ISSN: 2231-3656

International Journal of Pharmacy and Industrial Research (IJPIR)

IJPIR |Vol. 16 | Issue 3 | Jul – Sep 2026

www.ijpir.com

DOI: https://doi.org/10.61096/ijpir.v16.iss3.2026.1055.1064

Dandelion+: Scientific Evidence for A Polyherbal Formulation Targeting Hepatoprotection, Antioxidant Defence, and Respiratory Wellness — A Narrative Review of *Phyllanthus Amarus, Taraxacum Officinale, and Silybum Marianum*

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Published on: 03.08.2026
Published by: Futuristic Publications

Abstract: DANDELION+ is a proprietary polyherbal formulation from Biotex Life Solutions combining three botanicals with documented hepatoprotective, antioxidant, anti-inflammatory and respiratory activity: *Phyllanthus amarus* Schumach. & Thonn. (Bhumyamalaki), *Taraxacum officinal* F.H. Wigg. (Dandelion) and *Silybum marianum* (L.) Gaertn. (Milk thistle). This narrative review discusses the rationale for combining these ingredients, based on published preclinical, mechanistic and clinical evidence for each herb individually and combined. *Phyllanthus amarus* shows hepatoprotective effects across models of chemically induced liver injury; its constituents (phyllanthin, hypophyllanthin, niranthin, corilagin, geraniin, gallic and ellagic acids, rutin, quercetin) modulate lipid peroxidation, antioxidant enzymes and hepatic signalling (NF-κB, MAPK, PI3K-Akt, iNOS, COX-2, TNF-α, IL-1β, IL-6). *Taraxacum officinale* demonstrates hepatoprotective activity across alcohol-, acetaminophen-, carbon-tetrachloride- and diet-induced liver injury models. *Silybum marianum* contains silymarin, an established antioxidant, anti-inflammatory, membrane-protective and antifibrotic agent. The three ingredients also show respiratory relevance in preclinical models of airway inflammation, acute lung injury and airway smooth-muscle relaxation. Their distinct but overlapping antioxidant and anti-inflammatory mechanisms support a rationale for combination in DANDELION+, positioned for hepatoprotection, antioxidant defence and respiratory wellness rather than disease treatment. Limitations and priorities for future study are identified.

Keywords: *Phyllanthus amarus; Taraxacum officinale; Silybum marianum; hepatoprotection; silymarin*

1. Introduction

Oxidative stress and inflammation are recognised as key pathogenic mechanisms in a range of liver and respiratory diseases. In liver disease, oxidative stress manifests as increased production of reactive oxygen species (ROS) and reduced levels of glutathione, affecting mitochondrial function and leading to lipid peroxidation, inflammatory cytokine cascade activation and fibrosis development in response to various insults, including toxins, metabolic disturbances, alcohol abuse, viral hepatitis and drug-induced injury. In respiratory disease, similar mechanisms contribute to the development of allergic airway inflammation, acute lung injury, epithelial cell damage, airway smooth muscle contraction and enhanced susceptibility to infections, particularly influenza virus infection. Due to the complexity of the underlying pathogenic mechanisms, individual plant extracts may contain multiple bioactive constituents targeting different aspects

of the disease process, making herbal medicines interesting candidates for preclinical and clinical investigation.

In this context, it is notable that Biotex Life Solutions has developed DANDELION+, a polyherbal formulation containing three different botanical ingredients with reported antioxidant and anti-inflammatory activity. The name of the product is based on one of the three active ingredients, *Taraxacum officinale* (dandelion), which appears to be the most widely used of the three herbs included in the formulation, with the other two, *Phyllanthus amarus* and *Silybum marianum*, possessing complementary hepatoprotective, antioxidant and anti-inflammatory properties. The rationale for developing DANDELION+ is therefore based on combining the beneficial effects of three botanical ingredients with documented activity against liver damage and inflammation, as well as respiratory tract inflammation and infection.

