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TARAXACUM OFFICINALE; TRADITIONAL AND EXPERIMENTAL BIOLOGICAL ACTIVITIES

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ABSTRACT

It is observed that *Taraxacum officinale* has been traditionally used for the treatment of various diseases for many years, and its use has also been identified clinically in disorders such as dyspepsia, liver, gallbladder, and urinary tract diseases.It is a plant with many bioactivities, especially strong anti-inflammatory, antioxidant, and hepatoprotective properties. When considering its side effects and toxicity, it is seen that there are no serious side effects or toxicity. In light of this information, it is evaluated that if brought into herbal medicine format due to its strong antioxidant, anti-inflammatory, anticancer, and hepatoprotective effects, it could be effective in the treatment of commonly seen diseases such as cancer, liver, and gallbladder diseases. According to the results of bioactivity studies conducted on the plant, *Taraxacum officinale* has been reported analgesic, antiallergic, antidepressant, anti-inflammatory, anti-hyperglycemic, anticarcinogenic, antimicrobial, antimutagenic, antioxidant, antispermic, antithrombotic, diuretic, hypolipidemic, immunological, choloretic, and prebiotic effects. Additionally, that it has hepatoprotective, nephroprotective, and neuroprotective properties. The acute toxicity of *Taraxacum officinale* seems to be low; when 95% ethanol extract of the whole plant was administered intraperitoneally in rats, the lethal dose was found to be 28.8 mg/kg. When 50% ethanol extract of the whole plant was administered intraperitoneally to rats, the maximum tolerable dose was found to be 500.0 mg/kg. No adverse or complex toxic effects have been reported for *Taraxacum officinale*. This literature review was prepared with the studies of articles on the Google Scholar and PubMed platforms. This review confirms the importance of phytotherapy studies for pharmacological purposes, aiming at therapeutic improvement.

Keywords: *Taraxacum officinale*, antioxidant, anti-inflammatory, anticancer, in vivo, in vitro.

1. INTRODUCTİON

The Asteraceae family is one of the largest families of flowering plants, encompassing nearly 1000 genera and approximately 20,000 species (Tanker N, 2007). The Taraxacum genus comprises around 2000 species and is a member of the Asteraceae family. In a study, it was found that this genus includes numerous subspecies, which are divided into approximately 30-57 varieties (Schütz et al., 2006). There are 45 species of this genus in Turkey (Soest, 1975).

Taraxacum officinale is a perennial and resilient plant. Its underground parts consist of a sturdy taproot, which can be dark brown or blackish in color and can reach lengths of up to 15-30 cm.Lateral roots can extend up to 60-100 cm and have rhizomes that can turn into several heads at distances of 20 to 50 cm from the taproot. When cut, the roots underground are suitable for

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the formation of new plants (Schütz et al., 2006; WHO Monographs, 2007; PDR for Herbal Medicines, 2008). The name *Taraxacum officinale* is derived from the Greek words "taraxis" (inflammation) and "akeomai" (to heal). In English-speaking countries, the plant is known as "dandelion" due to its serrated leaves, while in France, it is known as "dent-de-lion". Additionally, the term "pissenlit" is commonly used due to the plant's diuretic effects (Schütz et al., 2006).

T. officinale contains numerous phenolic compounds contributing to antioxidant, anti-inflammatory, and antimicrobial activities (Park et al., 2011; Colle et al., 2012; Kenny et al., 2015; Martinez et al., 2015;). A study by Williams et al. extensively covered the bioactivity attributed to flavonoid and phenolic fractions of *Taraxacum officinale* (Williams et al., 1996).

2. Traditional Use of Taraxacum officinale

The traditional use of *T. officinale* is widespread and dates back centuries. The earliest records of the plant's usage date back to the 10th and 11th centuries when Arab physicians utilized it in the treatment of liver and spleen disorders. Additionally, records of the plant's medicinal use in Western countries (such as Germany) date back to the 16th century. German physician and botanist Leonhard Fuchs (1543) documented the use of the plant for gout, diarrhea, and spleen disorders. Its use for liver complaints is based on the belief that its yellow flowers are beneficial for gallbladder disorders (Schütz et al., 2006).

In North America, *T. officinale* root infusions and decoctions have been used for kidney diseases, dyspepsia, arthritis, rheumatism, and eczema. In Mexico, the whole plant decoction is used for diabetes, while in Germany, fresh plant juice is used as a tonic (Schütz et al., 2006).

In Jordan, the plant has been indicated for use in the treatment of panophthalmitis, chronic constipation, and diabetes (Tahtamouni et al., 2011). In Traditional Chinese Medicine, it is used for the treatment of acute mastitis and urinary tract diseases. Additionally, in China, it is known to be used alongside other herbs for hepatitis, upper respiratory tract infections, bronchitis, pneumonia, and strengthening immune response.

In Ayurvedic medicine, *T. officinale* is noted for its use in the treatment of chronic ulcers, tuberculosis, gout, and for dissolving gallstones (PDR for Herbal Medicines, 2008).

In Türkiye, some species are observed to be sold as vegetables in Istanbul markets during spring, and they are used as vegetables in the Aegean Region (Baytop, 1999). The fresh leaves of the plant are used in salads, while roasted roots are used in coffee blends; its extracts are used as sweeteners in alcoholic beverages, frozen desserts, jellies, puddings, and cheeses (Schütz et al., 2006).

3. METHODOLOGY

This article was developed through a literature review on the PubMed and Google Scholar platforms. The keywords used were "*Taraxacum officinale*", "antioxidant", "anticancer", "anti-inflammatory", "antimicrobial"and "biological activities". After reading the titles of the articles, it was observed that some of them did not meet the study criteria, and therefore these articles were excluded from the study. The most relevant articles were selected for reading their to compose this study.

4.Biological Activities of *Taraxacum officinale*

4.1. Analgesic Activity

In the hot plate test, dry ethanolic extract of *T. officinale* was administered intraperitoneally to mice at a dose of 100 mg/kg, and the response time was examined after 180 minutes. As a result, an increase of 38% in response time was observed. In another study, when dry ethanolic extract

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of T. officinale was applied to mice at a dose of 100 mg/kg in a pain model induced by phenylquinone, the Writhing response (tail withdrawal time) decreased by approximately 24%; when administered orally at a dose of 1 g/kg, this response decreased by approximately 44% (Schütz et al., 2006).

4.2. Anti-allergic Activity

The methanol root extract of *Taraxacum officinale* has been found to exhibit inhibitory activity against leukotriene B4 formation from activated human neutrophils (Kashiwada et al., 2001). The active principles identified in the extract are sesquiterpene glycosides: 14-O-β-d-glucosyl-11,13-dihydro-taraxinic acid and 14-O-β-d-glucosyl-taraxinic acid (Schütz et al., 2006).

4.3. Antidepressant Activity

Li and colleagues investigated whether aqueous extracts of *T. officinale* leaves and roots had antidepressant effects in rats using forced swimming test, tail suspension test, and open field test. For acute effects (one day), the extracts were administered at a dose of 200 mg/kg, while for chronic effects (14 days), doses of 50, 100, and 200 mg/kg were administered. Behavioral changes and concentrations of corticotropin-releasing factor, adrenocorticotropic hormone, and corticosterone were measured after administration. Rats treated with aqueous extracts of T. officinale leaves and roots showed a significant decrease in immobility time in the forced swimming test and tail suspension test for 14 days. Decreases in corticotropin-releasing factor and corticosterone levels were observed when assessing hormonal changes. In acute administration, a significant decrease in immobility time in the tail suspension test was observed in rats, while locomotor activity was not affected in the open field test. Evaluation indicated that the aqueous extracts of *T. officinale* leaves and roots exhibited antidepressant effects and demonstrated their potential use in neuroendocrine mechanisms (Li et al., 2014).

4.4. Anti-inflammatory Activity

In in vitro studies, it has been determined that *T. officinale* leaf extract at concentrations of 100 and 1000 µg/mL inhibits the production of TNF-α and IL-1 in astrocytes induced with P substance and lipopolysaccharide, exhibiting anti-inflammatory effects in the central nervous system (ESCOP Monographs, 2003).

The effect of 80% ethanolic dry extract of *T. officinale* root on carrageenan-induced rat paw edema has been investigated. When administered orally at a dose of 100 mg/kg, the edema decreased by 25%. In contrast, the use of indomethacin at a dose of 5 mg/kg caused a 45% reduction in edema. In another study, it was found that intraperitoneal administration of the extract at a dose of 100 mg/kg resulted in a 42% reduction in rat paw edema (ESCOP Monographs, 2003).

It reduces IL-6 and TNF-α production during pancreatitis and the course of the disease. The anti-inflammatory effects of *T. officinale* leaf extracts on acute cholecystokinin-octapeptide-induced pancreatitis in rats have been evaluated. Protective effects were demonstrated by significant decreases in pancreatic wet weight and secretion of cytokines (IL-6 and TNF-α), along with increased expression of heat shock proteins (HSP60, HSP72) in the pancreas (Seo et al., 2005).

Animal studies have also reported the protective anti-inflammatory effects of *T. officinale* on acute lung injury induced by LPS in rats. *T. officinale* inhibits the production of inflammatory cytokines (TNF-α and IL-6) in bronchoalveolar lavage fluid 6 hours after injury induction and reduces the number of neutrophils and lung wet weight 24 hours later. Additionally, *T. officinale* has reduced myeloperoxidase activity and increased superoxide dismutase activity in the lungs induced by LPS. This effect has been attributed to luteolin, which blocks signaling cascades

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involving mitogen-activated protein kinase (MAPK), extracellular signal-regulated kinase (ERK), and protein kinase B (Akt), thereby reducing neutrophil chemotaxis and respiratory burst and being beneficial in acute lung injury (Lee et al., 2010; Liu et al., 2010).

In a study involving a seven-herb combination containing *T. officinale*, it was found that anal bleeding significantly decreased and disease activity reduced in patients with inflammatory bowel disease. While the etiology of this disease remains uncertain, treatment typically involves systemic immunosuppression due to the significant feature of damage to the mucosal layer of the gastrointestinal tract. It should be noted that the combined action mechanisms of many plants could lead to reduced leukocyte infiltration and mucosal ulceration, which could improve the development of acute colonic inflammation. A herbal medicine with various components working synergistically inhibited the proinflammatory transcription factor NF-kB activity; reduced the expression of COX-2, TNF-α, IL-1, IL-6, and iNOS; and decreased the production of nitric oxide, reactive oxygen species, leukotrienes, and prostaglandins, indicating its potential use as an adjunct therapy for inflammatory bowel disease (Jackson et al., 2008).

