

Review Article

Ficus carica Tree Latex is Used for Treating Warts: Is it a Coincidence or a New Point of View?

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Background: Warts are common skin growths, viral in origin. In fact, many infections arise from members of the human papillomavirus (HPV) family. Traditional treatments for warts have existed to date, but all such procedures can be expensive, invasive, painful, and sometimes ineffective. Recently, there has been growing interest in remedies that can be considered alternatives to mainstream treatments.

Aim of the study: This review discusses the complementary and alternative medicinal (CAM) properties that are gaining popularity as a therapeutic approach, of the *Ficus carica* (fig) tree latex, its possible modes of action against warts, and anecdotal evidence about its effectiveness.

Method: Data were obtained from clinical and animal studies published in English between 1997 and September 2025 and collected from Google Scholar, PubMed, Scopus, and the Cochrane Library.

Results: *F. carica* latex contains proteolytic enzymes (ficins) that digest keratin and destroy the hyperkeratotic structure of warts, exposing infected tissue to immune clearance. In addition, polyphenols and flavonoids provide antioxidant and anti-inflammatory effects, while furocoumarins such as psoralen and bergapten exert antiviral and phototoxic actions that inhibit viral replication within wart tissue. While individual results may vary, many users report a reduction in the wart size or a complete clearance.

Conclusion: *F. carica* (fig) tree latex can be introduced as a novel treatment for cutaneous warts. Further studies are needed for the establishment of a standardized treatment approach, assessment of long-term efficacy, and elucidation of the exact mechanisms of action of *F. carica* latex.

Keywords: complementary and alternative medicine (CAM); *Ficus carica*; human papillomavirus (HPV); latex; wart

1. Introduction

Warts are small, rough lesions and usually raised growths that often appear on the skin and normally result from the virus known as the human papillomavirus (HPV). They may be seen on any other part of the body, such as hands, feet, face, and private parts of the body. Warts are sometimes painful, especially if they develop on the soles of the feet, where the weight of the body falls. Warts are common throughout the world. Available epidemiological studies highlight that warts remain a common dermatological

problem worldwide, with variation depending on age, anatomical site, and viral subtype. A large US population-based study reported that the prevalence of common warts in children was around 5%–10%, while a Dutch study found prevalence rates of up to 33% among primary school-children, strongly influenced by environmental and household factors. Genital warts show a distinct epidemiological pattern. A systematic review estimated the incidence of genital warts at 160–289 cases per 100,000 person-years, with a lifetime prevalence of up to 10% in sexually active populations. US insurance-based data confirmed that the

prevalence of anogenital warts peaked in individuals aged 20–29 years, with some decline following HPV vaccination programs. Additional virological data demonstrate that specific HPV types are strongly associated with cutaneous wart subtypes and vary with patient characteristics [1–7]. Due to the risk of cervical cancer, and also the psychosocial impact of warts, early diagnosis and intervention for treatment are essential. The common treatments that may be prescribed include the various modes of cryotherapy, salicylic acid, and laser treatment because they are the most accessible and effective forms of treatment. It is not indicated for long-term use with conventional therapies due to side effects, including skin irritation, erythema, peeling, stinging sensation, and pain. New modes of treatment include immunotherapy, topical antiviral agents, and combination therapies that can be given in resistant cases and speed up the process of the treatment [1, 8–10]. Also, scientists turned to natural remedies that have fewer adverse effects for treatment or in combination with other treatments. Herbal remedies are becoming more and more common in complementary and alternative medicinal (CAM), due to their minimal side effects and high efficacy. A total of 36% of American adults over the age of 18 use CAM, a trend that is spreading throughout the world [1, 10–12]. Among many of the natural therapies that have gained widespread interest for their possible efficiency in the treatment of warts, *Ficus carica* (fig) tree latex can be considered. It is also known as fig milk. Fig tree latex has traditionally been used in folk medicine for anti-inflammatory, antifungal, antiviral, and antibacterial action. Several studies have now been able to establish the efficacy of fig tree latex in the treatment of warts. Its mode of action against warts is caused by various mechanisms of action that will be discussed further. Also, it can be useful in combination with other therapies or as adjuvant therapy to the main therapies, such as cryotherapy or the usage of salicylic acid to reduce the duration and adverse effects of the treatments [13–17]. This review highlights the possible benefits of fig tree latex in the treatment of warts, its mechanisms of action, and its limitations. Also, we conclude with some recommendations on the directions of future research and possible pharmaceutical options.