The reasons for selecting these three specific botanical ingredients for the formulation are diverse. First, the three herbs contain phytochemical constituents targeting different aspects of liver damage and inflammation, including inhibition of various pro-inflammatory cytokines and pathways (NF-κB, IL-6, TNF-α, among others). Second, the three botanical ingredients possess overlapping antioxidant mechanisms of action, with reported activation of the Nrf2/HO-1 pathway in cell culture and animal models. Third, the three herbs demonstrate respiratory tract anti-inflammatory activity in preclinical studies, providing additional justification for developing a combined formulation. In addition, each of the three ingredients possesses documented safety profiles in clinical studies, although the clinical evidence for the overall formulation remains limited to date.

Based on these considerations, the current narrative review aims to provide an overview of the published evidence for the pharmacology, efficacy, safety and mechanism of action of the three ingredients in DANDELION+ to serve as the rationale for combining these three botanical ingredients into a single polyherbal formulation and identify areas for future study.

2. Methodology

The present article was prepared as a narrative review of the published literature on the ingredient botanicals of the DANDELION+ formulation. The narrative review approach was adopted, as the objective of this study was to collate the pharmacological and mechanistic evidence on the three ingredient botanicals, rather than perform a quantitative analysis of the treatment effects.

The PubMed, PubMed Central, and publisher websites were searched for relevant studies, with the backward search from the key review and mechanistic articles published through June 2026. The search strategy combined the botanical names, common names, ingredient-related terms, and the key pharmacological activity descriptors: "*Phyllanthus amarus* hepatoprotective", "*phyllanthin hypophyllanthin* anti-inflammatory", "*Taraxacum officinale* hepatoprotective", "dandelion antioxidant liver", "taraxasterol acetaminophen hepatotoxicity", "*Taraxacum officinale* respiratory", "*Silybum marianum* hepatoprotective", "silymarin antioxidant liver", "silybin liver fibrosis", "silymarin airway inflammation", "silibinin allergic airway inflammation".

The inclusion criteria comprised in vitro, animal, and isolated compound studies, phytochemical analyses, narrative reviews, systematic reviews, and meta-analyses of clinical studies. The eligible studies covered the pharmacological effects and clinical applications of the DANDELION+ ingredient botanicals in terms of hepatoprotection, antioxidant activity, anti-inflammatory effects, and respiratory-relevant effects. The findings of the included studies were thematically synthesised to inform the present narrative review.

3. Product Overview: DANDELION+ by Biotex Life Solutions

DANDELION+ is a multi-herbal health product developed by Biotex Life Solutions, incorporating three botanical ingredients with documented hepatoprotective, antioxidant, anti-inflammatory, and respiratory effects. The choice of the three ingredient botanicals reflects a synergistic approach to the formulation, as the combined use of *Phyllanthus amarus, Taraxacum officinale,* and *Silybum marianum* covers a broader therapeutic spectrum than the use of any one of them alone. The three botanical ingredients were selected for their reported antioxidant, immunomodulatory, hepatoprotective, antifibrotic, and anti-inflammatory activities.

The DANDELION+ formulation contains: 1) *Phyllanthus amarus* Schumach. & Thonn. (Tamalaki, Bhumyamalaki), primarily used as a *whole* herb or leaf; 2) *Taraxacum officinale* F.H. Wigg. (dandelion), used as a root, leaf, and/or flower; and 3) *Silybum marianum* (L.) Gaertn. (milk thistle), used as a fruit/seed (achene). The name DANDELION+ is derived from the key role of the dandelion botanical in the

formulation, with the plus sign indicating that the DANDELION+ formulation also contains *P. amarus* and *S. marianum*.

4. Botanical and Phytochemical Considerations of DANDELION+ Ingredients

The efficacy of any herbal formulation depends on the botanical identity, part of the plant used, the preparation technology, phytochemical composition, and the presence of standardised bioactive constituents. This is particularly important for the DANDELION+ formulation, as the three ingredient botanicals differ in terms of their phytochemical profiles and require standardised processing to ensure consistency of the extract quality.

4.1. *Phyllanthus amarus*: Lignan-Rich Hepatoprotective Botanical

The herb *Phyllanthus amarus* belongs to the *Phyllanthaceae* family and is known as Tamalaki or Bhumyamalaki in Ayurveda. The taxonomic complexity of this botanical is noteworthy, as several species of the Phyllanthus genus are used interchangeably as "*Phyllanthus amarus*" in traditional medicine and commercial herbalism. This includes *P. niruri, P. fraternus,* and *P. urinaria,* which are botanically distinct and exhibit different phytochemical profiles. Therefore, any formulation containing *P. amarus* as an ingredient must be produced with authenticated botanical material.

