between phytochemicals and their functional properties should be investigated regarding the therapeutic effects. Many of the bioactive components of dandelion, like phenolic acid, have been studied on various illnesses both in vivo and in vitro to support the plant's traditional use and highlight its potential benefits (Xie *et al.*, 2018).

## 1.3. Therapeutic Effect of Dandelion Root

### 1.3.1. Dandelion in Hepatic Disorders

The essential organ in the body is the liver as it carries many functions which transform and purify the body from chemicals. However, the liver is primarily responsible for the elimination of common toxins, chemicals, and heavy metals from the body. Furthermore, medicinal products, environmental conditions, infections, accumulation of triglyceride, obesity, insulin resistance, and microorganisms all take part in the functioning of the liver as well as its associated illnesses. *T. officinale*, commonly used as a hepatoprotective agent is a well-known therapeutic herb (Mahboubi and Mahboubi, 2020). Non-alcoholic fatty liver disease (NAFLD) is the most prevalent form of liver disease worldwide. However, a small percentage of people with NAFLD may develop non-alcoholic steatohepatitis (NASH), a more severe form of liver disease. Histologically, NASH has been associated with the presence of hepatic steatosis and symptoms related to hepatocyte destruction. The occurrence of significant fibrosis is a major histological characteristic related to mortality in NASH, because several pathological changes may be attributed to

hepatic fibrosis (Younossi *et al.*, 2015, Caballeria *et al.*, 2018). Because CLD mortality is becoming more common and mostly affects adults in their working age it has become a global health concern and is likely to become more prevalent than any other cause of death by 2020. Hepatic injury in CLD results from metabolic, toxic, viral, or autoimmune injuries. The cause of CLD changed recently from being predominantly chronic hepatitis B or C to being primarily alcohol and obesity-induced chronic liver disorders. Reduced daily physical activity is another unappreciated primary cause of many chronic diseases, including CLD. Numerous studies have shown that the inflammatory process based on diet may potentially contribute to or cause CLD. The primary organ for the body's inflammatory and immune responses is the liver. Histological findings revealed that as hepatocyte injury proceeds and sustains a chronic inflammatory response, there is a significant risk of progression towards cirrhosis, hepatocellular carcinoma, and chronic liver failure in CLD. Oxidative stress has been identified in multiple studies to be the primary underlying cause of hepatocellular injury in CLD. In response to the harming stimuli, activated Kupffer cells in the liver produce the majority of ROS. Low levels of ROS production by mitochondria are required for metabolic adaptability in both physiological and pathological situations, and moderate levels of ROS control the release of inflammatory mediators. Tissue damage can result from a high, excessive release of ROS, which can trigger autophagy or apoptosis. By producing ROS, Kupffer cells in the liver cause necrosis and apoptosis in hepatocytes and activate hepatic stellate cells, which in turn cause these cells to phenotypically change into cells that excessively produce extracellular matrix and cause liver fibrosis (Teodorescu *et al.*, 2021, Y. Zhang, 2023).

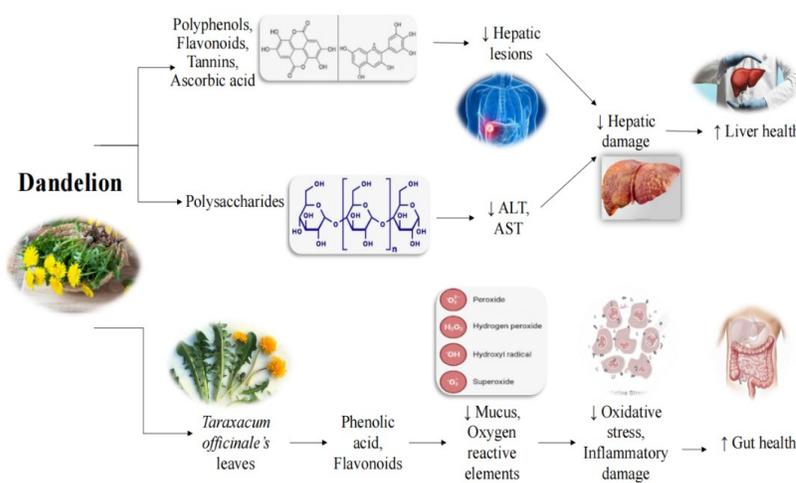
Liver failure may be classified as acute on chronic liver failure (ACLF), acute liver failure, or acute end-stage liver disease. Acute liver failure is a severe injury of the liver that occurs in the absence of previous illnesses of the liver. ACLF is a disorder where patients with chronic liver disease, whether or not they have previously been diagnosed with cirrhosis, experience acute hepatic deterioration that results in liver failure and one or more extrahepatic organ failures. This condition is associated with an increased risk of death for up to 3 months. ACLF occurs in between 24% and 40% of people, mainly in adolescents or middle-aged individuals, and it may be reversible (Pfungstgraf *et al.*, 2021, Tharwat and Al-Hawas, 2024). The particular mechanisms of ACLF are unknown, however, the pathophysiology is represented by four levels of representation for initiating events, and a direct result of such events is hepatic injury, as well as injury in response to and failure of other organs. Inflammation, use of alcohol, bleeding from GI, viral hepatitis B reactivation, hepatitis A and E viruses superinfections, autoimmune intractable hepatitis acute events, Wilson's disease, and hepatic diseases may all play a part in this process. During the propagation phase, the release of pro-inflammatory mediator's increases, activating an innate inflammatory response ailment as well as circulatory dysfunction of endothelium, eventually leading to the failure of organs. However, the macrophages of the liver synthesize the anti-inflammatory cytokines and generate a compensatory inflammatory response problem ultimately leading to acquired immunodeficiency disease or chronic immune system paralysis. ACLF risk factors can be identified by regulating the state of oxidation, infections, necrosis, and apoptotic biomarkers. ACLF requires the presence of multiple organ failure, and the kidneys are the highly affected organs. As a result, new preventative medicines for chronic hepatic disorders must be developed to avoid ACLF. Phototherapy has been a significant contributor to the treatment of various diseases due to prolonged studies on the use of herbal medicines. Medicinal plants were being used worldwide for the treatment of liver illnesses as many phytochemicals are hepatoprotective. Herbal treatments with anti-inflammatory and antioxidant properties could be a great source of bioactive components because oxidative stress and ACLF inflammation are crucial pathogenic procedures (Pfungstgraf *et al.*, 2021, Al-Saeed *et al.*, 2023).