2. Method of Search

Data were obtained from clinical and animal studies published in English between 1997 and September 2025, and collected from Google Scholar, PubMed, Scopus, and the Cochrane Library with operators (AND/OR) to identify relevant studies. Search terms included related keywords to “*Ficus carica*” OR “Fig Latex” AND “Cutaneous warts” OR “Wart” OR “human papillomavirus” OR “HPV” AND “Novel therapeutic pathway.” Original articles with accessible full text and data reporting the biological activity or clinical effect of *F. carica* latex were included. Additional references were identified by screening the bibliographies of selected articles. Duplicate and nonrelevant publications were excluded. The final selection focused on studies presenting experimental, preclinical, or clinical evidence of fig

latex in relation to wart treatment and related mechanisms of action.

2.1. HPV and Warts. Warts, caused by HPV, are small growths and seldom harm the skin. More than 100 types exist; they can grow on the skin, in the mouth, on the genitals, and around the anal surface areas. Some of them are common warts, plantar warts, flat warts, filiform warts, and genital warts. Warts are cosmopolitan in distribution, but they affect all age groups. Genital warts are caused by some high-risk strains of HPV, which can be sexually transmitted and occur around the genital area, leading to cancer. These malignancies are seen most in patients with tobacco or alcohol abuse or patients with weak immune systems, like HIV patients. In addition to the unappealing appearance, they can be transmitted to others. Warts are transmitted through direct skin contact with the HPV that causes them or indirectly by touching contaminated surfaces like towels or razors. Transmission is more likely in moist environments and with weakened immune systems. So, treating them is important to avoid transmission and other complications [18, 19].

2.2. Wart Treatment Methods and Their Complication. Warts are treated using different approaches such as destructive techniques, immunotherapy, antimitotic drugs, and other remedies. The invasive treatment methods include surgical excision, cryotherapy, laser therapy, electrosurgery, and curettage. Conventional destructive therapies include topical chemotherapy, bichloroacetic acid, trichloroacetic acid, salicylic acid, podophyllin, cantharidin, and 5-fluorouracil [20]. Imiquimod, zinc sulfate, diphenylcyclopropenone, and cimetidine are some of the immunotherapies used that induce humoral and cellular immune responses [2]. The current treatment protocol for warts involves either a single therapy or a combination of therapies. However, these methods are also problematic. There are side effects to salicylic acid treatments, such as skin irritation, redness, peeling, and a stinging sensation. Also, it could cause unwanted dryness and irritation of the surrounding skin in long-term usage. Cryotherapy destroys the tissue both directly and indirectly. Note that this should usually be done by the healthcare professional. It also has a high cost, long therapy duration, and low patient compliance. It is accompanied by pain, blister and swelling, and discoloration of the skin [8]. Using surgery for the removal of warts may be unsuccessful because the virus itself is not harmed in this method, and there is a risk of recurrence. Another thing is the high expense of these surgeries, which we should bear in mind [21]. Imiquimod has lots of side effects, like causing erythema, itching, and inflammation. Besides, it is not recommended for oral, urethral, intravaginal, cervical, rectal, or intra-anal HPV disease. Also, it is not recommended for children ages 2–12 due to studies failing to demonstrate efficacy [22]. Despite the different treatments available for warts, these treatments often do not eliminate the virus itself, which leads to the recurrence of the disease. Also, some of these methods have side effects or

need to be performed by a specialist, which imposes costs on the patient. For this reason, efforts to find effective and cost-effective alternative treatments with high patient adherence are always ongoing.

2.3. Botanical Identity, Taxonomy, and Distribution of *F. carica*. *F. carica* L., commonly known as the fig tree, belongs to the genus *Ficus* and family Moraceae, which includes more than 800 species of latex-bearing plants. It is a small deciduous tree or shrub, typically 3–10 m in height, with broad lobed leaves and a characteristic milky latex present in stems, leaves, and unripe fruits. The species is native to the Middle East and the Mediterranean basin, where it has been cultivated for over 5000 years, and has since naturalized in many warm-temperate and subtropical regions worldwide.