The methanol extract of dried *T. officinale* leaves reduced ear inflammation when applied at a dose of 2.0 mg to each ear in mice. In another study, oral administration of 1.0 g/kg of 95% ethanolic extract of the whole plant prevented inflammation induced by benzocaine in rats (WHO Monographs, 2007).

In a study in rats, the methanolic extract of *T. officinale* and *T. platycarpum* flowers inhibited ear edema induced by tetradecanoylphorbol-13-acetate by 87%. When extracts of T. officinale leaves and roots were applied to 69 rats, ear edema decreased by 51% (Schütz et al., 2006).

The aqueous methanol root extract of *T. officinale* was fractionated sequentially with butanol, ethyl acetate, and hexane. The ethyl acetate and aqueous fractions inhibited leukotriene B4 formation by 21% and 32% (at 3 µg/mL), respectively. However, the butanol fraction showed statistically significant inhibition with 86% inhibition (Schütz et al., 2006).

Jeon and colleagues prepared 70% ethanolic extracts from all parts of the *T. officinale* plant and obtained ethyl acetate, n-butanol, and aqueous fractions. In a carrageenan-induced air pouch model, the ethanol *T. officinale* plant extract inhibited exudate production and significantly reduced nitric oxide (NO) and leukocyte levels in the exudates. These fractions also showed suppressive effects on NO production, iNOS, and COX-2 expression in the carrageenan-induced air pouch model and lipopolysaccharide-stimulated macrophages (Jeon et al., 2008).

Koh and colleagues investigated the anti-inflammatory effects of *T. officinale* methanolic leaf extract and fractions on lipopolysaccharide (LPS)-stimulated mouse macrophage RAW 264.7 cell line. The LPS-induced production of NO, proinflammatory cytokines, and PGE(2) was dose-dependently inhibited. The levels of proinflammatory cytokines including TNF-α, IL-1β, and IL-6, along with the activation of iNOS, COX-2, and mitogen-activated protein kinases were analyzed. *T. officinale* methanolic leaf extract dose-dependently inhibited NO production, PGE(2), and proinflammatory cytokines TNF-α and IL-1β. The chloroform fraction significantly suppressed the production of NO, PGE(2), and two proinflammatory cytokines (TNF-α and IL-1β) in a dose-dependent manner; their IC_{50} values were 66.51, 90.96, 114.76, and 171.06 µg/ml, respectively. The ethyl acetate fraction also inhibited the production of inflammatory molecules. Both the chloroform and ethyl acetate fractions dose-dependently reduced the LPS-induced expression of iNOS and COX-2 and the activation of MAP kinases. Among the fractions of the methanol extract, the chloroform and ethyl acetate fractions exhibited the most effective anti-inflammatory activities. The results indicate that the anti-inflammatory effects of *T. officinale* leaves are likely mediated through the downregulation of NO, PGE(2), and proinflammatory cytokines and the inactivation of the MAP kinase signaling

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pathway, resulting in decreased expression of iNOS and COX-2. It was observed that the chloroform and ethyl acetate fractions had stronger anti-inflammatory effects (Koh et al., 2010).

Both methanol and water dandelion extracts inhibited iNOS gene expression and its transcription factor NF-κB in RAW 264.7 cells stimulated with lipopolysaccharide (LPS), paralleled by a decrease in nitrite levels (Park et al., 2011b).

In a study conducted by Park and colleagues in 2014, the anti-inflammatory effect of polysaccharides isolated from T. officinale was analyzed in RAW 264.7 cells. It was found that the polysaccharides reduced INOS and TNF-α production (Park et al., 2014).

Both extracts significantly reduced NO production without cytotoxicity, with IC_{50} values of 79.9 and 157.5 μg/ml, respectively. Dandelion extracts restored decreased antioxidant enzyme activities including glutathione (GSH) and superoxide dismutase, catalase, GSH-peroxidase, and GSH-reductase. Methanol extract exhibited stronger antioxidative and anti-inflammatory capacities than water extract, which was attributed to its high content of total phenols, luteolin, and chicoric acid.

In another study, combined treatment with luteolin and chicoric acid derived from *T. officinale* synergistically reduced cellular concentrations of nitric oxide (NO) and prostaglandin E2 (PGE2) in RAW 264.7 cells stimulated with lipopolysaccharide (LPS), and also inhibited inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) expression. Additionally, the combined treatment reduced the levels of proinflammatory cytokines tumor necrosis factor (TNF)-α and interleukin (IL)-1β. Both luteolin and chicoric acid suppressed oxidative stress but did not exhibit any synergistic activity. When luteolin and chicoric acid were applied together, they inhibited the phosphorylation of NF-κB and Akt, but had no effect on extracellular signal-regulated kinase (ERK), c-Jun NH2-terminal kinase (JNK), and p38. This anti-inflammatory signaling cascade overlapped only with the treatment of luteolin alone. The results suggest that luteolin plays a central role in improving LPS-induced inflammatory cascades through the inactivation of NF-κB and Akt pathways, and chicoric acid enhances the anti-inflammatory activity of luteolin by reducing NF-κB (Park et al., 2011a).

Awortwe and colleagues investigated the anticholinergic effect of *T. officinale* leaf extract in ovalbumin-sensitized guinea pigs' trachea. The numbers of neutrophils, lymphocytes, and monocytes in blood samples were analyzed in the presence and absence of *T. officinale* leaf extract. When prednisolone was used as a reference standard at a dose of 2.5 mg/kg, T. officinale leaf extract showed significant antagonistic effects against acetylcholine and ovalbumin and reduced the numbers of monocytes, lymphocytes, and neutrophils (Awortwe et al., 2011).

The anti-inflammatory effect of taraxasterol isolated from *T. officinale* was investigated. Rat macrophage RAW 264.7 cells stimulated with lipopolysaccharide were treated with taraxasterol at doses of 1.5 or 12.5 μg/mL, followed by stimulation with 1 μg/mL lipopolysaccharide. The concentrations of inflammation parameters, including PGE-2, TNF-α, IL-1β, IL-6, and NF-κB activation, were evaluated. The assessment revealed that taraxasterol inhibited the production of NO, PGE-2, TNF-α, IL-1β, and IL-6 in a dose-dependent manner. Additionally, further studies showed that taraxasterol prevented the translocation of NF-κB from the cytoplasm to the nucleus induced by LPS. The results suggest that taraxasterol has an anti-inflammatory effect by blocking the NF-κB pathway (Zhang et al., 2012).

The anti-inflammatory effect of taraxasterol, a pentacyclic triterpene isolated from *T. officinale,* on chondrocytes was investigated. It was found that taraxasterol dose-dependently reduced the production of PGE-2 and NO, inhibited the expression of INOS and COX-2, and dose-dependently blocked NF-κB expression (Piao et al., 2015).

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4.5. Anti-hyperglycemic activity

T. officinale root extracts were administered orally to rats at a dose of 25 g/kg. When an oral glucose tolerance test was conducted, it was found that it did not produce any hypoglycemic activity (ESCOP Monographs, 2003).

The effect of *T. officinale* ethanolic dry extract on insulin released from insulinoma β-cells was tested at concentrations ranging from 1 to 40 µg/mL. Glibenclamide was used as a reference standard, and it was observed that T. officinale extract increased insulin levels at a concentration of 40 µg/mL (Schütz et al., 2006).

In another study, it was found that aqueous *T. officinale* root extract inhibited α-glucosidase (Schütz et al., 2006).

The ethanolic extract of *T. officinale* roots with a concentration of 60% has been prepared. When this extract was administered to non-obese diabetic rats induced with alloxan at a dose of 20 mg/kg, a significant decrease in glucose and fructose levels was observed. Additionally, oxidative stress markers, such as glutathione-S-transferase and malondialdehyde concentrations, were examined. An increase in glutathione-S-transferase concentration and a decrease in malondialdehyde concentration were observed (Schütz et al., 2006).

T. officinale leaf extract was applied to diabetic rats induced with streptozotocin. As a result, a decrease in hepatic malondialdehyde and serum glucose concentrations was observed (Schütz et al., 2006).

4.6. Anticarcinogenic Activity

The effects of the aqueous herbal extract of *T. officinale* on cytokine production and cytotoxicity have been investigated. Specifically, the aqueous extract of *T. officinale* has partially reduced cell viability by 26% over time and partly in a dose-dependent manner. Additionally, maximum secretion of TNF-a (186 ± 2.0 pg/mL) and IL-1 (66 ± 1.7 pg/mL) was observed in cells treated with the extract at a concentration of 0.2 mg/mL for 48 hours. Increased levels of TNF-a and IL-1 were found to contribute to the apoptosis induced by the observed T. officinale extract, which was almost completely blocked by the addition of anti-TNF-a and IL-1 antibodies. These results indicate that the extract induces cytotoxicity in liver cells through the secretion of IL-1α and TNF-α (Baba et al., 1981).

It has been proven that the aqueous leaf extract of *T. officinale* inhibits the invasion of breast cancer cells and prevents prostate cancer cells from entering collagen (Schütz et al., 2006).

Sigstedt et al. prepared three different aqueous extracts from mature leaves, flowers, and roots of T. officinale and examined their effects on tumor progression processes. The study showed that aqueous extracts prepared from flowers and roots of *T. officinale* did not affect the growth of both cell lines, whereas the aqueous extract from *T. officinale* leaves reduced the growth of breast cancer cells (Sigstedt et al., 2008).

The proapoptotic effect of ethanol extract obtained from *T. officinale* flowers on human ovarian cancer cells was investigated by Choi et al. Cells were treated with the ethanol extract of T. officinale flowers for 24 hours at concentrations ranging from 1.5625 to 100 µg/mL. The extract exhibited a dose-dependent significant antiproliferative effect, indicating its potential anticancer properties (Choi and Kim, 2009).

The anticarcinogenic effects of *T. officinale* on cell proliferation and metastasis formation have been investigated in vitro. The results demonstrate that these extracts induce apoptosis in human

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hepatoma cells (HepG2) and exhibit cytotoxic activities in human colon carcinoma cell lines (Caco-2) (Koo et al., 2004).