Due to its strong phytochemical composition which has shown an effect against hepatic injury, dandelion is frequently used in the prevention and treatment of liver illnesses. The study's objective was to examine the possible preventive impact of ethanolic *T. officinale* root extract (TOERE) on an observed model of rats for acute and chronic liver failure. Human serum albumin causes chronic liver failure. Five pairs of male Wistar rats were taken. TOERE treatment at three distinctive dosages before initiation of ACLF declined liver injury marker of serum and renal tests (creatinine, urea test, and state of oxidation tests). As a result, TOERE reduced the degree of liver tissue lesions, also the study indicated that oxidative stress reduction may be the mechanism of TOERE's hepatoprotective impact in ACLF (Pfungstgraf *et al.*, 2021). Several studies investigated the therapeutic properties of various dandelion extracts using models of oxidative stress and liver damage caused by carbon tetrachloride (CCl<sub>4</sub>). In one of the experiments on this subject, a single dose of CCl<sub>4</sub> was used to induce hepatitis, and the extracts were administered for 7 days. The liver lesions and the activities of Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) are greatly reduced by the pre-treatment with dandelion water extract, even though CCl<sub>4</sub> significantly increases the serum AST and ALT activities. It was proposed that the polysaccharides from the dandelion root have hepatoprotective properties by preventing oxidative stress and inflammatory responses. Additionally, it has been demonstrated that dandelion root fractions, namely an enriched fraction of SL, and an ethanolic extract exhibit hepatoprotective potential against CCl<sub>4</sub>-induced hepatotoxicity in mice. However, the post-treatment with ethanolic extract and SL significantly prevented hepatotoxicity, as seen by the decreased levels of hepatic enzyme indicators such as ALT, AST, Alkaline phosphatase

(ALP), and total bilirubin. Ultimately, it was determined that SL derived from dandelions protects mice from acute hepatotoxicity caused by CCl<sub>4</sub> infusion (Ignat *et al.*, 2021, Ijaz *et al.*, 2023).

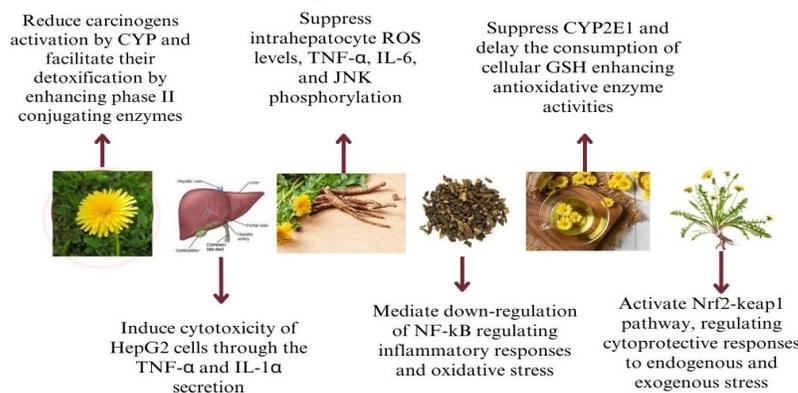
In a mouse model that demonstrates acute liver injury induced by sodium dichromate poisoning, it was discovered that the leaf extract significantly reduced oxidative stress, genotoxicity, and hepatotoxicity. Ascorbic acid, polyphenols, flavonoids, and tannins in dandelion leaf water extract are considered to be the active ingredients responsible for their hepatoprotective properties. As previously mentioned, antioxidant components in dandelion leaf extracts are responsible for their therapeutic effects in the management of liver lesions (Ignat *et al.*, 2021, Musaddaq *et al.*, 2024). Fig 1 shows the mechanistic effect of dandelion on gut and liver health.

In a rat model, Acetaminophen (APAP) was induced by two pure water-soluble polysaccharide fractions from dandelion root which were extracted and studied for their potential hepatoprotective properties. These findings demonstrated that via activating the Nrf2-Keap1 pathway, the two polysaccharides found in dandelion roots can protect the liver from hepatic damage caused by APAP. The main regulator of cytoprotective actions against endogenous and exogenous stresses is triggered by ROS and electrophiles (Ignat *et al.*, 2021, Mushtaq *et al.*, 2024). The mechanism of action of dandelion root in combating hepatic disorders has been demonstrated in Fig 2.



**Fig 1:** Overview of Mechanistic Effect of Dandelion on Gut and Liver Disease

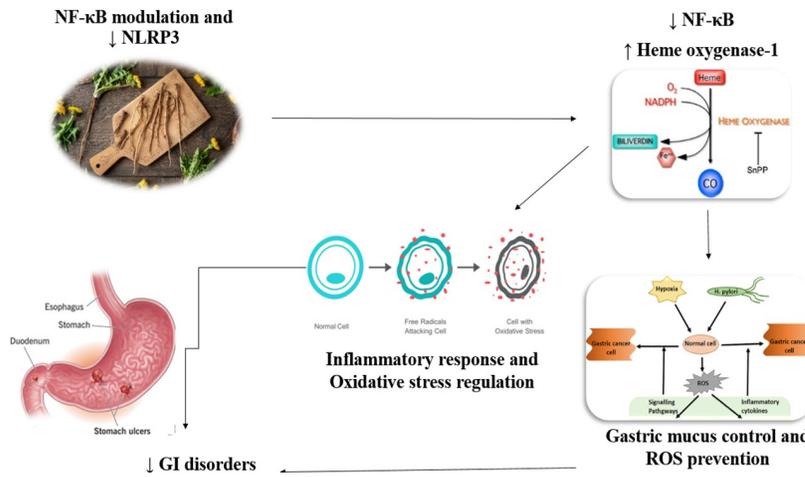
### Dandelion Mechanism of Action in Hepatic Disorder



**Fig 2:** Mechanism of Dandelion Root Against Hepatic Disorder.

Fig 3 shows that phase II conjugating enzymes and cytochrome P450 (CYP) in dandelion metabolize different components to nontoxic metabolites. Dandelion extracts stimulate the production of interleukin-1 alpha (IL-1 $\alpha$ ) and tumor necrosis factor alpha (TNF- $\alpha$ ) in HepG2 (Human Hepatocellular Carcinoma) cells. Reactive oxygen species (ROS) levels were significantly reduced by dandelion extract, which prevents liver fibrosis. They also prevent nuclear factor kappa B (NF- $\kappa$ B)-mediated inflammation. Dandelion inhibits the oxidative stress caused by the c-Jun N-terminal kinase (JNK) and Cytochrome P450 2E1 (CYP2E1) pathways. Reduced glutathione (GSH)

depletion was reversed by the polysaccharides in dandelion. The nuclear factor erythroid 2-related factor 2 Kelch-like ECH-associated protein 1 (Nrf2-keap 1) signaling pathway contributes to the antioxidant activity of dandelion.