As a plant of high cultural and medicinal value, *F. carica* is not only an important fruit crop but also a traditional source of medicinal latex for dermatological conditions such as warts, which reflects the close interplay of ethnomedicine and modern pharmacological exploration. Latex from *F. carica* was chosen as the main focus of this review and as the preferred plant part for potential therapeutic use against warts, rather than fruit or leaves, because it contains the highest concentration of proteolytic enzymes (ficins) responsible for keratin degradation and wart removal. While fruits and leaves are rich in polyphenols and antioxidants with general health benefits, they lack the potent enzymatic activity and localized keratolytic effect required to target hyperkeratotic wart tissue. Furthermore, latex provides a concentrated mixture of bioactive compounds, including furocoumarins and triterpenes, that add antiviral and immunomodulatory properties, whereas extracts from fruits or leaves are more suitable for systemic or dietary use rather than topical therapy. Thus, the biochemical profile, topical applicability, and traditional evidence strongly support latex as the most rational plant part for managing warts [23, 24].

The growth of *F. carica* is favored in warm Mediterranean climates characterized by hot, dry summers and mild, moist winters. The plant grows well in a wide range of soils, from sandy to loamy substrates, provided that drainage is adequate to avoid root rot; it tolerates both slightly acidic and alkaline soils. Optimal growth occurs in full sunlight, which enhances photosynthesis and secondary metabolite accumulation, although the plant can also survive in partial shade with reduced vigor. It is drought tolerant once established but benefits from supplemental irrigation during fruit development. Seasonal and environmental factors, such as temperature, sunlight exposure, and soil nutrition, significantly influence latex composition, particularly the levels of proteolytic enzymes and phototoxic furocoumarins, which are central to its medicinal applications [16, 25, 26]. So, the latex composition is not fixed. Protease profiles and activity vary among fig cultivars and across tissues, and classical and modern studies show marked seasonal dynamics, ficin activity peaks in certain seasons and is higher in unripe tissues, while phototoxic furocoumarins (psoralen and bergapten) are concentrated in leaves and shoot sap,

increase with sunlight exposure, and were not detected in the fruit sap in older analytical work. More recent surveys across many cultivars confirm wide ranges of psoralen–bergapten in leaves, and metabolomic work documents geographic-cultivar effects on phenolics and terpenoids. These differences can influence efficacy (keratolysis) and safety (phototoxicity). Sourcing unripe fruit latex from defined cultivars in low-UV seasons should enhance protease-to-furocoumarin ratios; therefore, we will specify cultivar-collection region, plant part, and collection season, standardize by ficin units, and monitor furocoumarins to ensure consistent therapeutic outcomes and reproducible safety [16, 25, 26].

2.4. The Mechanisms of Action of Fig Tree Latex in the Treatment of Viral Infections. *F. carica* latex and other plant parts are rich in diverse biologically active components that contribute to its therapeutic potential. The latex contains proteolytic enzymes (ficins) that degrade keratin, facilitating wart removal and enhancing immune recognition of infected cells. Ficins cleave structural proteins in the hyperkeratotic wart (e.g., corneodesmosomal and cytoskeletal proteins), facilitating keratolysis, sloughing of infected keratinocytes, and improved immune access to HPV-infected cells; high protease activity has been demonstrated across fig cultivars and is particularly abundant in latex from unripe tissues [27–35]. In parallel, irritant constituents of the latex trigger a localized inflammatory response that can augment cell-mediated immunity against HPV, analogous to contact immunotherapy mechanism of action. The latex and leaves also contain linear furocoumarins (psoralen and bergapten) that, upon UVA exposure, form DNA adducts and crosslinks and can inhibit viral replication in photosensitized cells (a phototoxic mechanism of action that is therapeutically exploitable only with strict photoprotection due to burn risk). Beyond HPV, in vitro work shows fig latex extracts inhibit adenovirus (ADV), echovirus-11 (ECV-11), and herpes simplex virus-1 (HSV-1) at noncytotoxic concentrations, supporting the intrinsic antiviral potential of latex phenolics, terpenoids, and proteins and providing a wider antiviral context for its traditional wart use. Together, these data support a multimodal action against warts, proteolytic keratolysis and tissue maceration by ficins, irritant-driven immunostimulation, and, under UV, psoralen-mediated nucleic acid damage. We emphasize that direct anti-HPV in vitro data are still limited, but the combined mechanisms of action plausibly target the wart microenvironment where HPV persists [16, 32, 36].