For 10 days, the alcoholic extract of dandelion administered to mice significantly inhibited the growth of Ehrlich ascites carcinoma cells inoculated one week after administration. Non-dialyzable hot water extract obtained from dandelion roots (Tof-CFr) has shown antitumor activity. Tof-CFr exhibited antitumor effects in Ehrlich ascites carcinoma in ddY mice and in senescent tumor lines obtained from C3H/He-MM46 mice. It has been suggested that the mechanism of the antitumor effect of Tof-CFr is similar to that of antitumor polysaccharides, such as lentinan, which are glucose polymers, and it also enhances resistance to viral infections (Koo et al., 2004).

Additionally, raw extracts of *T. officinale* leaves have been shown to reduce the growth of ERK-dependent MCF-7/AZ breast cancer cells by 40% at 96 hours of incubation (Sigstedt et al., 2008). Furthermore, an extract obtained from *T. officinale* roots inhibited the invasion of MCF-7/AZ breast cancer cells, while an extract from dandelion leaves inhibited the invasion of LNCaP prostate cancer cells. Inhibition of invasion was evidenced by decreased phosphorylation levels of focal adhesion kinase and decreased activities of matrix metalloproteinases (MMPs), as well as decreased activity of sulforhodamine B (Sigstedt et al., 2008). In a recent study, it was found that aqueous dandelion root extract effectively induced apoptosis in human leukemia cell lines in a dose- and time-dependent manner, and apoptosis was found to occur through caspase activation (Ovadje et al., 2011). Interestingly, peripheral blood mononuclear cells (PBMCs) exposed to the same treatment conditions as leukemia cells were not significantly affected. Lupane triterpenoids isolated from the roots, 18α,19α-epoxy-21β-hydroxylup-3-one and officinatrion, showed moderate cytotoxic activities against mouse leukemia lymphocyte L1210 cell line (IC50 10.5 and 10.1 μM) (Saeki et al., 2013).

Clearly, the effects on cell proliferation could be attributed to the inhibition of ERK activity; ERK is a key determinant in the mitogen-activated protein kinase (MAPK) pathway involved in cell survival, differentiation, and growth (Roberts et al., 2007). Future elucidation of the active components of individual extracts and their isolation will be important to understand the antiproliferative effects of dandelion leaf extracts.

Previously reported tumor cell growth inhibition by Taraxacum extracts has been attributed to triterpenoids and sesquiterpenes (Takasaki et al., 1999). It has been reported that taraxasterol and taraxerol, triterpenoids, exhibited significant inhibitory effects (Ovesna et al., 2004); indeed, the results strongly suggest the potential role of taraxasterol as a chemopreventive agent. In other studies, it has been indicated that the same active compound isolated from lupane-type triterpenoids, lupeol, inhibited the growth of mouse melanoma cell line (B16 2F2) and induced melanogenesis (Hata et al., 2000; Hata et al., 2006).

The major limitation of current cancer chemotherapies is the side effects causing serious toxicity, and another disadvantage is the loss of effectiveness due to chemotherapy resistance (Kekre et al., 2005; Ma et al., 2009). A recent study indicates that components of dandelion root aqueous extracts promote cancer cell death by inducing or selectively inducing extrinsic apoptosis in human leukemia cells through signal complex induction (Chatterjee et al., 2011; Ovadje et al., 2011). Dandelion root extracts at low concentrations particularly have the ability to induce apoptosis in cancer cells, such as the human acute T-cell leukemia (Jurkat) cell line, without showing toxicity to non-cancerous cells. A possible mechanism of action for how dandelion root extracts work has been associated with very early caspase-8 activation followed by caspase-3 activation. Additionally, it has been observed that Jurkat cells expressing a dominant-negative Fas-associated death domain (FADD) protein, which does not form a complete death-inducing signaling complex (DISC), are resistant to dandelion root extract

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treatment, further confirming that this pathway induces receptor-mediated apoptosis (Ovadje et al., 2011).

Regarding chemoprevention, it is important to remember that angiogenesis consists of processes such as the breakdown of existing blood vessel basement membranes, migration, proliferation, and rearrangement of endothelial cells, and the formation of new blood vessels (Risau et al., 1995). Therefore, suppression of angiogenesis may be advantageous in preventing neoplastic growth and inflammation (Tong et al., 2004). Ethanol extracts of dandelion flowers and leaves have been reported to have anti-angiogenic activity (Kuusi et al., 1985; Kashiwada et al., 2001; Jeon et al., 2008). Such activity may stem from the presence of specific flavonoid compounds like luteolin, providing a pharmacological basis for dandelion's traditional medicinal use in the treatment of inflammatory diseases and cancer (Jeon et al., 2008).

4.7. Antimicrobial Activity

When the 95% ethanol extract of the aerial dry parts of *T. officinale* was applied at a dose of 1.0 mg/kg in vitro, it did not inhibit the growth of Bacillus globifer, B. mycoides, B. subtilis, *Escherichia coli*, *Fusarium solani, Klebsiella pneumoniae, Penicillium notatum, Proteus morganii, Pseudomonas aeruginosa, Salmonella gallinarum, Serratia marcescens, Staphylococcus aureus, Mycobacterium smegmatis,* and *Candida albicans.* Additionally, when the 50% ethanol extract of the whole plant was applied at 50 µL per plate, no antibacterial effect was observed against *Escherichia coli, Salmonella enteritidis, Salmonella typhosa, Shigella dysenteriae,* and *Shigella flexneri* (WHO Monographs, 2007).

Antifungal proteins isolated from *T. officinale* seeds by Odintsova and colleagues have been examined, demonstrating inhibitory effects against phytopathogenic fungi using various analytical methods (Odintsova et al., 2010).

Astafieva et al. (2012) demonstrated that three peptides, ToAMP1, ToAMP2, and ToAMP3, obtained from T. officinale flowers, exhibited high antimicrobial activity against fungal and bacterial pathogens.

In another study by Astafieva et al. (2013), a new peptide isolated from acetic acid extraction of *T. officinale* flowers showed significant antifungal activity against important pathogens.

In a subsequent study by Astafieva et al. (2015), two new homologous peptides showing no similarity to known proteins were found isolated from *T. officinale* flowers. When the bioactivities of these peptides were examined, they showed antifungal activity against fungi and inhibited the growth of both Gram-positive and Gram-negative bacteria. Additionally, it was found that the deglucosylated peptide was less effective against Bipolaris sorokiniana.

4.8. Antiviral Activity

Rehman et al. investigated the anti-HCV (Hepatitis C virus) activity of *T. officinale*, rich in flavonoids. The methanol extract of *T. officinale* leaves was primarily examined for its cytotoxic activity in human hepatoma and Chinese hamster ovary cell lines. Sofosbuvir was used for comparative analysis for antiviral activity. Phytochemicals present in the extract, such as D-glycopyranoside, kaempferol, and luteolin, showed less efficacy compared to the standard drug sofosbuvir. It was found that the leaf extract of *T. officinale* potentially inhibited viral replication without exhibiting toxic effects on normal fibroblast cells in the body (Rehman et al., 2016).

In vitro studies on *T. officinale* demonstrated that taraxinic acid, found in *T. officinale* roots, inhibited the response to HIV-1 (Human Immunodeficiency Virus 1) in acute inflammatory cells and slowly activated non-infected proliferating cells when mixed (ESCOP Monographs, 2003).

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Aqueous *T. officinale* extract exhibited strong activity against HIV-1 RT (Reverse Transcriptase) and inhibited both HIV-1 vector and hybrid-MoMuLV/MoMuSV retrovirus replication in vitro (Han et al., 2011). The potential applications of *T. officinale* extracts in developing antiretroviral therapy with fewer side effects are noteworthy.

4.9. Antimutagenic Activity

Di Giorgio et al. prepared a liquid herbal formulation by diluting tinctures of *Berberis vulgaris*, *T. officinale*, and *Arctium lappa*. The antimutagenic effects of this preparation against mitomycin C were evaluated. Micronucleus analysis was conducted in Chinese hamster ovary cells before and after treatment. The results demonstrated strong anti-clastogenic activity of the tincture. It was observed that this preparation reduced micronucleus levels in erythrocytes of mice exposed to mitomycin C and prevented DNA damage by more than 80% in the testes, brain, lungs, kidneys, and liver (Di Giorgio et al., 2015).

4.10. Bile Secretion / Digestive Stimulatory Activities.

These refer to the abilities of specific substances or compounds to increase bile production and secretion from the liver and stimulate digestion. Bile is a fluid produced by the liver and stored in the gallbladder. It plays a critical role in digestion, particularly in the digestion and absorption of fats and fat-soluble vitamins.

Substances with bile secretion and digestive stimulating activities can enhance the efficiency of digestion by increasing bile flow. This process supports the digestion of nutrients by emulsifying fats and facilitating their breakdown by digestive enzymes. This, in turn, promotes the absorption of nutrients, especially fats, and supports overall digestive function.

It is known that some natural compounds and plants are investigated for their bile duct secretion and digestive stimulating properties. Among these, Dandelion (*Taraxacum officinale*) is notable. *T. officinale* extracts may have the potential to increase bile production and improve digestion.

Sesquiterpene lactones, found in dandelion leaves and roots as bitter principles, have been found to have digestive stimulating and mild laxative effects (Kuusi et al., 1985). Extracts made from Taraxacum officinale roots have been found to exhibit a cholagogic effect upon oral administration, increasing bile flow (Vogel, 1977).

4.11. Antioxidant Activity

It has been found that lyophilized extracts of *T. officinale* leaves reduce lipid peroxidation and NADPH cytochrome P-450 reductase activity in rat liver microsomes (ESCOP Monographs, 2003). The antioxidant activity of the root extract has been compared with the aqueous leaf extract; due to the presence of flavonoids and high polyphenols, the free radical scavenging activity in the H2O2/OH luminal microperoxidase system was found to be higher in the aqueous leaf extract compared to the root extract (ESCOP Monographs, 2003).

The total antioxidant capacity (%) of *T. officinale* is 6.38 based on the DPPH scavenging activity of T. officinale leaves, and the contribution of major caffeoyl derivatives is as follows: chlorogenic acid 1.26%, chicoric acid 68.96%, and total caffeoyl derivatives 70.22% (Didier et al., 2011).

The antioxidant activity of *T. officinale* extract has been investigated in Wistar rat liver microsomes induced with NADPH and ADP-Fe+2. Both leaf and root extracts were found to dose-dependently reduce lipid peroxidation induced by decreased cytochrome c. In several studies, lyophilized aqueous dandelion root and leaf extracts have been shown to have hydrogen donating ability, strong reducing properties, and free radical scavenging capacity. Due to the

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higher polyphenol content, the leaf extract was determined to have higher antioxidant activity (Schütz et al., 2006).