The bioactive constituents of *P. amarus* include: Lignans: phyllanthin, hypophyllanthin (major constituents used for standardisation), niranthin, nirtetralin; Ellagitannins and hydrolysable tannins: corilagin, geraniin; Phenolic acids: gallic acid, ellagic acid; Flavonoids: rutin, quercetin derivatives. The diverse phytochemical profile underpins the traditional and scientific interest in *P. amarus*, with its hepatoprotective, antioxidant, anti-inflammatory, immunomodulatory, and antiallergic activities reported in a series of preclinical studies [1–7, 12–17].

4.2. *Taraxacum officinale*: Broad-Spectrum Antioxidant and Hepatoprotective Botanical

Taraxacum officinale belongs to the Asteraceae family and is commonly known as dandelion. The pharmacological potential of this plant has been demonstrated in multiple preclinical studies, although its efficacy depends on the part of the plant used. Thus, the root of *T. officinale* is associated with prebiotic, hepatoprotective, and antioxidant effects, while the leaf is rich in flavonoids, phenolic acids, and minerals with antioxidant and hepatic metabolic activities. The flower contains polyphenols with anti-inflammatory and antioxidant properties. In particular, the polyphenolic extract of the dandelion flower has been shown to suppress ROS, NO, and lipid peroxidation in vitro and in vivo [27–31, 38–42].

The major constituents of *T. officinale* include: Phenolic acids: chicoric acid, chlorogenic acid, caffeic acid, ferulic acid; Flavonoids: luteolin, apigenin, quercetin derivatives; Sesquiterpene lactones and triterpenes: taraxinic acid derivatives, taraxasterol, β-sitosterol; Polysaccharides: inulin-type fructans (in the root), dandelion root polysaccharides. Notably, taraxasterol is a bioactive constituent of *T. officinale* with antioxidant and hepatoprotective activities [37, 50].

4.3. *Silybum marianum*: Liver-Protective Botanical Containing Silymarin

The third ingredient of the DANDELION+ formulation is *Silybum marianum* (L.) Gaertn., also known as milk thistle. This is a well-known hepatoprotective botanical whose fruit/seed (achene) is the source of the flavonolignan mixture referred to as silymarin. Silymarin comprises several flavonolignans and flavonoids, including silybin (silibinin), isosilybin, silychristin, silydianin, and taxifolin. Among these, silybin is the most studied component of silymarin [53–57].

The pharmacological effects of silymarin are multifactorial, as this botanical extract can modulate lipid peroxidation, glutathione metabolism, membrane integrity, mitochondrial function, and xenobiotic metabolism pathways. Silymarin can also suppress pro-inflammatory signalling pathways (NF-κB, MAPK), the expression of inflammatory cytokines, and the progression of hepatic fibrosis. The main limitation of silymarin is its poor oral bioavailability, and several approaches have been proposed to improve the oral bioavailability of silymarin, including phytosome complexes, phosphatidylcholine-containing preparations, liposomes, and nanoparticles [57, 62, 63, 67].

5. Hepatoprotective Evidence for DANDELION+ Ingredients

5.1. *Phyllanthus amarus*: Preclinical Evidence for Liver Protection

The hepatoprotective potential of the *P. amarus* ingredient of DANDELION+ has been demonstrated in a series of preclinical studies. Thus, the aqueous and leaf extracts of *P. amarus* were shown to attenuate ethanol-induced liver injury in vivo and in vitro through membrane-protective and antioxidant mechanisms

[8,10]. The ethanolic extract of *P. amarus* reduced the damage to the liver in a murine model of aflatoxin B1-induced liver injury through antioxidant mechanisms [9].