2.5. Why *F. carica*? Comparative Analysis With Other Plant Latexes. Compared with other latex-based folk therapies, *F. carica* offers a favorable balance of evidence, mechanisms of action, practicality, and safety when used correctly: (i) *Chelidonium majus* (celandine) latex contains isoquinoline alkaloids (e.g., chelidonine); while used traditionally for warts, regulatory assessments document hepatotoxicity signals with systemic use and contact dermatitis risk, limiting enthusiasm despite anecdotal

efficacy. (ii) *Euphorbia* spp. latices (e.g., *Euphorbia peplus* and *Euphorbia tirucalli*) are rich in diterpene (phorbol) esters that are strongly irritant/cytotoxic and are well known to cause severe dermatitis and accidental ocular injuries, creating safety drawbacks for self-treatment. (iii) *Carica papaya* latex (papain) is proteolytic and theoretically keratolytic but lacks controlled wart-specific clinical evidence and can disrupt the skin barrier and promote sensitization [37, 38]. In contrast, *F. carica* latex has randomized comparative clinical data versus cryotherapy showing similar or better clearance with fewer adverse effects, is inexpensive and locally available in many settings, and mechanistically combines potent proteolysis (ficins) with adjunct antiviral/irritant effects; importantly, choosing unripe fruit latex (high protease and low furocoumarin content) and enforcing photoprotection mitigates psoralen-related risks. These considerations, plus cultural acceptance and ease of standardized topical formulation, motivated our choice of *F. carica* latex for study [37, 38].

2.6. Evidence of *F. carica* Efficacy in the Treatment of Warts. The brief information of this part is presented in Table 1. A six-month follow-up study of 25 patients was conducted, and 44% of the warts exposed to fig tree latex were completely cured. According to this study, treatment of warts with fig tree latex offers several beneficial effects, including shorter duration of treatment, fewer side effects, ease of use, patient compliance, and low recurrence rate [34].

Sh. Bohlooli et al. recruited 25 patients aged between 5 and 32 years, from an outpatient clinic; all of the patients had at least two common warts symmetrically located on the hands, especially on forearms or feet. None of the patients had systemic diseases. Participants started to self-apply a drop of fig tree latex on warts three times daily for at least 4 days. The warts on the opposite side received standard cryotherapy. Follow-ups continued at 1 and 2 weeks after the treatment initiation. A 6-month follow-up was also planned. Results show that after 2 weeks, 11 patients experienced complete resolution with significant improvement by the end of the first week. However, fig tree latex was slightly less effective than cryotherapy in this study. Adverse effects, primarily pain and burning, were observed only in cryotherapy. After a 6-month follow-up, wart recurred in 2 patients (8%) in the fig tree latex group and 5 patients (20%) in the cryotherapy group [39].

F. Hemmatzadeh et al. involved 12 cows with papillomatosis and randomly added them into three groups: Group A (received 10% salicylic acid solution), Group B (received fig tree latex), and Group C (control group and received a saline solution as a placebo). The treatments were applied every 5 days until complete wart removal. The involved animals were examined and monitored for changes in the warts' size, shape, location, and number. The results demonstrated that in Group B, 5 days after treatment, warts started to shrink, and by Day 10, half of the warts completely dropped off, and after 25 days, the rest of the warts had disappeared, except one of the warts remained until Day 30.

While local inflammatory reactions such as erythema and erosion were observed in Group A after salicylic acid application, no inflammatory reactions were observed in Group B. Some of the features of fig tree latex, including its proteolytic and keratolytic effects and viscosity, make it more effective in treating warts compared to salicylic acid. Overall, the study suggests that fig tree latex may be more effective than salicylic acid in treating papillomatosis in animal species, and perhaps in humans [31].

S. Hashemi and S. Abediankenari started a study on a 22-year-old man with common warts (*Verruca vulgaris*) located on the hallux of his left foot. He started to apply one drop of fig tree latex on the wart daily for 10 subsequent days. On day 24 from the initiation of fig tree latex application, the wart became absent, and no recurrence of the wart after 6 months from therapy was observed [40].