The effects of *T. officinale* Weber's root, stem, leaf, and flower extracts on lipozomal lipid peroxidation induced by ascorbic acid and Fe+2 have been investigated. It was found that the ethyl acetate fraction of the flower extract, along with CCl4 and chloroform, as well as the aqueous stem and root extracts, reduced lipid peroxidation. In another study, it was indicated that the aqueous stem extract of *T. officinale* and the ethyl acetate and aqueous flower extracts provided maximum inhibition of hydroxyl radical production. Additionally, it was observed that the n-butanol extract of roots and the ethyl acetate and chloroform extracts of leaves inhibited hydroxyl radical production (Hu and Kitts, 2004). In another study, it was found that low concentrations of luteolin and luteolin-7-O-glucoside in *T. officinale* flower extract suppressed COX-2, iNOS, NO, and prostaglandin E2 in activated bacterial lipopolysaccharides in RAW 264.7 macrophage cells (Hu and Kitts, 2005). However, it was noted that high concentrations of chlorogenic and caffeic acids in the extract did not inhibit NO production (Schütz et al., 2006).

The water and ethyl acetate fractions of *T. officinale* flowers exhibited antioxidant activity in the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical model, and both fractions reduced the breakage of supercoiled DNA strands induced by non-specific and specific hydroxyl radicals (Hu and Kitts, 2003). Both fractions showed a higher affinity of the ethyl acetate fraction for reducing the oxidation of structured phosphatidylcholine liposomes induced by peroxyl radicals compared to the water fraction. At low concentrations, both fractions exhibited prooxidant activity in Cu2+-induced structured liposome and hLDL oxidation models, indicating that the reducing power of *T. officinale* flower extract led to the generation of reactive copper ions. However, at high concentrations, the presence of ethyl acetate did not promote oxidation in the presence of Cu2+, indicating that this fraction's antioxidant activity was sufficient to minimize the potential oxidative mechanism associated with prooxidant activity related to metal ion reducing activity. It was determined that the *T. officinale* flower extract inhibited oxidative stress due to the presence of both luteolin and luteolin 7-glucoside and contributed to observed in vitro antioxidant and Caco-2 cell cytotoxic activities. Additionally, it was reported that luteolin and luteolin-7-O-glucoside significantly suppressed nitric oxide and prostaglandin E2 production in activated RAW264.7 macrophage cells at concentrations below 20 μM (Hu and Kitts, 2004). Their inhibitory effects were further reduced by suppressing the expression of inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) proteins, associated with enzymatic activity rather than reduction. The presence of the *T. officinale* flower extract also reported similar suppressed enzymes, particularly the ethyl acetate fraction of the dandelion flower extract containing 10% luteolin and luteolin-7-O-glucoside. Further studies have shown that the *T. officinale* flower extract has significant antioxidant activity in both biological and chemical models (Hu and Kitts, 2005). Additionally, it was determined that the inhibitory activity of the flower extract on reactive superoxide and hydroxyl radicals and nitric oxide was due to its phenolic content. The properties of chain-breaking antioxidants, such as extended delay stage and reduced spread rate, were observed in the oxidation of linoleic acid emulsion with the addition of flower extract. The DPPH radical scavenging activity and synergistic effect with α-tocopherol were attributed to the reducing activity derived from the phenolic content. The addition of the flower extract was observed to significantly and concentration-dependently decrease nitric oxide production in bacterial lipopolysaccharide-stimulated RAW264.7 cells. Furthermore, the addition of the flower extract significantly inhibited peroxyl radical-induced cellular oxidation of RAW264.7 cells within a range of concentrations.

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T. officinale methanol and water extracts' antioxidant effect was investigated in lipopolysaccharide-stimulated RAW 264.7 cells, dependent on luteolin, chicoric acid, and total phenolic content. In the study, both methanol and water extracts of *T. officinale* were found to significantly reduce nitric oxide (NO) production and increase the levels of antioxidant enzymes such as superoxide dismutase, catalase, GSH-peroxidase, and GSH-reductase. It was determined that *T. officinale* methanol extract with higher luteolin, chicoric acid, and total phenolic content exhibited stronger antioxidant activity (Park et al., 2011).

Colle et al. investigated the effect of *T. officinale* leaf extract on reactive oxygen species and oxidative stress induced by acetaminophen hepatotoxicity in cells. They found that *T. officinale* leaf extract exhibited scavenging effects against 2,2-diphenyl-1-picrylhydrazyl and nitric oxide radicals (Colle et al., 2012).

T. officinale ethanol plant extract showed scavenging activity in the 1,1-diphenyl-2-picrylhydrazyl (DPPH) test and decreased cellular reactive oxygen species (ROS) levels (Jeon et al., 2008). Among the protective mechanisms, there are scavenging activities against reactive oxygen species (ROS) and reactive nitrogen species (RNS) dependent on phenolic compounds present in the extract.

The protective effect of *T. officinale* fruit extract was investigated in vitro against decreased cellular viability and increased lipid peroxidation induced by sodium nitroprusside in the striatum, hippocampus, and cortex of rats. The antioxidant mechanism of *T. officinale* fruit extract against NO, OH, and H_2O_2 was elucidated. After applying *T. officinale* fruit extract to the striatum, hippocampus, and cortex induced by sodium nitroprusside, cellular viability was tested. After this application, lipid peroxidation was measured, and the study revealed that T. officinale fruit extract inhibited decreased cellular viability induced by NO, OH, H_2O_2, and Fe^{+2}-induced oxidation and increased lipid peroxidation. Additionally, it was determined that antioxidant activity was explained by the presence of phenolic compounds (Colle et al., 2012).

Park et al. analyzed the antioxidant activity of two new polysaccharides obtained from *T. officinale* extract in RAW 264.7 cells. It was indicated that these polysaccharides induced oxygenase and thereby protected cells from oxidative stress (Park et al., 2014).

Kenny et al. identified phenolic compounds, chlorogenic acids, in *T. officinale* extract. When they compared the ethyl acetate extract of *T. officinale* roots with the synthetic antioxidant Trolox, they found that *T. officinale* extract exhibited stronger antioxidant activity. It was mentioned that chlorogenic acid derivatives contributed significantly to the antioxidant activity (Kenny et al., 2015).

The effect of *T. officinale* leaf and flower extracts on skin aging was investigated; changes occurring before and after exposure to ultraviolet radiation, a factor in skin aging, were examined. It was found that *T. officinale* leaf and flower extracts inhibited reactive oxygen species and matrix metalloproteinase production, while *T. officinale* root extract showed less activity. It was revealed that *T. officinale* leaf and flower extracts significantly prevented cellular aging (Yang et al., 2015).

Munoz Mingarro et al. compared the differences in antioxidant and cytotoxic activities among southern European species such as *T. obovatum* (Willd.) DC., *T. marginellum* H. Lindb., *T. hispanicum* H. Lindb., *T. lambinonii* Soest, and *T. lacistrum* Sahlin. In vitro measurements were conducted for antioxidant activity and cytotoxicity. The investigations showed that *T. obovatum* extract was a very effective free radical scavenger, while *T. marginellum* extract significantly reduced reactive oxygen species levels (Munoz Mingarro et al., 2015).

3.12. Neuroprotective Activity.

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Studies have shown that a diet enriched with spirulina (*Arthrospira platensis*) or dandelion in female rats (mothers) reduces brain and cerebellar damage in newborn rats exposed to lead acetate. This reduction occurred through the decrease of lead-induced oxidative stress and associated cerebellar tissue damage (reduced weight and protein content) (Gargouri et al., 2012).

4.13. Fertility and Antifertility Activity.

The effect of T. *officinale* aqueous extract on reproductive activity has been investigated due to its prescription among the native population in Jordan to enhance sperm quality. Thirty-three adult male rats were divided into three groups receiving distilled water orally for 60 days: one group received a low dose, another a high dose of the extract, and the third served as a control. Significant decreases in testicular weight were observed in the two experimental groups receiving the extract, while no effect was observed on body or organ weight. Additionally, parameters such as sperm count, motility, and normal morphology, pregnancy rate, and the diameter and wall thickness of seminiferous tubules showed a decrease, while no changes were observed in the control group. Contrary to expectations, an increase in the proportion of sperm with damaged chromatin integrity was observed. The researchers concluded that the aqueous extract of *Taraxacum officinale* acted not as a fertility enhancer, as prescribed by Jordanian herbal experts, but as an antifertility agent (Tahtamouni et al., 2011).

Another study investigated the antifertility activity of *T. officinale* leaves. Fifty adult male rats were divided into groups, with one group receiving the aqueous extract of the leaves at doses of 1.06 g/kg or 4.60 g/kg, another group receiving the aqueous extract of the whole plant at a dose of 2.30 g/kg, and the control group receiving distilled water. As a result, significant decreases in testicular and seminal vesicle weights, a decrease in serum testosterone concentration, abnormalities in sperm parameters, and a decrease in pregnancy parameters were observed in the rats given the extract (Tahtamouni et al., 2016).

Research has shown that oral intake of dandelion T-1 extract in mice for 6 weeks increased estrogen receptors (ERalpha and ERbeta), progesterone receptor (PR), and follicle-stimulating hormone receptor (FSHR). This suggests a potential application of dandelion extract in the clinical treatment of reproductive hormone-related disorders (Zhi et al., 2007).

In a pilot study comparing the effects of natural treatment herbal and dietary interventions on sex steroid hormone metabolism, Greenlee et al. (2007) compared placebo-controlled, parallel-arm studies in 40 healthy premenopausal women over five menstrual cycles. The herbal supplement contained *Curcuma longa*, *Cynara scolymus, Rosmarinus officinalis*, *Schisandra chinensis, T. officinale*, and *Silybum marianum*, while dietary interventions included raw vegetables like cabbage or dark leafy greens. In the early follicular phase, compared to placebo, the herbal supplement reduced levels of androgens such as dehydroepiandrosterone (-13.2%), dehydroepiandrosterone sulfate (-14.6%), and androstenedione (-8.6%), and estrogen such as estrone sulfate (-12.0%), with no significant effect on other sex steroid hormone levels. No statistically significant differences were observed compared to placebo with dietary interventions.