**Fig 3:** Mechanism of Dandelion Root in Gut Disorder.

In a study, D galactose was utilized to determine a liver dysfunctional model due to oxidative stress in mice and observed that dandelion has been shown to improve exercise capacity for mice with impaired liver function. In this investigation, the performance and function of dandelions in enhancing running potential, persistence of swimming, blood biological indicators, histopathological modifications, and tissue messenger RNA change have been investigated. The outcome from animals displayed that dandelion enhanced the duration that liver-dysfunctional mice utilized for running and swimming, until they were completely depleted, reduced the amount of blood lactic acid and serum blood urea nitrogen in the liver, and improved the degrees of both muscle and hepatic glycogen. Histopathological observations have indicated that dandelion has reduced liver lesions. The positional investigation displayed that protocatechuic acid, gallic acid, p-coumaric acid, rutin, myricitrin, isoquercitrin, isochlorogenic acid A are major constituents. In China, dandelion is a perpetual plant that has long been utilized as a conventional remedy and as a superfood. Functional foods from plants have beneficial effects on liver protection and promotion of hepatic function, which is an important effect of such natural functional foods in terms of improving liver function through antioxidants (Truong *et al.*, 2024).

Moreover, in another study it was examined that the therapeutic characteristics of dandelion provide the theoretical framework for future research and consumption of dandelion. The liver is the major organ of the oxidative stress response and plays an important role in determining the level of oxidation and causing the body to produce free radicals and lipid peroxides simultaneously. There may be lesions in liver tissue due to high levels of free radicals. Furthermore, impaired liver function is associated with decreased vasoconstriction levels and reduced blood supply to various organs directly reducing the ability to exercise. The lesions in the liver tissues were confirmed by the pathological findings of this study. In particular, dandelion inhibited liver dysfunction through effective reduction of these lesions (Y. Zhang *et al.*, 2022).

Oxidative stress caused by alcohol and NAFLD caused by high-fat diet was reduced by aqueous dandelion root extract. Additionally, dandelion polysaccharides (DP) are claimed to possess antioxidant and anti-inflammatory properties. Dandelion has long been used as a food and medicine in China. All dandelion components, particularly the polysaccharide-rich root region, can be utilized as a therapeutic herb. Polysaccharides biological activities are greatly influenced by a variety of elements, such as their chemical composition, molecular weight, glycosidic linkages, extraction and isolation techniques, and even their molecular weight. According to studies, oxidative stress is the primary cause of liver damage. The main defense mechanism for both the liver injury prevention and treatment is increasing the levels of antioxidant enzymes (Cai *et al.*, 2017).

### 1.3.1. Dandelion Root in Gut Disorders

Dandelion contains several GI-protecting substances, including sitosterol, inulin, polysaccharides, luteolin, and its glucosides, caffeic acid, taraxasterol, and chlorogenic acid (CGA). Dandelions and their constituents have been demonstrated to be pharmacologically effective against various GI problems, including dyspepsia, gastritis, ulcerative colitis (UC), small intestinal ulcer, liver issues, gallstones, gastroesophageal reflux condition, acute pancreatitis, and GI cancer. While the relationship of dandelion components with GI health-associated biological substances (such as GI microbiota and similar biological regulators), the primary molecular procedures comprised

immuno-inflammatory processes, apoptosis mechanisms, autophagy mechanisms, and cholinergic mechanisms may be included. As a beneficial therapeutic herb, it is widely used in conventional therapies, ethno medicine, and possible treatments to manage a wide range of ailments, including some GI problems, from digestive complaints to complicated illnesses. Dandelion may be used in the development of several health-promoting preparations to provide beneficial health-related properties (Li *et al.*, 2022). The herb provides laxative, diuretic, and effective anti-diabetic properties in Turkish traditional medicine. In traditional Chinese medicine, Dandelion can be used to strengthen the immune system's resistance against upper respiratory tract infections, pneumonia, and bronchitis. Dandelion can be utilized along with various other herbs to cure hepatitis. Their extracts contain lipotropic compounds that can enhance hepatocyte functioning. There are numerous health benefits associated with using dandelion extracts or the plant itself, such as its anti-inflammatory, anti-carcinogenic, anti-rheumatic, and hypoglycemic properties (Rolnik and Olas, 2021, Ivanov, 2014, Di Napoli and Zucchetti, 2021, Faria *et al.*, 2019).

Various prior investigations have shown that one of the main pathogenic causes of this disease is an imbalance between pro-and anti-inflammatory cytokines. Several signaling pathways control the production of these cytokines, with two of the most recent ones gaining attention. The Nod-like receptor protein 3 (NLRP3) inflammasome and the nuclear factor kappa B (NF- $\kappa$ B) pathway are involved in the process of inflammation. Both NF- $\kappa$ B and NLRP3 inflammasome expression and activity are significantly increased in an inflamed gut. Oxygen free radicals have the ability to rapidly damage the intestinal mechanical barrier by stimulating the production of inflammatory mediators. In medicinal applications, certain bioactive polysaccharides are already being utilized due to their beneficial and non-toxic characteristics. The mechanism for reducing the inflammation has been slightly improved. It has been confirmed that dandelion may modulate the NF- $\kappa$ B pathway and prevent the NLRP3 inflammasome from activation. Furthermore, a recent study showed that by activating heme oxygenase-1 and inhibiting NF- $\kappa$ B, dandelion root extract (DRE) provides protective benefits against colitis induced by Dextran Sodium Sulfate. One of the primary bioactive components of dandelion is DP. The research found that many of the bioactivities found in dandelion, including those that are anti-inflammatory, antioxidant, immunomodulatory, antibacterial, and anti-cancer have also been found in DP. By controlling the oxidative stress and the inflammatory response, DP may serve as a potential therapeutic intervention for patients with ulcerative colitis (Wang *et al.*, 2023, Haroon *et al.*, 2023). The mechanism of dandelion root against gut disorders is shown in Figure 2.