The evidence on the liver-protective effects of *P. amarus* is further supported by the findings on isolated phyllanthin, which attenuated CCl4-induced liver damage in an experimental animal model [11]. The treatment with standardised *P. amarus* extract reduced liver oxidative stress and demonstrated membrane-protective and cytoprotective effects in an in vitro model of hepatocellular damage [12]. In a model of liver fibrosis, phyllanthin attenuated TGF-β1/ALK5/Smad signalling and exerted antifibrotic effects [17]. Clinical trials on the effects of *P. amarus* on hepatitis B are conflicting [18–23], and the evidence on the clinical efficacy of *P. amarus* is limited to its antioxidant and anti-inflammatory effects on the liver.

5.2. *Taraxacum officinale*: Preclinical Evidence for Liver Protection

The hepatoprotective effects of the *T. officinale* ingredient of DANDELION+ have been investigated in a variety of experimental models of liver injury. Thus, the aqueous extract of the root of *T. officinale* attenuated ethanol-induced liver injury in vitro and in vivo [28]. The root extract of T. officinale demonstrated antifibrotic effects in an experimental model of CCl4-induced liver injury [29]. The leaf extract of *T. officinale* attenuated acetaminophen-induced liver damage through antioxidant mechanisms [31], and taraxasterol reduced the damage to the liver in an experimental model of acetaminophen hepatotoxicity through Nrf2-mediated antioxidant pathways [37]. The leaf extract of *T. officinale* protected against sodium dichromate-induced liver injury [34], methionine- and choline-deficient diet-induced liver injury [32], and high-fat diet-induced non-alcoholic fatty liver disease [33].

The evidence for the hepatoprotective effects of *T. officinale* was further supported by the findings on the effects of the root polysaccharides of *T. officinale* on liver injury. Thus, TOP1 and TOP2, the two polysaccharides isolated from the root of *T. officinale*, attenuated CCl4-induced liver injury through NF-κB signalling pathways [35,36]. Overall, the findings on the effects of *T. officinale* indicate that this botanical ingredient can reduce the damage to the liver in a variety of experimental models of liver injury.

5.3. *Silybum Marianum*: Clinical and Preclinical Evidence for Liver Protection

The third ingredient of DANDELION+ is *S. marianum*, a botanical with documented hepatoprotective effects. Thus, silymarin has been investigated in a variety of clinical trials on patients with cirrhosis, chronic hepatitis, non-alcoholic fatty liver disease (NAFLD), non-alcoholic steatohepatitis (NASH), drug-induced liver injury, and amatoxin poisoning [53–57,62,63]. The mechanisms of the hepatoprotective effects of silymarin encompass the inhibition of lipid peroxidation, preservation of glutathione, stabilisation of cell membranes, and modulation of phase I and II drug-metabolising enzymes. Silymarin can also reduce the production of pro-inflammatory cytokines (TNF-α, IL-1β, IL-6), inhibit NF-κB, MAPK, COX-2, iNOS, and NLRP3 inflammatory pathways, and attenuate liver fibrosis by inhibiting hepatic stellate cells.

The evidence for the clinical efficacy of silymarin in liver diseases is mixed, with some clinical studies reporting beneficial effects and others demonstrating the lack of efficacy [53–57,62,63]. Thus, the randomised controlled trial by Ferenci et al. on patients with cirrhosis showed that the treatment with silymarin was associated with reduced mortality [53]. In contrast, the randomised trial on patients with chronic hepatitis C showed that the oral administration of high-dose silymarin did not reduce ALT levels compared to the placebo [55]. The randomised trial on patients with NASH showed that silymarin failed to meet the primary endpoint of histological improvement [59]. Overall, the clinical evidence on the efficacy of silymarin is limited to its beneficial effects on certain populations of patients with liver diseases.

6. Antioxidant and Anti-inflammatory Mechanisms of DANDELION+ Ingredients

The antioxidant and anti-inflammatory mechanisms of the three DANDELION+ ingredients form the basis of the hepatoprotective effects of this multi-herbal formulation.

For the *P. amarus* ingredient: The anti-inflammatory effects of *P. amarus* are mediated by the inhibition of inducible nitric oxide synthase (iNOS), cyclooxygenase-2 (COX-2), and pro-inflammatory cytokines, as well as the suppression of NF-κB signalling pathways [15]. The standardised extract of *P. amarus* and isolated phyllanthin inhibited lipopolysaccharide (LPS)-induced inflammation in macrophages through the NF-κB, MAPK, and PI3K-Akt pathways [16,24,25]. The polyphenolic constituents of *P. amarus*, including corilagin, geraniin, gallic acid, ellagic acid, rutin, and quercetin derivatives, possess antioxidant properties [1–7,12].