Administration of aqueous *T. officinale* extract to male rats at high (1/10 LD_{50}) and low (1/20 LD_{50}) doses resulted in a significant decrease in testicular weight, sperm count, motility, and normal morphology, pregnancy rate, and the diameter and wall thickness of seminiferous tubules. Additionally, morphological abnormalities in seminiferous tubules and stasis in spermatogenesis were observed in the group treated with the extract. Furthermore, the proportion of sperm with damaged chromatin integrity was significantly higher in both groups treated with the extract. The researchers concluded that the aqueous extract of *Taraxacum*

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officinale acted not as a fertility enhancer, as prescribed by Jordanian herbal experts, but as an antifertility agent (Tahtamouni et al., 2011).

4.14. Anticoagulant/Antithrombotic Activities.

Ethanol extracts of *T. officinale* roots have been shown to inhibit human platelet aggregation, at least in vitro. These extracts can dose-dependently inhibit platelet aggregation induced by ADP (adenosine 5'-diphosphate) at a concentration equivalent to 40 mg of dried root per human platelet-rich plasma, with maximum inhibition reaching 85%. Low molecular weight polysaccharides provided 91% inhibition, while a fraction enriched with triterpenes and steroids also exhibited 80% inhibition of platelet aggregation, all at a concentration equivalent to 40 mg of crude material per platelet-rich plasma (Neef et al., 1996).

The dose-dependent inhibitory effect of ethanol extract of *T. officinale* root on human platelet aggregation has been documented (Schütz et al., 2006).

4.15. Diuretic Activity

T. officinale has been widely used as a diuretic in traditional folk medicine and modern phytotherapy in Europe, Asia, and America. For example, its common names in French and Italian, "pissenlit" and "piscialetto" respectively, both refer to its ability to induce urination. Indeed, the diuretic effect of *T. officinale* leaves has been demonstrated in mice, although it is potent at high doses in one study and only modestly effective in another. Dandelion exhibits stronger diuretic effects compared to other plants such as horsetail and juniper berries. Notably, 100% of the weight loss observed in these animal studies is attributed to the diuretic effect of dandelion. The use of *T. officinale* for the prevention and treatment of kidney stone formation has been investigated using female Wistar rats. *T. officinale* has shown a positive effect on urolithiasis by synergizing with six other herbs in an infusion, attributed to a disinfectant effect and speculatively to the presence of saponins (Grases et al., 1994). However, more effective and equally harmless substances are available for all these beneficial effects.

A study in animals found that high doses (2 g/kg body weight) of *T. officinale* leaves had diuretic effects comparable to the prescription diuretic furosemide. It was concluded that dandelion contains three times more potassium compared to other herbal diuretics and provides more potassium than is lost with diuretic intake. Therefore, *T. officinale* could provide a significant potassium contribution therapeutically by replacing the potassium loss induced by most diuretics (Rácz-Kotilla et al., 1974).

When administered orally to rats at doses of 8.0-50.0 mL/kg, a 95% ethanol extract of the whole plant increased diuresis and decreased body weight. Similarly, when a 30% ethanol extract of the whole plant was orally administered to mice at a dose of 0.1 mL/kg, increased diuresis was observed. However, significant diuretic effects were not observed when petroleum ether, chloroform, or methanol extracts of *T. officinale* roots were administered to rats at a dose of 50 mg/kg (WHO Monographs, 2007).

In another study, it was found that when *T. officinale* root and herb aqueous extracts were separately administered orally to male rats at a dose of 50 mL/kg, the herb extract exhibited higher diuretic activity (Schütz et al., 2006).

Clare and colleagues conducted a pilot study testing the hydroethanolic extract of *T. officinale* leaves on 17 volunteers. The aim of the study was to investigate whether there was an increase in urinary frequency and volume. Urinary output and fluid intake of the participants were recorded. Baseline values for urinary frequency and voiding rate were determined 2 days before the administration of *T. officinale* extract, and then monitored 1 day after administration and again 24 hours later. A significant increase in urinary frequency was observed during the first

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5-hour period after the initial dose, a significant increase in voiding rate during the subsequent 5-hour period after the second dose, and no change in the measured parameters after the third dose. Based on these initial human data, it is suggested that the ethanolic extracts of dandelion may have diuretic effects in humans. However, due to the limited sample size of this study (n = 17), these findings need to be confirmed. Further studies are needed to determine the value of this plant for inducing diuresis in humans (Clare et al., 2009).

4.16. Detoxification and hepatoprotective activities.

T. officinale has been used in traditional medicine to maintain liver health and treat various dermatological and systemic disorders due to its claim to "detoxify" the blood. The hepatoprotective properties of dandelion have been recently reviewed (Singh et al., 2008). It has been shown that dandelion modulates phase I and phase II enzymes in rat liver microsomes; for example, after rats were given ad libitum access to a 2% *T. officinale* solution, the activity of two cytochrome P450 (CYP) isoforms, CYP1A2 and CYP2E, in liver microsomes decreased significantly up to 15% of control values (Maliakal et al., 2001).

Many in vivo studies exist, one of which aimed to investigate the effects of *T. officinale* leaf extracts on the liver antioxidant system in rats fed a high-cholesterol diet. The control group received a diet without extracts, while the other three groups received dandelion leaf extracts, namely water, ethyl acetate, and ether extracts. There was no significant difference in cytochrome P-450 content among the four groups. Xanthine oxidase activity in the liver was significantly lower in the water extract group compared to the other three groups. Superoxide dismutase activity was significantly lower in the three *T. officinale* leaf extract groups, but catalase activity was significantly higher in these groups compared to the control group. Both glutathione peroxidase and GST activity were significantly increased in the water extract group compared to the control group. Lipid peroxide content was lower in the water extract group compared to the control group (Cho et al., 2003).

Park and colleagues investigated the effects of two polysaccharides isolated from *T. officinale* on oxidative stress and inflammation induced by carbon tetrachloride (CCl4) in Sprague-Dawley rat livers. It was observed that when the polysaccharides isolated from *T. officinale* were administered at a dose of 304.92 mg via gastric gavage for 7 days, hepatic lesions decreased, and AST and ALT levels decreased. The polysaccharides reduced hepatic damage induced by CCl4 in Sprague-Dawley rats by regulating markers such as NF-kB, iNOS, COX-2, TNF-a, and IL-1. Additionally, histopathological observations showed low levels of inflammatory cell infiltration, central lobular steatosis, apoptosis, and necrosis in the treated animals. The polysaccharides also increased free radical scavenging activity, reversed other hepatitis symptoms including glutathione depletion, and increased antioxidant enzyme activities (Park et al., 2010).

Mahesh and colleagues evaluated the hepatoprotective potential of ethanol extracts of *T. officinale* roots and fractions enriched with sesquiterpene lactones against carbon tetrachloride (CCl4)-induced hepatotoxicity in mice. The study recorded a significant increase in alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and total bilirubin levels, as well as a decrease in glutathione levels, liver lipid peroxidation, and liver weight in CCl4-induced rats. Following the administration of the extract, a decrease in alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and total bilirubin levels, an increase in decreased glutathione levels, a decrease in liver lipid peroxidation, and histopathological evaluations indicating reduced oxidative stress were reported, along with a decrease in liver weight. Therefore, sesquiterpene lactones in *T. officinale* exhibited protective effects against acute hepatotoxicity induced by CCl4 in mice. Additionally, the activity of

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sesquiterpene lactones was thought to be due to the synergistic effect of two specific sesquiterpene lactones identified from enriched ethyl acetate fractions (Mahesh et al., 2010).

Gulfraz and colleagues investigated the effect of ethanol and n-hexane leaf extracts of *T. officinale* on CCl_4-induced liver toxicity. When ethanol and n-hexane extracts of *T. officinale* were administered to rats at doses of 200 mg/kg and 400 mg/kg, along with silymarin at a dose of 100 mg/kg, a decrease in cytotoxicity was observed. Both extracts reduced liver toxicity, but the ethanol extract was found to be more effective (Gulfraz et al., 2014).

Fibrosis, characterized by extracellular matrix accumulation and disruption of normal tissue architecture, is a common cause of chronic organ failure, including kidneys, and is a leading cause of morbidity and mortality worldwide (Wynn et al., 2007).

In another study conducted by Domitrović and colleagues on carbon tetrachloride (CCl4)-induced hepatic fibrosis, the efficacy of *T. officinale* root aqueous ethanol extract was investigated. Following intraperitoneal administration of the extract at doses of 200 and 600 mg/kg once daily for 10 days, the degree of hepatic fibrosis, hydroxyproline content, oxidative stress, hepatic superoxide dismutase (Cu/Zn SOD) activity, and expression and specific tissue distribution analysis of glial fibrillary acidic protein, alpha-smooth muscle actin (alpha-SMA), and metallothionein I/II in the liver were measured. The results showed that hepatic superoxide dismutase activity was normalized, hepatic fibrotic tissues were significantly reduced, glial fibrillary acidic protein modulated alpha-smooth muscle actin expression, and metallothionein I/II expression increased in the group treated with the extract. Thus, it was proven that the T. officinale root aqueous ethanol extract enhanced hepatic regenerative properties (Domitrović et al., 2010).

The effect of decoction and ethanolic extract of *T. officinale* root on alcohol-induced liver cells has been investigated. Hepatocyte damage was observed when the decoction of *T. officinale* root prepared with hot water was applied, and the hepatoprotective effect of *T. officinale* ethanol extract was not observed. In a study conducted on mice, when the decoction of *T. officinale* root was administered at a dose of 1 g/kg and compared with the control group, a decrease in the activities of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and lactate dehydrogenase in serum was observed. Significant increases in antioxidant activities such as catalase, glutathione-S-transferase, glutathione peroxidase, glutathione reductase, and glutathione were observed in the liver. Other parameters such as improved malondialdehyde levels, increased antioxidative potentials, and decreased lipid peroxidation were also observed. Hepatoprotective activity was recorded in an in vivo environment (You et al., 2010).

Colle and colleagues conducted a study on acetaminophen hepatotoxicity. The effect of *T. officinale* leaf extract on acetaminophen-induced liver dysfunction was investigated. The study found that *T. officinale* application reduced the levels of thiobarbituric acid reactive substances, sulfhydryl levels, and serum levels of aspartate and alanine aminotransferases induced by acetaminophen (Colle et al., 2012).

The efficacy of *T. officinale* against sodium dichromate-induced necrosis and DNA fragmentation in hepatocytes has been investigated. In the study, Wistar rats were orally administered T. officinale leaf extract at a dose of 500 mg/kg per day for 30 days, followed by sodium dichromate injection for 10 days. As a result, the extract significantly improved the biochemical serum parameters of the rats and exhibited hepatoprotective effects (Hfaiedh et al., 2016).