The pathogenesis of UC is restricted to the colonic mucosa, in comparison with the Crohn's disease, which can affect any area of the GI tract. Importantly, UC is associated with an increased risk of colorectal cancer. When damage to the intestinal epithelial cells affects the function of the intestinal epithelium, unusual immune responses and immunosuppressive effects may occur. Therefore, intestinal epithelial integrity is essential for maintaining gut health. Using cytoprotective medicines that target intestinal epithelial cells is crucial in UC treatment therapies (Ding and Wen, 2018). One of the prevalent GI disorders, ulcers, occurs as a result of a distortion of the defensive (gastric mucosal integrity) and offensive (gastric acid secretion) levels. Researchers of alternative medicine often use different plants to treat an array of illnesses, and one such plant is *T. officinale*, commonly known as dandelion. Natural occurring plants with a wide range of bioactive chemical components have been incorporated into traditional and alternative medicine, which have been identified and separated for medicinal purposes. It has been found that the aqueous extracts of dandelion leaves exhibit anti-ulcer properties. The antioxidants found in the plant extracts can contribute to the ameliorating effect on the gastric mucosa by limiting the production of acid; as a result of their potential to limit the production of acid, the antioxidants found in plant extracts may be the cause of the ameliorating effect on the gastric mucosa, as demonstrated by the increase in weight of gastric wall of mucus and the percentage inhibition. Thus, a reduction in the stomach wall's area relates to an improvement in the ulcer healing process (Berezi *et al.*, 2019). 10% of people worldwide suffer from ulcers, which is a serious GI illness with a variety of etiologies. The main causes of peptic ulcers are characterized by inflammation, mucosal bleeding, and GI pain in patients. These causes include smoking, excessive stress, long-term alcohol use, and *Helicobacter pylori* bacterial infection. An imbalance between the gastro-protective factors and aggressive factors could lead to the development of these ulcers. To effectively repair peptic ulcers, the current treatment strategy involves inhibiting gastric acid secretions, promoting gastro-protection, preventing apoptosis, and stimulating epithelial cell proliferation. Herbal remedies are typically utilized in chronic conditions where long-term treatment with medication is needed. Upper GI damage such as ulcers, and lesions may result from the gut mucosa's auto-digestion and the disintegration of the gastric mucosal barrier, as well as life-threatening perforation and hemorrhages, which are symptoms of pylorus ligation-induced ulcers. Stomach ulcers occur as a result of pyloric ligation of the stomach, leading to the accumulation of gastric acid. This approach effectively prevents ulcers by acting as an agent that increases mucus secretion while decreasing gastric acid production (Sahoo *et al.*, 2016, Nowak *et al.*, 2019).

Herbs are important in the development of various therapeutic remedies. Dandelions, in particular, are commonly utilized in traditional Chinese therapies to manage the issues such as tumors, hepatitis, and digestive problems. It has been demonstrated that dandelion root aqueous extract reduces alcohol-induced liver damage by

enhancing anti-oxidative potential and decreasing lipid peroxidation. However, research on how the dandelion can reduce inflammation and antioxidant damage in UC is relatively limited (Ding and Wen, 2018). Over 1 million new cases and 0.7 million deaths from gastric cancer occur each year, making it the second most common cause of cancer-related deaths globally and the fourth most prevalent malignancy. Natural products and natural health products have gained recognition as essential components in the formulation of various medicines. According to the research findings, DRE may inhibit the capacity of the stomach cancer cells to proliferate and multiply (Zhu *et al.*, 2017).

### 1.3.3. Gastro protective effect of Dandelion root

When the preventive barrier of the duodenum, stomach, or esophageal mucosa is damaged, peptic ulcers can develop. Because of an imbalance in protective factors, the cause of stomach ulceration is complex and multidisciplinary. Most experiments are performed in rodents for pharmacological screening, and gastric lesions are measured after a stomach dissection, macroscopic and microscopic examination of ulcerative lesions may be performed. The purpose of this examination was to evaluate the gastro protective effects of *T. officinale* aqueous extract (AETo) in rats. After that, rats were treated with AETo, and the area and histologic characteristics of the stomach ulcers were calculated, followed by histochemical analysis. The action of AETo has been studied against inflammatory anti-oxidative stress mediators in ulcerated tissues. In addition, they have been using ultrasonography to assess the thickness of the stomach wall, AETo's chemical composition was also examined (Zanatta *et al.*, 2021). Histological analysis confirmed the reduction in ulceration areas, increased mucin levels and gastro protective effects of AETo in rats. Glutathione (GSH) levels increased in association with the gastro protective effect. Furthermore, AETo has been found in rats to diminish the thickness of the stomach wall. Phenolic acid and flavonoid have been identified as the primary active substances by a phytochemical analysis of AETo. Finally, there is a reduction of oxidative stress and inflammatory damage as well as an increase in mucin levels associated with the gastro protective effect of AETo. The mechanisms of *T. officinale* stomach protection will be beneficial in the development of new compounds that protect against GI adverse effects (Zanatta *et al.*, 2021). Lesions in the stomach can affect the mucosa, the extensive covering of the GI wall, and the muscle tissue, leading to issues such as hemorrhage or perforation. Traditionally, dandelion has been used to manage GI problems, stomach discomfort, and kidney stones, as well as hepatic disorders, owing to its hepatoprotective properties. Reduced GSH plays a crucial role in the antioxidant defense mechanism, contributing to the protection of physiological system integrity and the regulation of gastric mucus. GSH helps prevent damage to cells from oxygen-reactive elements. The infusion of dandelion leaves is employed to treat diabetic, hepatic, and GI diseases, while also providing anti-inflammatory and diuretic properties (Zanatta *et al.*, 2021).