For the *T. officinale* ingredient: The antioxidant effects of *T. officinale* were demonstrated in a variety of in vitro and in vivo studies using different parts of the plant. Thus, the extract of the flower of *T. officinale* reduced ROS production, NO levels, and lipid peroxidation [40]. The sesquiterpene lactones of *T.*

officinale induced Nrf2 in macrophages [41]. The treatment with the extract of *T. officinale* activated the Nrf2-MAPK/PI3K pathway and increased HO-1 in macrophages [42], which explains the antioxidant and anti-inflammatory effects of this botanical. Indeed, the antioxidant effects of *T. officinale* were shown in several preclinical studies on experimental liver injury models, including acetaminophen hepatotoxicity, alcohol-induced liver injury, sodium dichromate-induced liver injury, and CCl4-induced liver injury [27–33].

For the *S. marianum* ingredient: The antioxidant effects of silymarin are achieved through the direct scavenging of ROS, inhibition of lipid peroxidation, preservation of glutathione, protection of mitochondria, and chelation of pro-oxidant metal ions [55–58,62–67]. Silymarin can also induce the Nrf2-mediated antioxidant response and protect against oxidative stress [55–58,62–67]. The anti-inflammatory effects of silymarin are multifactorial and include the inhibition of NF-κB, MAPK, TNF-α, IL-1β, IL-6, COX-2, iNOS, nitric oxide, prostaglandins, and NLRP3 inflammasome [55–58,62–67]. Overall, the antioxidant and anti-inflammatory effects of silymarin are broader than those of the other two ingredients of DANDELION+.

The anti-inflammatory effects of the three DANDELION+ ingredients are mediated by the inhibition of pro-inflammatory signalling pathways, including NF-κB, MAPK, PI3K-Akt, and NLRP3 inflammasome. For P. amarus, the anti-inflammatory activity is associated with the suppression of iNOS, COX-2, and pro-inflammatory cytokines [15,16,24]. For *T. officinale*, the anti-inflammatory effects are mediated by Nrf2 and NF-κB pathways [38–42]. For *S. marianum*, the anti-inflammatory effects are achieved through the inhibition of NF-κB, MAPK, TNF-α, IL-1β, IL-6, COX-2, iNOS, nitric oxide, prostaglandins, and NLRP3 inflammasome [55–58,62–67]. The antioxidant effects of the three ingredients are also mediated by Nrf2 and NF-κB pathways [38–42,55–58,62–67]. The presence of these overlapping mechanisms supports the synergy hypothesis for DANDELION+.

7. Respiratory-Relevant Evidence for DANDELION+ Ingredients

The respiratory effects are an emerging area of the pharmacological potential of DANDELION+ ingredients, as the preclinical evidence suggests that all three ingredients can attenuate lung injury and airway inflammation.

For the *P. amarus* ingredient: The respiratory-relevant effects of *P. amarus* are primarily linked to its antiallergic and anti-inflammatory properties. Thus, phyllanthin and hypophyllanthin attenuated ovalbumin-induced asthma in a murine model through the modulation of IgE, Nrf2, iNOS, TNF-α, and interleukins [26]. Hypophyllanthin demonstrated histamine H1 receptor antagonism in molecular docking simulations, and the extract of *P. amarus* showed antihistamine-like effects [19]. The respiratory effects of *P. amarus* are explained by the antioxidant and anti-inflammatory activities of its phytochemical constituents, including phyllanthin, hypophyllanthin, corilagin, gallic acid, ellagic acid, rutin, and quercetin derivatives [1–7,12].

For the *T. officinale* ingredient: The evidence for the respiratory effects of *T. officinale* is derived from several preclinical studies. Thus, Liu et al. showed that the extract of T. officinale attenuated LPS-induced acute lung injury in a murine model [44]. He et al. demonstrated that the aqueous extract of *T. officinale* inhibited influenza virus infection in vitro and in vivo [45]. Awortwe et al. showed that the extract of *T. officinale* leaves reduced cholinergic-induced bronchoconstriction and inflammation in ovalbumin-sensitised guinea pigs [46]. Zhao et al. demonstrated that the extract of *T. officinale* relaxed the airway smooth muscle by blocking voltage-gated calcium channels and non-selective cation channels [47].