4.17. Anti-Obesity / Anti-Hyperlipidemic Activity

Research has shown that plants like *T. officinale* exhibit anti-obesity and anti-hyperlipidemic activity. These properties are effective against metabolic disorders such as obesity and high

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lipid levels. Substances demonstrating this activity may regulate fat metabolism, reduce fat accumulation, lower cholesterol and triglyceride levels, and decrease the risk of obesity-related diseases.

Studies have investigated the anti-obesity and anti-hyperlipidemic activity of plants like *T. officinale.* Extracts obtained from the roots or leaves of these plants may have anti-obesity effects by reducing fat absorption and accelerating metabolism. Additionally, they may be effective against hyperlipidemia by correcting lipid profiles and increasing antioxidant activity.

The anti-obesity and anti-hyperlipidemic activity of *T. officinale* has been examined in numerous research studies. These studies typically involve the use of extracts from the plant's roots and leaves.

In one study, it was shown that *T. officinale* leaf extract significantly inhibited porcine pancreatic lipase activity. In the same study, it was found that dandelion extract significantly inhibited the increase in plasma triglyceride levels in mice and reduced the areas under the plasma triglyceride response curves. These results indicate that *T. officinale* possesses both in vitro and in vivo pancreatic lipase inhibitory activity.

In another study, supplementation with dandelion root and leaves was found to positively alter plasma antioxidant enzyme activities and lipid profiles in rabbits exposed to cholesterol. These findings suggest that *T. officinale* may have potential hypolipidemic and antioxidant effects.

In conclusion, studies on the anti-obesity and anti-hyperlipidemic activity of *T. officinale* suggest that the plant may possess these properties. However, further research is needed, and clinical trials are required to support these effects.

Authors have concluded that dandelion root and leaf may protect against oxidative stress-related atherosclerosis and reduce the atherogenic index. These results indicate that *T. officinale* possesses both in vitro and in vivo pancreatic lipase inhibitory activity.

In a non-washout crossover randomized double-blind study involving men with hypercholesterolemia, dietary supplementation with inulin was found to improve blood lipid profiles and positively alter the colonic environment (Causey et al., 2000).

In another study, the inhibitory effect of *T. officinale* on pancreatic lipase was investigated. The effects of 95% *T. officinale* extract were compared with Orlistat. In an in vivo setting, *T. officinale* 95% ethanol extract was orally administered to mice at a dose of 5 mL/kg, and plasma triglyceride levels were measured at 0, 90, 180, and 240 minutes post-administration. *T. officinale* extract inhibited pancreatic lipase activity by 86.3%, while Orlistat inhibited it by 95.7%. The *T. officinale* extract showed dose-dependent inhibition, with an IC_{50} value of 78.2 µg/ml. A single dose of ethanol extract given to mice significantly inhibited the increase in plasma triglyceride levels at 90 and 180 minutes and reduced the areas under the plasma triglyceride response curve. The results demonstrate that *T. officinale* exhibits pancreatic lipase inhibitory activities in both in vitro and in vivo environments (Zhang et al., 2008).

T. officinale root and leaf extracts were investigated for their hypolipidemic effects in rabbits fed a high-cholesterol diet. Four groups were formed: rabbits fed a normal diet, rabbits fed a high-cholesterol diet, rabbits fed with 1% (w/w) *T. officinale* leaf extract, and rabbits fed with 1% (w/w) *T. officinale* root extract. The study showed that rabbits fed with *T. officinale* roots and leaves exhibited positive changes in plasma antioxidant enzyme activities and lipid profiles, suggesting potential hypolipidemic and antioxidant effects (Choi et al., 2010).

The effect of *T. officinale* on adipocyte differentiation and lipogenesis in preadipocytes has been investigated. It was found that the extract regulates the synthesis of long non-coding RNAs

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involved in adipogenesis control and the synthesis of specific genes related to adipocyte differentiation (Gonzalez et al., 2014).

Kim and colleagues investigated the hypolipidemic effect of *T. officinale* on rabbits fed an atherogenic diet. For six weeks, one group was administered with 1.5% and 3% *T. officinale* water extract, another group with 1.5% and 3% *T. officinale* ethanol extract, and a control group received no treatment. Significant decreases in atherogenic indexes were observed in the groups administered with *T. officinale.* Hepatic total lipids, triglycerides, and cholesterol levels decreased in the group treated with *T. officinale* ethanol extract, while only cholesterol levels decreased in the group treated with T. officinale water extract (Kim et al., 2014).

4.18.Immune Modulatory Activity

Studies in mice have shown that dandelion hydroalcoholic extract exhibits immunomodulatory properties (Modaresi & Resalatpour, 2012). In all doses of 50, 100, and 200 mg/kg, the number of white blood cells (WBC) and heart rate significantly increased, and at a dose of 200 mg/kg, the WBC count increased significantly to reach normal body balance. All three doses of dandelion significantly increased lymphocyte counts compared to controls.

When *T. officinale* aqueous extract was administered to mice via intragastric route at a dose of 3.3 g/kg per day for 20 days, it was found to decrease cyclophosphamide-induced immune damage. The application of the whole plant's aqueous extract to mice with impaired immune functions, without a specific dose or route of administration, was observed to strengthen the immune systems of the mice. In mice treated with the plant's aqueous extract, decreased production of TNF-α and IL-1 was observed (WHO Monographs, 2007).

Jinchun and Jie investigated the effect of *T. officinale* extract on physical fatigue in mice by subjecting them to a forced swimming test. Four groups of Kunming mice were formed, and each group was orally administered with *T. officinale* extract at doses of 10, 30, and 100 mg/kg for six weeks, while one group received sterile distilled water. After six weeks, the mice underwent a forced swimming test, and their blood biochemical parameters were measured. As a result, *T. officinale* extract was found to reduce physical fatigue, increase the maximum swimming capacity of mice, effectively delay the decrease in blood glucose, and prevent the increase in lactate and triglyceride concentrations (Jinchun & Jie, 2011).

A similar study was conducted by Lee et al. In the study, changes in fatigue status and immunity of mice subjected to a forced swimming test after administration of *T. officinale* extract were investigated. Mice treated with *T. officinale* extract at a dose of 100 mg/kg for ten days showed significant reduction in immobility time, increase in glucose levels providing energy, decrease in lactate dehydrogenase levels indicative of muscle damage, and significant decrease in blood urea nitrogen levels. Additionally, the effect of *T. officinale* on cytokine and NO production in peritoneal macrophages of mice was examined. T. officinale, when used in combination with recombinant interferon-gamma, induced TNF-α, IL-12p70, and IL-10 and increased NO production through iNOS induction. Thus, considering all the results, it was indicated that *T. officinale* improves immunological parameters (Lee et al., 2012).

4.19. Anticholitic Activity

A herbal combination consisting of *Taraxacum officinale* along with *Hypericum perforatum, Melissa officinalis, Calendula officinalis*, and *Foeniculum vulgare* has been found effective in the treatment of chronic colitis in 24 human patients (Chakŭrski et al., 1981). By the 15th day of treatment, it was observed that spontaneous and perceived pain along the large intestine disappeared in 95.83% of the patients admitted to the clinics. Daily bowel movements became regular in patients with constipation syndrome and diarrhea syndrome.

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In in vivo studies conducted on *Taraxacum officinale*, a decoction made from fresh leaves or roots of *T. officinale* (equivalent to 5 grams of dried plant material) was administered intravenously to dogs. Thirty minutes after administration, it was observed that the bile secretion volume from the liver doubled. When *T. officinale* extract was administered intraduodenally to rats, it was noted that bile volume increased by one-third every hour. The alcoholic extract of the whole plant was also administered intraduodenally to rats, and it was observed that bile secretion increased by over 40% after 2 hours (ESCOP Monographs, 2003).

In another study, *Taraxacum officinale* extract was applied to Wistar rats, resulting in a 12% increase in choleretic activity (Schütz et al., 2006).

CONCLUSION

Based on the context of the articles and dissertations used as the basis for this study, it can be argued that the plant species *Taraxacum officinale* holds significant importance for advancements in phytotherapy medicine. Traditionally used for the treatment of various diseases for many years, *Taraxacum officinale* has also been clinically identified in conditions such as dyspepsia, liver, gallbladder, and urinary tract disorders. However, as evidenced here, emerging data reveal that it possesses numerous bioactivities, particularly potent anti-inflammatory, antioxidant, anticancer, and hepatoprotective properties. When considering its side effects and toxicity, it is observed that there are no serious adverse effects or toxicity associated with its use.

Plant foods and their phytochemicals should not be evaluated as drugs, especially for the treatment of serious pathological conditions. However, Taraxacum officinale and its formulations have demonstrated potential in preventing or mitigating several degenerative diseases such as atherosclerosis, coronary artery disease, obesity, diabetes, and cancer. The mechanisms of action of Taraxacum officinale phytochemicals are diverse, with many of them identified to involve multiple cellular signaling pathways including NFkB, Akt, MEK, ERK, sVCAM-1, MAPK, MMP, TNF, IL, and others.

Additionally, *Taraxacum officinale* is regularly consumed in several countries (either as a whole or as a component of other preparations), and it is known to be safe for human consumption. Further experimentation is needed to evaluate the phytopharmacological uses of *Taraxacum officinale*, especially in terms of isolating and purifying its components. Another noteworthy area for investigation is the exploration of *Taraxacum officinale'*s effects on food genomics and its ability to inhibit or enhance the expression of genes associated with degenerative diseases.

In conclusion, considering the strong antioxidant, hepatoprotective, and anti-inflammatory effects, it is assessed that if formulated into herbal medicine, *Taraxacum officinale* could be effective in the treatment of common diseases such as cancer, liver, and gallbladder disorders.

REFERENCES

Astafieva AA, Rogozhin EA, Odintsova TI, Khadeeva NV, Grishin EV, Egorov TA. (2012). Discovery of novel antimicrobial peptides with unusual cysteine motifs in dandelion Taraxacum officinale Wigg. flowers. Peptides, 36(2), 266-271.

Astafieva AA, Rogozhin EA, Andreev YA, Odintsova TI, Kozlov SA, Grishin EV, Egorov TA. (2013). A novel cysteine-rich antifungal peptide ToAMP4 from Taraxacum officinale Wigg. flowers. Plant Physiology Biochemistry, 70,93-99.