### 1.3.4. Other Health Benefits of Dandelion Root

For centuries, traditional Chinese, Arabian, and Native American medicine have utilized the root of the dandelion to treat a variety of illnesses, from cancer to digestive problems. Prostate cancer cells induce cell death in response to dandelion root and lemongrass extract in a manner that is dependent on both time and the dose. Unlike taxol-like chemotherapies, these extracts cause the prostate cancer cells to undergo apoptosis without significantly affecting healthy colon mucosa. Moreover, the researchers examined the anti-cancer effect of DRE and lemongrass extract *in vivo* and discovered that both extracts were beneficial in lowering the tumor load in mice (Nguyen *et al.*, 2019). DRE stimulates leukemia, colorectal, and pancreatic cancer cell apoptosis by activating many death-signaling pathways. By inhibiting the PI3K/AKT pathway, DRE can reduce inflammation caused by the lipopolysaccharides. Additionally, they have an anti-oxidative effect on alcohol-induced liver damage by decreasing lipid peroxidation (Zhou *et al.*, 2022).

For a very long time, dandelion has been used to cure a variety of illnesses, such as jaundice, gonorrhea, and pneumonia. Dandelions are available in many different types, with over 2000 species globally, roughly 100 of which are mostly found in China. When compared to other herbals, dandelion possesses numerous characteristics that make it a valuable crop for industrial production, including strong adaptability, abundant resources, simpler cultivation, and sustainable production. However, due to the dandelion's significant economic and therapeutic potential, it has gained a lot of interest as one of the very first categories of edible and medicinal plants to be approved by the Chinese Ministry of Health. DP are a group of major dandelion constituents that have been shown to have anti-tumor, anti-complementation, hepatoprotective, and anti-oxidative properties. One of the main components of dandelion roots water extract, which has been demonstrated to possess anti-tumor properties, is fructan-type polysaccharides such as inulin. More importantly, preliminary experimental results and early scientific research also supported this claim (S. Zhang *et al.*, 2021, Shaker *et al.*, 2023).

Despite its weedy nature, the plant has great potential for treating a variety of illnesses. Since ancient times, people have used the herb as medicine. A large variety of bioactive substances are believed to be present in

dandelion (Qadir *et al.*, 2022, Martinez *et al.*, 2015, Diaz *et al.*, 2018). Dandelion is cultivated for both food and medicinal purposes and has been utilized in ethno pharmacology as a traditional folk medicine in Russia, India, and China because of its hepatic and hyperglycemic effects. Salads are frequently consumed due to their higher number of micronutrients including vitamins and minerals. Dandelion has a wide range of medicinal effects, including the treatment of blisters, spleen issues, liver problems, and type 2-diabetes. Minerals, sugars, choline, vitamins, mucilage, and pectin, along with carbohydrates (such as inulin), carotenoids (such as lutein), fatty acids (such as myristic acid), and other nutrients are all present in dandelion roots (Wirngo *et al.*, 2016).

One of the many health benefits of inulin, a complex carbohydrate, helps eliminate pathogens from the GI tract and can prevent obesity, cancer, and osteoporosis. The leaf extracts are used as a coffee alternative, and beverage flavor enhancers are beneficial against obesity and cardiovascular diseases (Wirngo *et al.*, 2016). The family of *Asteraceae* is famous for its antioxidant and anti-proliferative properties in both in vitro and in vivo studies. Jaundice, Cholera, cancer, scurvy, arthritis, acidosis, headache, collagen formation, along with urinary acid problems have all been treated with this plant. Roots and new plants, in particular, are utilized for therapeutic purposes and have a strong anti-liver disease effect. The flowers, leaves, and roots, comprise phytonutrients, in addition to stems, which are responsible for *T. officinale* biological characteristics, with each part having biological activity against specific diseases (Kamal *et al.*, 2022).

Dandelions is a centuries-old medicinal herb used to treat inflammatory illnesses and specific changes in metabolism associated with obesity. Based on animal trials, the purpose of this analysis was to examine the potential uses of *T. officinale* flower water syrup (TOFS) in combination with a diet that is low in fat for the treatment of obesity. Albino male wistar rats at 25 weeks of age were incubated for 4 weeks on a conventional low-fat diet, either with or without additional TOFS. The thoracic aorta's reactivity and antioxidant capacity were assessed in the study. TOFS exhibited positive effects by modulating blood lipids High-density lipoproteins (HDL) and reducing atherosclerotic risk factors. An improved antioxidant state was obtained by a reduction in lipid peroxidation and an increase in plasma superoxide radical scavenging. ALP, an indicator of liver injury/illness, was effectively reduced. No significant differences were observed in feed consumption, body weight, the ratio of organs to body weight, blood glucose levels, or the levels of carbonyls in blood plasma and thoracic arteries. TOFS demonstrated beneficial properties through the control of prostanoids and the anti-oxidative state. Dandelion extracts from various parts are protective against plasma proteins in human plasma investigations. In another in vivo study, extracts of petals exhibited increased antioxidant activity, explaining the higher flavonoid concentration compared to other studied plant organs. Additionally, dandelion root and leaves have been demonstrated to have hypolipidemic and oxidative effects in cholesterol-fed rabbits (Majewski *et al.*, 2021).

Dandelion has been utilized for therapeutic purposes due to its biological activity against various illnesses. The chemical constituents of essential oils have been studied as a means of examining the anti-proliferative and antioxidant potential of dandelion. During 14 days of treatment with Dandelion essential oil, the anti-oxidative effects of mice liver and kidney homogenates were assessed. The essential oil of dandelion protected the liver and kidneys of mice by increasing antioxidant enzymes (Kamal *et al.*, 2022). Dandelion roots contain fructo-oligosaccharides (FOS), which are found in inulin. FOS is a complex carbohydrate that aids *bifidobacteria* in fighting infection in the digestive system. Mineral absorption causes FOS to stimulate the immune system, and this ultimately restricts the formation of abnormal cells. This complex carbohydrate may aid in bringing blood sugar levels back to normal. Studies on dandelion extracts suggest that dandelions may promote the release of insulin in pancreatic beta-cells, which may reduce the impact of hyperglycemia. It has been discovered that dandelion leaf extract significantly reduces the levels of triglyceride, cholesterol, and blood sugar in mice (Wirngo *et al.*, 2016).