For the *S. marianum* ingredient: The respiratory effects of *S. marianum* have been investigated in a number of preclinical studies. Silibinin attenuated allergic airway inflammation in a murine model through the inhibition of NF-κB [68]. In addition, silibinin was shown to suppress house dust mite-induced allergic airway inflammation [74]. Silymarin reduced cigarette smoke-induced airway inflammation in a murine model through the inhibition of autophagy and the ERK/p38 MAPK pathway [69,70]. Silybin inhibited LPS-induced lung injury through the suppression of NF-κB and NLRP3 pathways [71]. Silymarin attenuated HCl-induced acute lung injury through the Nrf2/HO-1 pathway [72]. More recently, the protective effects of silymarin were demonstrated in a murine model of sand dust-induced pulmonary inflammation [73] and methotrexate-induced pulmonary toxicity [75].

8. Comparative Evidence Strength and Formulation Synergy for DANDELION+

The three ingredients of DANDELION+ differ in terms of the quality of the published evidence. Thus, the evidence on the efficacy of *S. marianum* is the strongest, but the clinical trials on silymarin are inconsistent. The evidence on the efficacy of *P. amarus* is also strong, but it is mainly derived from

preclinical studies. The evidence on *T. officinale* is more limited compared to the other two ingredients, but it is mostly preclinical as well.

The formulation synergy hypothesis for DANDELION+ is based on the following considerations. First, the three ingredients of DANDELION+ are rich in phytochemical constituents with complementary mechanisms of action. Thus, the lignans and ellagitannins of *P. amarus* complement the phenolic acids, flavonoids, and sesquiterpene lactones of *T. officinale*, which in turn complement the flavonolignans of *S. marianum*. Second, the three ingredients of DANDELION+ demonstrate broad anti-inflammatory effects, with inhibition of NF-κB, MAPK, PI3K-Akt, and NLRP3 inflammasome being reported for all three ingredients. The anti-inflammatory effects of DANDELION+ ingredients are further supported by the suppression of pro-inflammatory cytokines and chemokines. Third, the three ingredients of DANDELION+ demonstrate hepatoprotective effects in a variety of preclinical models of liver injury. These effects are mediated by the antioxidant effects of the three ingredients, with suppression of lipid peroxidation and the Nrf2/HO-1 pathway being reported for all three ingredients. The formulation synergy hypothesis for DANDELION+ has not been tested in published clinical studies.

9. Safety Considerations for DANDELION+ Ingredients

The safety of DANDELION+ is determined by the safety profiles of its three ingredients. Thus, the *P. amarus* ingredient may interact with several drugs due to the inhibition of CYP isoenzymes, and caution is advised in patients taking antiviral, anticoagulant, antidiabetic, immunosuppressive, and anti-cancer drugs, as well as statins and anti-epileptic drugs [21–23]. In addition, *T. officinale* belongs to the Asteraceae family and may cause allergic reactions in patients hypersensitive to ragweed, daisies, chrysanthemums, and related plants. The diuretic effects of *T. officinale* may potentiate the effects of diuretics and lithium, and caution is advised in patients with hypertension or those taking other medications [27, 31]. Finally, the *S. marianum* ingredient of DANDELION+ is generally well-tolerated, but it may cause gastrointestinal discomfort, loose stools, bloating, nausea, headache, and skin rash [54,57,62]. Silymarin should be used with caution in patients taking anticoagulant, antidiabetic, and immunosuppressive drugs, as well as anti-cancer agents, antiviral, anti-epileptic drugs, statins, and sedatives [54, 57, 62].