Astafieva AA, Enyenihi AA, Rogozhin EA, Kozlov SA, Grishin EV, Odintsova TI, Zubarev RA, Egorov TA. (2015). Novelproline-hydroxyproline glycopeptides from the dandelion (Taraxacum officinale Wigg.) flowers: de novo sequencing and biological activity. Plant Science, 238, 323-329.

https://doi.org/10.55549/zbs.1564629

Awortwe C, Sackeyfio AC, Osei-Safo D, Bugyei KA, Asiedu-Gyekye IJ. (2011). Dual effect of Taraxacum officinale leaves: Anticholinergic and inhibitory effect on inflammatory cells in ovalbumin-sensitized guinea-pigs. Afrıcan Journal of Pharmacy and Pharmacology, 5(23), 2613-2619.

Baba, K., Abe, S., & Mizuno, D. (1981). Antitumor activity of hot water extract of dandelion, Taraxacum officinale-correlation between antitumor activity and timing of administration (author's transl). Yakugaku Zasshi: Journal of the Pharmaceutical Society of Japan, 101(6), 538-543.

Baytop T. (1999). Türkiye'de Bitkilerle Tedavi. (2.Baskı). İstanbul: Nobel Kitabevi, 227-228.

Causey, J. L., Feirtag, J. M., Gallaher, D. D., Tungland, B. C., & Slavin, J. L. (2000). Effects of dietary inulin on serum lipids, blood glucose and the gastrointestinal environment in hypercholesterolemic men. Nutrition Research, 20(2), 191-201.

Chakŭrski, I., Matev, M., Koĭchev, A., Angelova, I., & Stefanov, G. (1981). Treatment of chronic colitis with an herbal combination of Taraxacum officinale, Hipericum perforatum, Melissa officinaliss, Calendula officinalis and Foeniculum vulgare. Vutreshni bolesti, 20(6), 51-54.

Chatterjee, S. J., Ovadje, P., Mousa, M., Hamm, C., & Pandey, S. (2010). The efficacy of dandelion root extract in inducing apoptosis in drug-resistant human melanoma cells. Evidence-Based Complementary and Alternative Medicine, 2011.

Cho, S. Y., Oh, Y. J., Park, J. Y., Lee, M. K., & Kim, M. J. (2003). Effect of dandelion (Taraxacum officinale) leaf extracts on hepatic antioxidative system in rats fed high cholesterol diet. Journal of the Korean Society of Food Science and Nutrition, 32(3).

Choi EJ, Kim GH. (2009). Dandelion (Taraxacum officinale) flower ethanol extract inhibits cell proliferation and induces apoptosis in human ovarian cancer SK-OV-3 cells. Food Scıence and Bıotechnology, 18(2), 552-555.

Choi UK, Lee OH, Yim JH, Cho CW, Rhee YK, Lim SI, Kim YC. (2010). Hypolipidemic and antioxidant effects of dandelion (Taraxacum officinale) root and leaf on cholesterol-fed rabbits. InternatıonalJ ournal of Molecular Scıences, 11(1), 67-78.

Clare BA, Conroy RS, Spelman, K. (2009). The diuretic effect in human subjects of an extract of Taraxacum officinale folium over a single day. Journal of Alternative and Complementary Medicine, 15(8), 929-934.

Colle D, Arantes LP, Gubert P, da Luz SC, Athayde ML, Teixeira Rocha JB, Soares FA. (2012a). Antioxidant properties of Taraxacum officinale leaf extract are involved in the protective effect against the patoxicity induced by Acetaminophen in mice. Journal of Med icinal Food, 15(6):549-556.

Colle D, Arantes LP, Rauber R, de Mattos SEC, da Rocha JBT, Nogueira CW, Soares, FA. (2012b). Antioxidant properties of Taraxacum officinale fruit extract are involved in the protective effect against cellular death induced by sodium nitroprusside in brain of rats. Pharmaceutıcal Biology, 50(7), 883-891.

Didier, F., Catherine, F., Odile, T., & Jean-Louis, L. (2011). Caffeoyl derivatives: major antioxidant compounds of some wild herbs of the Asteraceae family. Food and Nutrition Sciences, 2011.

Di Giorgio C, Boyer L, De Meo M, Laurant C, Elias R, Ollivier E. (2015).In vitro and in vivo antimutagenic effects of DIG, a herbal preparation of Berberisvulgaris, Taraxacum

https://doi.org/10.55549/zbs.1564629

officinale and Arctium lappa, against mitomycin C. Journal of Natural Medıcınes, 69(3), 267-277.

Domitrović R, Jakovac H, Romić Z, Rahelić D, Tadić Z. (2010). Antifibrotic activity of Taraxacum officinale root in carbontetrachloride-induced liver damage in mice. Journal of Ethnopharmacol, 130(3), 569-577.

ESCOP Monographs: The Scientific Foundation for Herbal Medicinal Products. (2003). (2.Edition). Stuttgard:Thieme, 499-502.

Gargouri M, Ghorbel-Koubaa F, Bonenfant-Magné M, Magné C, Dauvergne X, Ksouri R, Krichen Y, Abdelly C, El Feki A (2012) Spirulina or dandelion-enriched diet of mothers alleviates lead-induced damages in brain and cerebellum of newborn rats. Food Chem Toxicol 50(7):2303–2310

Gonzalez-Castejon M, Garcia-Carrasco B, Fernandez-Dacosta R, Davalos A, Rodriguez-Casado A. (2014). Reduction of adipogenesis and lipid accumulation by Taraxacum officinale (dandelion) extracts in 3T3L1 adipocytes: an in vitro study. Phytotherapy Research,28(5), 745-752.

Grases F, Melero G, Costa-Bauzá A, Prieto R, March JG (1994) Urolithiasis and phytotherapy. Int Urol Nephrol 26(5):507–511

Greenlee H, Atkinson C, Stanczyk FZ, Lampe JW (2007) A pilot and feasibility study on the effects of naturopathic botanical and dietary interventions on sex steroid hormone metabolism in premeno- pausal women. Cancer Epidemiol Biomarkers Prev 16(8):1601–1609

Gulfrazl M, Ahamd D , Ahmad MS, Qureshi R, Mahmood RT, Jabeen N, Abbasi KS. (2014). Effect of leaf extracts of Taraxacum officinale on CCl4 induced hepatotoxicity in rats, in vivo study. Pakıstan Journal of Pharmaceutıcal Scıences, 27(4), 825-829.

Han H, He W, Wang W, Gao B (2011) Inhibitory effect of aqueous dandelion extract on HIV-1 replication and reverse transcriptase activity. BMC Complement Altern Med 11:112

Hata, K., Ishikawa, K., Hori, K., & KONISHI, T. (2000). Differentiation-inducing activity of lupeol, a lupane-type triterpene from Chinese dandelion root (Hokouei-kon), on a mouse melanoma cell line. Biological and Pharmaceutical Bulletin, 23(8), 962-967.

Hata, K., Mukaiyama, T., Tsujimura, N., Sato, Y., Kosaka, Y., Sakamoto, K., & Hori, K. (2006). Differentiation-inducing activity of lupane triterpenes on a mouse melanoma cell line. Cytotechnology, 52(3), 151-158.

Hfaiedh M, Brahmi D, Zourgui L. (2016). Hepatoprotective effect of Taraxacum officinale leaf extract on sodium dichromate-induced liver injury in rats. Envıronmental Toxıcology, 31(3), 339-349.

Hu, C., & Kitts, D. D. (2003). Antioxidant, prooxidant, and cytotoxic activities of solvent-fractionated dandelion (Taraxacum officinale) flower extracts in vitro. Journal of agricultural and food chemistry, 51(1), 301-310.

Hu, C., & Kitts, D. D. (2004). Luteolin and luteolin-7-O-glucoside from dandelion flower suppress iNOS and COX-2 in RAW264. 7 cells. Molecular and cellular biochemistry, 265, 107-113.

Hu, C., & Kitts, D. D. (2005). Dandelion (Taraxacum officinale) flower extract suppresses both reactive oxygen species and nitric oxide and prevents lipid oxidation in vitro. Phytomedicine, 12(8), 588-597.

https://doi.org/10.55549/zbs.1564629

Jackson, L. N., Zhou, Y., Qiu, S., Wang, Q., & Mark Evers, B. (2008). Alternative medicine products as a novel treatment strategy for inflammatory bowel disease. The American journal of Chinese medicine, 36(05), 953-965.

Jeon, H. J., Kang, H. J., Jung, H. J., Kang, Y. S., Lim, C. J., Kim, Y. M., & Park, E. H. (2008). Anti-inflammatory activity of Taraxacum officinale. Journal of ethnopharmacology, 115(1), 82-88.

Jinchun Z, Jie C. (2011). The effects of Taraxacum officinale extracts (TOE) supplementation on physical fatigue in mice. The African Journal of Traditional, Complementary and Alternative medicines , 8(2):128-33.

Kashiwada, Y., Takanaka, K., Tsukada, H., Miwa, Y., Taga, T., Tanaka, S., & Ikeshiro, Y. (2001). Sesquiterpene glucosides from anti-leukotriene B4 release fraction of Taraxacum officinale. Journal of Asian Natural Products Research, 3(3), 191-197.

Kenny O, Smyth TJ, Hewage CM, Brunton NP. (2015). Quantitative UPLC-MS/MS analysis of chlorogenic acid derivatives in antioxidant fractionates from dandelion (Taraxacum officinale) root .Internatıonal Journal of Food Scıence and Technology, 50(3), 766-773.

Kekre N, Griffin C, McNulty J.P Siyaram (2005). Pancratistatin causes early activation of caspase-3 and the flipping of phosphatidylserine followed by rapid apoptosis specifically in human lymphoma cells. Cancer Chemother Pharmacol. 56:29–38.

Kim JJ, Park CM, Kim MJ, Cho CW, Song YS. (2014). Hypolipidemic effect of dandelion (Taraxacum officinale) extracts via fecal lipid excretion in C57BL/6 mice fed an atherogenic diet. Food Scıence and Bıotechnology, 23(3), 841-847.

Koh YJ, Cha DS, Ko JS, Park HJ, Choi HD. (2010). Anti-ınflammatoryeffect of Taraxacum officinale leaves on lipopolysaccharide-ınduced ınflammatory responses in RAW 264.7 cells. Journal of Medıcınal Food, 13(4), 870-878.

Koo, H. N., Hong, S. H., Song, B. K., Kim, C. H., Yoo, Y. H., & Kim, H. M. (2004). Taraxacum officinale induces cytotoxicity through TNF-α and IL-1α secretion in Hep G2 cells. Life Sciences, 74(9), 1149-1157.