Adenosine monophosphate-activated protein kinase, a liver enzyme that significantly reduces fat storage and increases insulin sensitivity may be responsible for this effect. Several studies have shown that the active component of dandelion reduce excessive cholesterol, reverse streptozotocin-induced diabetes, and lessen oxidative stress in liver damage. It is important to note that CGA derived from dandelion is considered highly anti-oxidative. It can reduce oxidative stress in the liver and increase the production of glutathione, malondialdehyde, and other enzymes that scavenge ROS (Wirngo *et al.*, 2016). Due to the harmless bioactive compounds present in every part of the dandelion plant, they exhibit protective effects on pancreatic beta cells and against diabetes (Chatterji and Fogel, 2018). High levels of radiation have a detrimental impact on the organs of individuals. Traditionally, *Dandelion* has been used as a folk remedy. DRE treatment reduces oxidative stress in the liver and it has been shown that the follicle-stimulating hormone levels decline, testosterone, luteinizing hormone, inhibin B, and zinc levels increase. Histological alterations in the hepatic and testicular tissues further diminished the importance of DRE. Ultimately, it was discovered that DRE pre-irradiation therapy was effective in the rat liver and testicular tissues (Abdel-Magied *et al.*, 2019).

### 1.3.5. Anti-Oxidative Effect of Dandelion Root

The effects on choleric, anti-rheumatic and diuretic properties have been shown to be very beneficial with dandelion, which is an herbal medicinal product. Recently, based on research, oxidative stress has a significant role

in the development of metabolic syndrome linked to atherosclerosis. The purpose of this study was to investigate the potential hypolipidemic or anti-oxidative benefits of dandelion root and leaf derivatives in rabbits fed a high cholesterol diet. A sum of 28 male rabbits was split into four categories: 1<sup>st</sup> group receives normal diet, 2<sup>nd</sup> group receives diet high in cholesterol and containing 1% dandelion leaf, the 3<sup>rd</sup> group fed a diet high in cholesterol and containing 1% dandelion root. Following the course of the treatment interval, antioxidant enzymes of plasma and lipid profiles were regulated. Results indicate that dandelion root and leaf treatments improved lipid profiles and plasma antioxidant enzyme activity in rabbits fed a high-cholesterol diet, indicating that it could have hypolipidemic and antioxidant properties. In addition to protecting from oxidative stress, dandelion root and leaf may reduce the atherogenic index (Choi *et al.*, 2010).

More than 30,000 plants, as well as specific bacteria and fungi, have been shown to contain inulin, a plant polysaccharide of the fructan type that is greatly distributed in nature as a kind of storage carbohydrate. Among the many biological effects of inulin are its prebiotic characteristics, antioxidant, anti-tumor, and immunomodulatory properties. Food and Drug Administration (FDA) approved inulin as a natural ingredient in the food and pharmaceutical industries in 2018 because of its excellent bio-compatibility, diverse range of bioactivities, and suitable chemical characteristics. Inulin was believed to be used in food items as a thickening fat replacement, sweetener, water retention agent and stabilizer as well as drug carrier, and auxiliary therapeutic agent for a variety of ailments including diabetes and cancer (S. Zhang *et al.*, 2021).

The dandelion root and plant are used in food items, nutritional supplements, and pharmaceutical formulations for a variety of illnesses, primarily conditions affecting the liver, gallbladder, and kidneys. This is because dandelion fractions and their constituents have been shown to have a range of biological activities, including anti-inflammatory, antioxidant, and anti-hyperglycemic effects. Importantly, there have been no reported adverse effects, and the plant's chemical composition, along with its widely distributed global distribution, contributes to its popularity. Plant polyphenols, found in dandelion, have the potential to prevent the oxidation of dietary lipids, proteins, and vitamins. This, in turn, can provide beneficial health effects by inhibiting damage to the body's structural components, such as lipids, and proteins, through reduced biological degradation. The leaves and flowers of dandelion plants contain several polyphenolic substances, primarily phenolic acids and flavonoids (derivatives of apigenin and luteolin). One example is chicoric acid, a natural bioactive compound with anti-oxidative and hypocholesterolemic characteristics that have been proven to be useful in inhibiting the development and progression of atherosclerosis. Studies on male rats administered dandelion alcohol leaf fractions have shown protective effects against CCl<sub>4</sub>-induced liver tissue damage. Additionally, rats and rabbits whose diets included dandelions leaves and roots showed improved lipid profiles. In a different investigation, triglycerides were measured in the plasma of mice given an atherogenic diet for six weeks, total cholesterol, and serum low density lipoprotein (LDL) also reduced by dandelion water and ethanol fractions. Furthermore, in diabetic rats, dandelion water extract enhanced serum HDL-C levels while decreasing triglyceride and total cholesterol levels (Majewski *et al.*, 2020).

The therapeutic effect of dandelion against hepatic and gut disorders has been described in Table 2.

**Table 2:** Therapeutic effects of Dandelion

Target disease	Main component	Study subject	Methodology	Result	References
Liver dysfunction	Dandelion	Mice	↑ swimming endurance, histopathological changes and tissue mRNA expression changes and blood biochemical indices.	Extended running duration and ↓ the degree of serum lactic acid in blood as well as blood urea nitrogen in the liver. Reduce lesions in the liver.	(Y. Zhang et al., 2022)
Hepatic and testicular tissues		Rats	For 14 days before and after treatment with DRE, as a shot dose animal were exposed to gamma radiation and DRE were supplemented to rats.	Treatment with DRE, (Abdel-irradiation was Magied et al., 2019) orally testicular tissues of rats.	
Cancer	Dandelion	Mice	For 14 days, homogenate samples of liver and kidney put through APAP-induced oxidative stress were evaluated and then treated with dandelion essential oil	For cancer therapy, (Kamal et al., 2022) dandelion essential oil formulations were effective in	