The safety of the DANDELION+ formulation also depends on the quality of the botanical ingredients. Thus, BiotexLife Solutions should ensure that the DANDELION+ formulation complies with the Good Manufacturing Practice (GMP) guidelines. The manufacturer should implement appropriate quality control procedures, including authentication of botanical ingredients, specification of plant parts, standardisation of extracts, and testing of heavy metals, microbiological contaminants, and other potential toxins. In particular, the company should determine the levels of pyrrolizidine alkaloids and perform the relevant toxicological tests, as all three ingredients of DANDELION+ are known to contain hepatotoxic alkaloids.

10. Limitations of the Evidence and Future Research Directions

The limitations of the evidence for a multi-herbal formulation such as DANDELION+ should be acknowledged and considered when designing future studies. Thus, most of the evidence for the efficacy of the DANDELION+ ingredients comes from preclinical studies [16,26,27,43]. The results of preclinical studies cannot be directly extrapolated to humans due to interspecies differences in drug metabolism and response. Moreover, the clinical relevance of individual studies is limited by the differences in the study design, interventions, and outcome measures. In particular, the efficacy of a given botanical intervention may depend on the route of administration, dose, duration of treatment, and disease stage [54,57,62]. The formulation synergy hypothesis for DANDELION+ has not been tested in clinical trials.

Future research on DANDELION+ should be focused on the following areas. First, the preclinical studies on the individual ingredients of DANDELION+ should be complemented by formulation-level studies investigating the synergistic effects of the combination. The formulation synergy hypothesis for DANDELION+ is based on the similarities in the mechanisms of action of the three ingredients, but the interactions between individual constituents have not been characterised [16,27]. Second, the pharmacokinetics of the key constituents should be characterised in detail, as the oral bioavailability of many botanical constituents is limited [65,67]. Third, the interactions between DANDELION+ and other drugs should be investigated, as the inhibition of CYP isoenzymes is a major concern for the safety of this formulation [57]. Fourth, the mechanistic studies should be focused on the common mechanisms of action of the three ingredients, including the antioxidant effects mediated by the Nrf2/HO-1 pathway and anti-inflammatory effects mediated by NF-κB inhibition. Finally, future clinical studies on DANDELION+ should use standardised interventions and patient populations and should be designed to confirm or refute

the formulation synergy hypothesis. The clinical trials should also include a long-term follow-up of the patients to assess the safety profile of DANDELION+.

11. Conclusion

DANDELION+ is a multi-herbal formulation incorporating three botanical ingredients with documented hepatoprotective, antioxidant, anti-inflammatory, and respiratory effects. The three ingredients of DANDELION+, namely, *P. amarus*, *T. officinale*, and *S. marianum*, are characterised by a diverse range of phytochemical constituents and mechanisms of action. In particular, *P. amarus* contains lignans and ellagitannins, including phyllanthin, hypophyllanthin, corilagin, gallic acid, and ellagic acid. The hepatoprotective effects of *P. amarus* have been demonstrated in a variety of preclinical models of liver injury, and the antioxidant and anti-inflammatory effects of this botanical ingredient have been confirmed in vitro and in vivo [1–7,12–17]. *T. officinale* contains phenolic acids, flavonoids, and sesquiterpene lactones, including chicoric acid, chlorogenic acid, caffeic acid, ferulic acid, luteolin, apigenin, quercetin derivatives, and taraxasterol. The antioxidant effects of *T. officinale* have been demonstrated in several preclinical studies, and the hepatoprotective effects of this botanical ingredient have been confirmed in a variety of experimental models of liver injury, including toxic, metabolic, alcohol-induced, and inflammatory liver injury [27–33]. *S. marianum* contains flavonolignans and flavonoids, including silybin (silibinin), isosilybin, silychristin, silydianin, and taxifolin. The hepatoprotective and antioxidant effects of *S. marianum* have been demonstrated in a variety of preclinical studies, and the clinical evidence for the efficacy of this botanical ingredient is mixed but generally positive [53–57,62,63]. Overall, the three ingredients of DANDELION+ have been shown to reduce oxidative stress, inflammation, and liver injury in preclinical studies, and future clinical studies are needed to confirm these effects in humans.

Declaration of AI use

The authors utilised generative AI tools only to a limited extent for grammar checking and language support while preparing the manuscript. All scientific content, analyses, and conclusions are entirely those of the authors; they reviewed and revised the output and assume full responsibility for the final version of the manuscript.

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