Kuusi, T., Pyysalo, H., & Autio, K. (1985). The bitterness properties of dandelion. II. Chemical investigations. Lebensmittel-Wissenschaft+ Technologie, 18(6), 347-349.

Lee, J. P., Li, Y. C., Chen, H. Y., Lin, R. H., Huang, S. S., Chen, H. L., ... & Kuan, Y. H. (2010). Protective effects of luteolin against lipopolysaccharide-induced acute lung injury involves inhibition of MEK/ERK and PI3K/Akt pathways in neutrophils. Acta Pharmacologica Sinica, 31(7), 831-838.

Lee, B. R., Lee, J. H., & An, H. J. (2012). Effects of Taraxacum officinale on fatigue and immunological parameters in mice. Molecules, 17(11), 13253-13265.

Li YC, Shen JD, Li YY, Huang Q. (2014). Antidepressant effects of the water extract from Taraxacum officinale leaves and roots in mice. Pharmaceutical Biology,52 (8), 1028-1032.

Liu L, Xiong H, Ping J. (2010) Taraxacum officinale protects against lipopolysaccharide-induced acute lung injury in mice. J Ethnopharmacol.130:392–397.

Ma, P., Dong, X., Swadley, C. L., Gupte, A., Leggas, M., Ledebur, H. C., & Mumper, R. J. (2009). Development of idarubicin and doxorubicin solid lipid nanoparticles to overcome Pgp-mediated multiple drug resistance in leukemia. Journal of biomedical nanotechnology, 5(2), 151-161.

https://doi.org/10.55549/zbs.1564629

Mahesh, A., Jeyachandran, R., Cindrella, L., Thangadurai, D., Veerapur, V., & Muralidhara Rao, D. (2010). Hepatocurative potential of sesquiterpene lactones of Taraxacum officinale on carbon tetrachloride induced liver toxicity in mice. Acta Biologica Hungarica, 61(2), 175-190.

Maliakal, P. P., & Wanwimolruk, S. (2001). Effect of herbal teas on hepatic drug metabolizing enzymes in rats. Journal of Pharmacy and Pharmacology, 53(10), 1323-1329.

Martinez M, Poirrier P, Chamy R, Prufer D, Schulze-Gronover C, Jorquera L, Ruiz G. (2015). Taraxacum officinale and related species-an ethnopharmacological review and its potential as a commercial medicinal plant. Journal of Ethnopharmacology, 169, 244-262.

Modaresi, M., & Resalatpour, N. (2012). The effect of Taraxacum officinale hydroalcoholic extract on blood cells in mice. Advances in hematology, 2012.

Munoz Mingarro D, Plaza A, Galan A,Vicente JA, Martinez MP, Acero N. (2015). The effect of five Taraxacum species on in vitro and in vivo antioxidant and antiproliferative activity. Food and Function, 6(8), 2787-2793.

Neef, H., Cilli, F., Declerck, P. J., & Laekeman, G. (1996). Platelet anti-aggregating activity of Taraxacum officinale Weber. Phytotherapy Research, 10(SUPPL. 1).

Odintsova TI, Rogozhin EA, Sklyar IV, Musolyamov AK, Kudryavtsev AM , Pukhalsky, VA, Smirnov, AN, Grishin, EV , Egorov, TA. (2010). Antifungal Activity of Storage 2S Albumins from Seeds of the Invasive Weed Dandelion Taraxacum officinale Wigg. Protein and Peptide Letters,17(4), 522-529.

Ovadje P, Chatterjee S, Griffin C, Tran C, Hamm C, Pandey S. (2011). Selective induction of apoptosis through activation of caspase-8 in human leukemia cells (Jurkat) by dandelion root extract. J Ethnopharmacol 133(1): 86–91

Ovesna, Z., Vachalkova, A., Horvathova, K., & Tothova, D. (2004). Pentacyclic triterpenoic acids: new chemoprotective compounds Minireview. Neoplasma, 51(5), 327-333.

Park CM, Jin KS, Lee YW, Song YS. (2011). Luteolin and chicoric acid synergistically inhibited inflammatory responses via in activation of PI3K-Akt pathway and impairment of NF kappa B translocation in Lps stimulated RAW 264.7 cells. European Journal of Pharmacology, 660(2-3), 454-459.

Park CM, Park JY, Noh KH, Shin JH, Song YS. (2011a).Taraxacum officinale Weber extracts inhibit Lps-induced oxidative stres and nitric oxide production via the NF kappa B modulation in RAW 264.7 cells. Journal of Ethnopharmacology, 133(2), 834-842.

Park CM, Cho CW, Song YS. (2014). Top 1 and 2, polysaccharides from Taraxacum officinale, inhibit NF kappa B-mediated inflammation and accelerate Nrf2-induced antioxidative potential through the modulation of PI3K-Akt signaling pathway in RAW 264.7cells. Food and Chemıcal Toxıcology ,66,56-64.

Park CM, Youn HJ, Chang, HK,Song YS. (2010). TOP 1 and 2 polysaccharides from Taraxacum officinale, attenuate CCl4-induced hepatic damage through the modulation of NF kappa B and its regulatory mediators. Food and Chemıcal Toxıcology,48 (5), 1255-1261.

https://doi.org/10.55549/zbs.1564629

Piao, T., Ma, Z., Li, X., & Liu, J. (2015). Taraxasterol inhibits IL-1β-induced inflammatory response in human osteoarthritic chondrocytes. European Journal of Pharmacology, 756, 38-42.

PDR for Herbal Medicines. (2008). (2.Edition). Montvale, New Jersey, 252-254.

Râcz–Kotilla, E., Racz, G., & Solomon, A. (1974). The action of Taraxacum officinale extracts on the body weight and diuresis of laboratory animals. Planta medica, 26(07), 212-217.

Rehman S, Ijaz B, Fatima N, Muhammad SA, Riazuddin S. (2016). Therapeutic potential of Taraxacum officinale against HCV NS5B polymerase: in-vitro and in silico study. Biomedicine and Pharmacotherapy, 83,81-891.

Risau, W. (1995). Differentiation of endothelium. The FASEB journal, 9(10), 926-933.

Roberts, P. J., & Der, C. J. (2007). Targeting the Raf-MEK-ERK mitogen-activated protein kinase cascade for the treatment of cancer. Oncogene, 26(22), 3291-3310.

Saeki, D., Yamada, T., In, Y., Kajimoto, T., Tanaka, R., Iizuka, Y., ... & Masuda, K. (2013). Officinatrione: an unusual (17S)-17, 18-seco-lupane skeleton, and four novel lupane-type triterpenoids from the roots of Taraxacum officinale. Tetrahedron, 69(5), 1583-1589.

Schütz K, Carle R, Schieber A. (2006). Taraxacum--a review on its phytochemical and pharmacological profile. Journal of Ethnopharmacology,107(3), 313-323.

Sigstedt, S. C., Hooten, C. J., Callewaert, M. C., Jenkins, A. R., Romero, A. E., Pullin, M. J., ... & Steelant, W. F. (2008). Evaluation of aqueous extracts of Taraxacum officinale on growth and invasion of breast and prostate cancer cells. International journal of oncology, 32(5), 1085-1090.

Seo SW, Koo HN, An HJ. (2005). Taraxacum officinale protects against cholecystokinin-induced acute pancreatitis in rats. World J Gastroenterol.11:597–599.

Soest J. L. Van, (1975).Taraxacum Wiggers. Davis PH.(Edıtor). Flora of Turkey and the East Aegean Islands. Univeristy press: Edinburgh Vol. 5, 788-812.

Tahtamouni LH, Alqurna NM, Al-Hudhud MY, Al-Hajj HA. (2011). Dandelion (Taraxacum officinale) decreases malerat fertility in vivo. Journal of Ethnopharmacol, 135(1), 102-109.

Tahtamouni LH, Al-Khateeb RA, Abdellatif RN, Al-Mazaydeh ZA, Yasin SR, Al- Gharabli S, Elkarmi AZ. (2016). Anti-spermatogenic activities of Taraxacum officinale whole plant and leaves aqueous extracts. Veterinary Research

Takasaki, M., Konoshima, T., TOKUDA, K., Masuda, K., Arai, Y., SHIOJIMA, K., & AGETA, H. (1999). Anti-carcinogenic activity of Taraxacum plant. II. Biological and Pharmaceutical Bulletin, 22(6), 602-610.

Tong, Y., Zhang, X., Zhao, W., Zhang, Y., Lang, J., Shi, Y., ... & Ding, J. (2004). Anti-angiogenic effects of Shiraiachrome A, a compound isolated from a Chinese folk medicine used to treat rheumatoid arthritis. European journal of pharmacology, 494(2-3), 101-109.

Vogel G (1977) Natural substances with effects on the liver. In: Wagner H, Wolff P (eds) New natural products and plant drugs with pharmacological, biological or therapeutic activity. Springer, Heidelberg

https://doi.org/10.55549/zbs.1564629

WHO Monographs on Selected Medicinal Plants. (2007). Spain,volume 3, 328-338.

Williams, C. A., Goldstone, F., & Greenham, J. (1996). Flavonoids, cinnamic acids and coumarins from the different tissues and medicinal preparations of Taraxacum officinale. Phytochemistry, 42(1), 121-127.

Wynn, T. A. (2007). Common and unique mechanisms regulate fibrosis in various fibroproliferative diseases. The Journal of clinical investigation, 117(3), 524-529.

Yang YF, Li SS. (2015). Dandelion extracts protect human skin fibroblasts from UVB damage and cellular senescence. Oxıdatıve Medıcıne and Cellular Longevıty, 619560.

Zhang J, Kang MJ, Kim MJ, Kim ME, Song JH, Lee YM, Kim JI. (2008). Pancreatic lipase inhibitory activity of Taraxacum officinale in vitro and in vivo. Nutrition Research and practice, 2(4), 200-203.

Zhang X, Xiong H, Liu L. (2012). Effects of taraxasterol on inflammatory responses in lipopolysaccharide-induced RAW 264.7 macrophages. Journal of Ethnopharmacol,141(1), 206-211.

Zhi, X., Honda, K. I., Ozaki, K., Misugi, T., Sumi, T., & Ishiko, O. (2007). Dandelion T-1 extract up-regulates reproductive hormone receptor expression in mice. International Journal of Molecular Medicine, 20(3), 287-292.

https://doi.org/10.55549/zbs.1564629