A. Ghanbari et al. investigated the effects of fig latex on cervical cancer cells. They used three types of cells: CaSki (HPV type 16), HeLa (HPV type 18), and HaCaT (HPV-free human immortalized keratinocytes). The results showed that fig latex inhibits the growth and migratory abilities of cervical cancer cells by several mechanisms of action. Fig extract decreases the migratory abilities of cervical cancer cells by reducing the expression of genes such as E6, E7, and P16 while increasing the expression of tumor-suppressor proteins like P53 and Rb. This process leads to the reduction of invasive potential in cervical cancer cells. Additionally, fig latex induces cell death in the Sub G1 phase and causes accumulation in the G1 phase, whereas HaCaT cells remained unaffected. Fig latex also targets the expression of Ki67, preventing cell proliferation, and thereby inhibiting cancer progression. Furthermore, fig latex suppresses the clonogenic ability of cervical cancer cells by inhibiting contact inhibition driven by cervical cancer, thereby restricting growth. Fig latex showed nontoxic effects on normal HaCaT cells at concentrations of 0.125 µg/mL for 48 h, indicating a potential therapeutic application for treating cervical cancer. Overall, the study highlights the potential of fig latex as a natural treatment for inhibiting cervical cancer cell growth [27].

V M Berlin Grace et al. used the methanolic extract of *Ficus* fruits on HPV type 18 virus loaded in the HeLa cell line. The results showed a reduction in the DNA of HPV18, and also the treatment showed a cytotoxicity effect assayed by MTT. DNA sample treated with fig extract has resulted in a hypochromic effect, indicating an increase in DNA fragmentation. After applying fig fruit extract for 24 h on cells, the PCR showed an extremely low expression of HPV 18, and after treatment for 48 h, HPV expression was nearly undetectable [41].

2.7. Limitations, Research Gaps, and Further Potential of *F. carica* Latex. Clinical and postmarketing-type evidence indicates that topical *F. carica* latex is generally well tolerated when applied to warts with photoprotection, but adverse events range from mild, self-limited irritant dermatitis (stinging and erythema) to, rarely, severe phytophotodermatitis with blistering burns after sun/UV exposure due

TABLE 1: Evidence of fig tree latex in the treatment of warts.

Disease	Intervention	Results	Reference
HPV type 18-associated genital warts	The cells were treated with the methanolic extract of <i>Ficus benghalensis</i> and their inhibitory activity was determined using the colorimetric method of tetrazolium salt; 3-(4,8-dimethylthiazol-2-yl) 2,5-diphenyltetrazolinumbromide (MTT) reduction.	The <i>F. carica</i> tree fruit extract reduced the HPV viral load in HPV 18-containing HeLa cells and showed effective cytotoxicity on the HeLa cell line.	[41]
Papillomatosis in cows	The animals were affected by teat papillomatosis. Case: A: treated by the fig tree B: treated by 10% S.A Control: C	S.A. and <i>F. carica</i> latex have similar therapeutic effects in treating heart papillomatosis in cows.	[31]
Common warts	<i>Ficus carica</i> latex was collected directly from the green fruits.	<i>F. carica</i> tree latex had a beneficial effect in the treatment of the warts, including short-duration therapy, ease of use, patient compliance, and a low recurrence rate.	[39]
Verruca vulgaris	Latex from fig trees	On Day 24, the absence of the wart occurred.	[40]
HPV-related cervical cancer (in vitro and cellular study)	Tested <i>F. carica</i> latex extract on HPV-infected cervical cancer cell lines; compared with untreated control cells.	Latex extract showed antiproliferative and proapoptotic effects on HPV-related cervical cancer cells, significantly reducing cell viability and inducing apoptosis, supporting its potential as an anticancer and antiviral agent.	[27]
Common warts (Verruca vulgaris)	Topical <i>F. carica</i> latex versus cryotherapy	Wart clearance was observed in 44.4% of the patients treated with fig latex compared with 28.6% in the cryotherapy group; fig latex was effective, painless, and associated with fewer side effects than cryotherapy.	[34]

to psoralen/bergapten; in the randomized comparison by Bohlooli et al., reported adverse effects occurred only in the cryotherapy arm, with none recorded in the fig-latex group, although the sample was small and follow-up short [32]. Case reports document allergic contact dermatitis to *F. carica* and immediate IgE-mediated reactions (including anaphylaxis) to fig fruit in sensitized individuals, underscoring the need for screening for fig allergy and cautious first application. We, therefore, recommend strict avoidance of UV/sunlight on treated areas for ≥ 48 –72 h post-application; confining application to the lesion with perilesional barrier protection; initial “test-spot” use; and prompt discontinuation if blistering, severe pain, or progressive dermatitis occurs; ocular exposure must be avoided [32].