Oxidative stress	Roots of dandelion	In vitro	In plasma, the hemostatic activity by using three determined hemostatic criteria plant preparations were investigated	Dandelion preparations, (Lis et al., 2018) exerts antioxidant and anti-coagulant actions of the hemostatic system, also considered as promising plant materials.
Antioxidant status	TOFS	Albino-Wistar rats	For four weeks, rats were fed with or without added TOFS along with normal fat diet	TOFS regulates blood lipids as well as shown (Majewski et al., 2020) beneficial impacts. The antioxidant status was ↑, by improving the plasma superoxide radical scavengers.
Liver	Dandelion leaf extract	Male Wistar rats (Diabetic)	Rats were subdivided into 6 pairs and every pair contains 6 rats. For biochemical inspection, the animals were sacrificed, and the liver was accumulated, and then homogenized	Dandelion leaf extract (Nzekwe et al., 2020) could ↑ liver antioxidant status.
Liver diseases	Dandelion root extract	Male Wistar rats	Chronic liver failure was caused by using human serum albumin and D-galactosamine lipopolysaccharides.	The extent of liver tissue lesions was ↓ by treatment with dandelion root extract. (Pfungstgraf et al., 2021)
Gastro effects	protective Dandelion	Rats	In an ulcerated tissue, the activity of aqueous extract of dandelion and the inflammatory oxidative stress was assessed.	The gastro protective outcome of aqueous extract of dandelion increases the mucin content as well as ↓ the oxidative stress and inflammatory injury. (Zanatta et al., 2021)
Ulcerative colitis	DRE	Mice	By ↓ the oxidative stress and inflammatory conditions, the accelerating acute injury.	DRE can be effective and ↑ considered as anti-colitis complex mixture and also used as an alternative to therapeutic intervention for UC. (Ding and Wen, 2018)
Chronic liver diseases	Dandelion leaves and root extract	Mice	The leaves and root extract of dandelion ↓ the marker enzymes of liver toxicity, and oxidative stress lipid peroxidation.	Liver marker enzymes, catalase, superoxide dismutase, and lipid peroxidation were ↓ by dandelion leaves extract. (Devaraj, 2016)
Anti-oxidative and Hypolipidemia	Dandelion root and leaf	Male rabbits (28)	Rabbits are divided into 4 sets; a normal diet group, a diet high in cholesterol, and a fourth group comprised of 1% dandelion root and high in cholesterol diet.	Lipid profiles and plasma antioxidant enzyme activities were changed with 1% dandelion leaf and high in cholesterol, and a fourth group root. (Choi et al., 2010)
Permethrin-induced liver injury	Dandelion	Mice	Mice were divided into four pairs. Negative control, permethrin, and fourth group were obtained permethrin and a diet with dandelion.	In mice, liver histological profile and alterations of Koubaa et al., 2020) acquired biochemical parameters were reversed with dandelion roots extracts.
Intestinal microbiota	Dandelion root	Albino rats	Includes 4 diet treatment groups and all the treatments were organized in a completely randomized design.	Uric acid, total protein, total oxidant status, serum cholesterol, triglyceride, bilirubin, and creatinine, were significantly ↓ with supplementation of dandelion root. (Rashid et al., 2022)
Hypercholesterolemia	Dandelion	40 albino Mice	Mice were split into 4 sets.	The serum of HDL and (El-Nagar et

effects on liver.	seeds extract	mice (male)	One group with untreated LDL, total cholesterol al., 2022b) control, treat 2nd group with and liver enzymes seed extract of dandelion, and activities, were ↓. treat the third group by using the With less steatosis, cholesterol powder and fourth inflammation, fibrosis, one with cholesterol and Hepatic tissues were dandelion extract. improved.
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#### 1.4. Dietary interventions using Dandelion plant

Dandelion have been extensively utilized in conventional and alternative forms of medicine throughout the world, according to results from the literature. Dandelions, mainly leaves abundant in vitamin C, flavonoids, and carotenoids, possess a strong antioxidant capacity. It might be a commonly available source of antioxidants and minerals in the normal diet of an individual. Since dandelion roots include carotenoids, chlorophyll, and fiber, using their leaves in fresh salads and their flowers in acidic dairy and cheese enhances the product's nutritional value as well as its appearance, and physical, chemical, and sensory properties (Fatima *et al.*, 2018).

They can be incorporated into various products, such as fresh salads using leaves and acidic dairy or cheese with flowers, affecting physical, chemical, and sensory properties. Several studies have aimed to explore various components of dandelion for their potential anti-diabetic, hepatoprotective, anti-steatotic, anti-lipidemic, and anti-cancer properties. It is advised that extensive *in vitro*, *in vivo*, and clinical research be carried out to better understand the physiological, biochemical, and pharmacological processes that support the health-promoting properties of dandelion. Currently, there is insufficient data from well-conducted clinical trials. The main advantages of using medicinal plants, such as dandelion, for therapy in various illnesses and disorders include safety, convenience, cost-effectiveness, and accessibility. The benefits of dandelion as a liver tonic have been recognized by traditional medicines, and it is frequently used in combination with other herbs to treat hepatitis in traditional Chinese medicine. The US (United States) Food and Drug Administration's "generally recognized as safe" list of foods and supplements includes dandelion extracts, indicating the plant's safety (Fatima *et al.*, 2018). In recent times, dandelion is regarded as a traditional remedy offering potential health benefits and is commonly consumed as coffee and herbal teas (Abdel-moemin and Osama Aboraya, 2014).

The literature highlights dandelion's traditional applications in treating renal ailments, diabetes, bacterial infections, and abnormalities related to the liver, kidney, and spleen. Additionally, it is recognized for its anti-inflammatory properties. Dandelion roots and young leaves are commonly used in various recipes as a substitute for coffee or tea, and dandelion are consumed as food, particularly as a salad ingredient. A 100 g sample of dandelion fresh leaves has been found to contain 88.5 g of water. Dandelion flower extracts can be used to improve the flavor of a wide variety of foods, such as puddings, baked cakes, candies, desserts, and other foods of a similar type. Since dandelion has been used for centuries as a food and an herbal treatment, so negative effects are relatively uncommon. The FDA has approved the safe use of dandelion root and dandelion extracts in dietary supplements. In several countries, fresh dandelion leaves and other parts can be consumed as food. Various studies on animals have been carried out to investigate the possible harmful effects of this plant (Kania-Dobrowolska and Baraniak, 2022). The roasted root of dandelion can be used in substitution for coffee and can be eaten raw in salads and sweets. Specifically, dandelion leaves contain approximately 297 mg of potassium per 100 g and more vitamin A than carrots. These leaves also contain numerous polyphenols, coumarins, and SL. Additionally, the flowers and leaves have also been used to extract flavonoids, while the dandelion root contains a significant quantity of SL. It is utilized in traditional Chinese, Arabian, and Native American medicine to treat a variety of liver-related ailments, inflammation, and cancer (García-Carrasco *et al.*, 2015).