Future work should focus on (i) standardizing ficin activity (U/mL) and defining a therapeutic window that maximizes keratolysis while minimizing irritancy, with batch-to-batch QC anchored to specific ficin isoenzymes; (ii) optimizing vehicles (occlusive films, hydrogels, and liposomal/niosomal carriers) to enhance localized penetration into hyperkeratotic tissue and reduce spread to perilesional skin; (iii) fractionating psoralen-poor, protease-rich latex to lower phototoxic risk while preserving efficacy; (iv) exploring combination regimens (e.g., sequential keratolysis with salicylic acid followed by latex or latex plus immune stimulants for recalcitrant warts); and (v) expanding indications to other epithelial viral lesions (with careful, indication-specific safety studies) [15, 17]. Mechanistic studies should map ficin-driven proteolysis on wart tissue *ex vivo*, quantify any direct anti-HPV effects, and profile host cytokine signatures postapplication; pragmatic multicenter randomized controlled trials versus first-line keratolytics and cryotherapy with patient-reported outcomes and cost-effectiveness analyses are warranted. Recent reviews of *F. carica* pharmacology and of ficin biochemistry support the feasibility of standardized, enzyme-titrated topical products suitable for regulatory development [15, 17].

3. Discussion

Warts are common benign skin growths caused by infection with HPVs, affecting both children and adults worldwide. Their prevalence varies between 5% and 33%, depending on age group, geographical region, and environmental factors. Although warts are generally harmless, they can cause cosmetic concerns, pain, and social discomfort and are often difficult to treat due to viral persistence and recurrence [42].

Conventional therapies such as cryotherapy and topical salicylic acid remain first-line treatments but are often associated with pain, burning sensations, erythema, scarring, and high costs, limiting their long-term use and patient compliance. These limitations have encouraged growing interest in safe, accessible, and cost-effective alternatives derived from natural sources [21].

F. carica latex represents one such promising candidate due to its multimodal mechanisms: proteolytic enzymes (ficins) that degrade keratin and remove hyperkeratotic

tissue, furocoumarins (psoralen and bergapten) that exert antiviral and phototoxic effects against HPV, and polyphenols and flavonoids that provide antioxidant and anti-inflammatory benefits, collectively aiding wart clearance [16, 32, 36].

The development of standardized fig latex-based pharmaceutical products offers promising opportunities for global health, particularly in regions with limited access to dermatological care. Potential formulations include topical gels, creams, or occlusive patches that confine the latex to warty tissue while minimizing irritation to surrounding skin. Key strategies involve optimizing ficin concentration for keratolysis, reducing or removing phototoxic compounds through selective fractionation, and stabilizing the enzymatic activity during storage. Importantly, the translation of this traditional therapy into modern pharmaceutical formulations requires rigorous standardization, including enzyme activity assays and furocoumarin quantification, to ensure reproducibility, efficacy, and safety [15, 17, 32].

While there are several anecdotal accounts regarding the effectiveness of fig tree latex in the removal or reduction of a wart, little scientific research is available on it [32]. Further well-designed preclinical experiments and standard clinical trials are needed to confirm efficacy, clarify the exact mechanisms of action, assess potential adverse reactions, and perform long-term follow-ups to evaluate recurrence rates.

4. Conclusion

Warts are common viral skin lesions caused by HPV, with a high global prevalence across different age groups. Conventional treatments such as cryotherapy and salicylic acid are widely used but often cause pain, burning, and irritation, in addition to being costly and requiring repeated clinical visits. Therefore, there is a growing need for effective, safe, and affordable alternative therapies that ensure better patient adherence. *F. carica* latex has shown promising effects in wart treatment due to its proteolytic enzyme ficin, which promotes keratin degradation, along with antiviral, antioxidant, and anti-inflammatory compounds that enhance healing and clearance. These multimodal mechanisms make fig latex a potential option for wart management. However, further standardized preclinical and clinical studies are required to confirm its efficacy, safety, and recurrence outcomes.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Mobina Rahnama: investigation, visualization, supervision, writing—original draft, and writing—review and editing.

Fatemeh Hajilou, Hadis Nasoori: supervision, writing—original draft, and writing—review and editing.

Naser-Aldin Lashgari: methodology, visualization, software, validation, conceptualization, supervision, and writing—review and editing.

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