Dandelion has been effectively utilized in the food industry for many years as a completely non-toxic and edible plant, despite being primarily known for its medicinal properties. Dandelion is listed as a safe product by the U.S. FDA for individuals with severe allergies. It's important to remember that the recommended dosage for the plant's aerial parts should not exceed 4 g or 12 g, and for the root, it should not exceed 1 g or 3 g. One can eat the roots, leaves, and flowers of dandelion either uncooked or cooked. Young dandelion leaves can be used to make soup, and fried dandelions are sometimes served with brown rice in Asian countries. Fresh dandelion leaves are an essential ingredient in Turkish cuisine, and dried, crushed leaves can also be used as a flavoring. Dandelion leaves have a high potassium concentration (397 mg/100g), which is believed to support the cardiovascular system. Studies have shown that consuming more potassium through food (approximately 3500 mg per day for an adult) can help lower blood pressure (Olas, 2022).

The petals can be utilized to make syrup, and the leaves, roots, and flowers are all suitable for making herbal drinks. Additionally, flower extracts can be used to improve the flavor of a variety of foods, including puddings, baked cakes, sweets, desserts, and jellies. People may add the flower buds to omelets and pancakes, and in certain European nations, they are seasoned with vinegar and consumed like capers. Dandelion extracts are also available

as nutritional supplements in capsule form, particularly in North America. One plant that is good for giving bees nectar is dandelion. Traditionally, dandelion is used as a tonic and stimulant, in addition to its flavorful characteristics (Olas, 2022).

Additionally, dandelion has a long history of being used as a remedy for ailments associated with the kidneys, liver, and gallbladder. The chemical substances in dandelion plants are what provide the plant its health benefits. These include phytosterols or triterpenes, which have anti-atherosclerotic properties, and SL, which has been demonstrated to have anti-inflammatory and anti-bacterial effects. Dandelions also contain a significant quantity of phenolic substances, particularly coumarins and phenolic acids, which have anti-inflammatory, anti-cancer, anti-bacterial, and anti-thrombotic effects. The roots contain a significant amount of inulin, which has probiotic, hypoglycemic, and immune-boosting properties (Olas, 2022).

*T. officinale* roots are rarely used in the food industry. Inulin is derived from this plant's roots and utilized as a basic ingredient in a microbiological production of fructose syrup. For toxin-clearing teas, the roots are the main ingredient which are being roasted and then serve as a substitute for coffee. According to research, dandelion root extracts have the potential to be utilized as a natural preservative to prevent oxidative processes that occur in food products (Cacak-Pietrzak *et al.*, 2021). While older leaves can be boiled, drained, and consumed as an herb to produce a mixture that tastes like spinach, younger dandelion leaves are used to make delicious sandwiches. The root can be boiled, peeled, dried, and ground into a powder to serve as a coffee substitute. In Chinese medicine, the researchers have long been used the roots to treat various conditions, including the common cold, bronchitis, pneumonia, hepatitis, dental issues, premenstrual syndrome, and elevated blood pressure (Berezi *et al.*, 2019).

A 4 to 10 g of raw, dried leaves and roots should be consumed daily by dividing it into a few meals. According to conventional knowledge, 50 g or more of raw dandelion parts can be taken every day. In the US, 3-5 mL of leaf and root tincture is often taken three times a day (Jędrejek *et al.*, 2017, Lis *et al.*, 2019).

### 1.5. Toxicity of Dandelion Root

Dandelion is considered to have low toxicity because it lacks contaminants or alkaloids in its various constituents. Studies involving rabbits, mice, and rats, with oral administration of dried dandelion plant and dandelion AETo for mice, failed to detect any observable or significant harmful effects. While allergic reactions are a possibility, especially among sensitive people, research indicates that sesquiterpene lactone and taraxinic acid are the components of dandelion responsible for allergic contact dermatitis and other symptoms in those with sensitivity. DRE proved to have no toxicity for healthy individuals (Wirngo *et al.*, 2016). The few human trials that are currently available indicate that using dandelion components appears to be safe, with no observed adverse effects on humans. Additionally, for several months rats given a diet supplemented with fresh dandelion plant parts did not show any signs of carcinogenic effects (Jędrejek *et al.*, 2017, Lis and Olas, 2019).

## 2. CONCLUSION

The leaves, root, and flower of dandelion provide a high content of polyphenols, flavonoids, minerals, dietary fiber and vitamins. Several studies have demonstrated the use of dandelion for anti-inflammatory conditions, the treatment of various disorders, and the maintenance of liver health. The polysaccharide in dandelion root provides protective effect and stimulates Nrf2-Keap1 pathway. As dandelion is considered an herbal medicine, it can also be utilized for the treatment of gastroprotective effects and GI disorders. Dandelion can prevent the activation of the NLRP3 inflammasome and regulate the NF- $\kappa$ B pathway to cure inflamed gut. Dandelion offers health-promoting properties, making it suitable for the production of various health-promoting products. Based on the results of various studies, it is concluded that dandelion provides beneficial effects against various diseases, primarily through its root and leaves. Upon investigating their bioactive components and nutritional composition against various diseases such as hepatic disorders, GI disorders (including UC, gallstones, gastritis, GI malignancy, and small intestinal ulcer), dandelion demonstrates positive health benefits. For future research, there is a need to explore natural ways of treating various illnesses through regular consumption of dandelion, particularly for hepatic and GI disorders.

### Abbreviations

Acute and chronic liver failure (ACLF)  
Chronic liver disease (CLD)  
Carbon tetrachloride (CCl<sub>4</sub>)  
Dandelion Root Extract (DRE)  
Dandelion polysaccharides (DP)  
Ethanoic *T. officinale* Root Extract (TOERE)  
Gastrointestinal (GI)

Glutathione (GSH)  
Hepatic encephalopathy (HE)  
Nod-like receptor protein 3 (NLRP3)  
Nuclear factor kappa B (NF- $\kappa$ B)  
Reactive Oxygen Species (ROS)  
Sesquiterpene lactones (SL)  
*T. officinale* flower water syrup (TOFS)  
*T. officinale* aqueous extract (AETo)  
Ulcerative Colitis (UC)

#### Declarations

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**Author Contributions:** All authors contributed equally to this work.

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