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Treatment of Psoriasis with the Help of Curcumin Hydrogel

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ABSTRACT

Psoriasis is a chronic inflammatory skin disorder that affects millions of people worldwide. Current treatments for psoriasis include topical corticosteroids, immunomodulators, and phototherapy, but these treatments may have limited efficacy or cause side effects. Curcumin, a natural compound with anti-inflammatory and antioxidant properties, has been shown to have potential as an alternative treatment for psoriasis. However, the low solubility and bioavailability of curcumin limit its effectiveness when administered orally or topically. Curcumin hydrogel, a topical formulation of curcumin, has been developed to address these limitations. In this review, we summarize the current research on the use of curcumin hydrogel in the treatment of psoriasis. We discuss the pharmacological properties of curcumin, the formulation of curcumin hydrogel, and the preclinical and clinical studies investigating the efficacy and safety of curcumin hydrogel in psoriasis. Overall, the available evidence suggests that curcumin hydrogel may be a promising alternative treatment for psoriasis, with potential benefits in reducing inflammation, promoting wound healing, and improving overall quality of life for psoriasis patients. Further research is needed to fully elucidate the mechanism of action of curcumin hydrogel and to optimize its formulation and delivery for maximum efficacy.

Keywords- Psoriasis, Inflammatory skin disorder, Antioxidant properties, Curcumin hydrogel.

I. INTRODUCTION

Traditional medicine has a long history of using natural and herbal products to treat various human diseases, and it has now become a multi-billion-dollar industry with a recorded costof USD 10 billion/year (1). Curcumin, a polyphenol derived from the turmeric plant (Curcuma longa) of the Zingiberaceae family, is one of the numerous herbal compounds available for medical purposes, with a range of therapeutic properties (2-5). Curcumin has been used for various purposes for centuries, including as a culinary spice, food additive (e.g., ice cream, yogurt, orange juice, biscuits, popcorn, cakes, cereals, sauces, gelatins), cosmetic ingredient, and natural product for treating different diseases,particularly chronic inflammatory conditions (6-10).

Figure 1: Curcumin extract

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Although the therapeutic benefits of curcumin have been recognized for centuries, its pharmacological properties have only been scientifically studied in the past century. Today, the wide range of curcumin's medical applications is attributed to its various properties, including antioxidant, anti-inflammatory, anti-proliferative, anti-carcinogenic, and anti-microbial effects (10-15).

In medicine, curcumin is used to treat various diseases, such as rheumatoid arthritis, eye diseases (e.g., chronic anterior uveitis, conjunctivitis), urinary tract infections, menstrual disorders, liver and gastrointestinal disorders (e.g., abdominal pain, inflammatory bowel disease) (16-18). Additionally, curcumin is used as an adjuvant therapy for treating skin cancers, chickenpox, and wound healing Although curcumin can be obtained from the diet, it is now formulated into tablets with different dosages, often combined with specific adjuvants (e.g., piperine, phospholipids) that improve its absorption and bioavailability (19-25).

1.1 Psoriasis

Around 2-3% of the global populace suffers from psoriasis, which is a persistent skin ailment caused by an autoimmune disorder. Current treatment options include topical corticosteroids, vitamin D analogs, and immunosuppressive agents, which can have significant side effects. Curcumin, a natural polyphenol found in turmeric, has been shown to have anti-inflammatory and antioxidant properties, making it a potential therapeutic option for psoriasis. Curcumin can be delivered using a hydrogel, which can enhance its stability and efficacy. This review aims to evaluate the current research on the use of curcumin hydrogel for the treatment of psoriasis (25-30).

Figure 2: Psoriasis

1.2 Types of Psoriasis

Here are some of the most common types of psoriasis:

1. Plaque psoriasis: This is the most common type of psoriasis, accounting for around 80-90% of cases. It is characterized by raised, red, and scaly patches of skin, often with a silvery-white coating. These patches can occur anywhere on the body, but are most commonly found on the scalp, elbows, knees, and lower back (31).

Figure 3: Plague Psoriasis on the lower back.

2. Guttate psoriasis: This type of psoriasis is characterized by small, teardrop-shaped patches that appear suddenly on the trunk, arms, legs, and scalp. It often develops after a streptococcal infection, such as strep throat, and is more common in children and young adults (32).

Figure 4: Guttate Psoriasis

3. Inverse psoriasis: This type of psoriasis appears in areas where the skin folds, such as the armpits, groin, and under the breasts. It is characterized by smooth, red patches of skin that can be itchy and painful (33).

Figure 5: Inverse Psoriasis in armpit

4. Pustular psoriasis: This type of psoriasis is characterized by the appearance of small, pus-filled blisters on the skin, surrounded by red, inflamed skin. It can be localized to certain areas of the body or can be widespread. It is more common in adults (34).

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Figure 6: Pustular Psoriasis

5. Erythrodermic psoriasis: This is the rarest and most severe type of psoriasis, characterized by widespread redness and scaling of the skin. It can be life-threatening and requires immediate medical attention (35).

Figure 7: Erythrodermic psoriasis

It is important to note that psoriasis can also affect the nails, causing pitting, discoloration, and separation from the nail bed. Additionally, psoriasis can affect the joints, causing a condition known as psoriatic arthritis, which can lead to joint pain, stiffness, and swelling. (36).

1.3 Hydrogel

Hydrogel is a three-dimensional network of polymer chains that can absorb and retain large amounts of water or biological fluids. It has a wide range of applications in various fields, including biomedical engineering, drug delivery, tissue engineering, and agriculture (37-40).

Hydrogels are formed by crosslinking polymer chains to create a network structure that can absorb water or biological fluids, such as blood or urine. The crosslinking can be achieved through physical, chemical, or biological methods, depending on the type of polymer and the intended application of the hydrogel (41).

Hydrogels are highly versatile materials with a wide range of applications. They can be used as scaffolds for tissue engineering, as drug delivery vehicles, and as wound dressings, among other uses (42). Hydrogels can also be engineered to have specific properties, such as mechanical strength, biocompatibility, and responsiveness to environmental stimuli, which make them useful in a variety of applications (43).

Some common polymers used to prepare hydrogels include polyethylene glycol (PEG), polyvinyl alcohol (PVA), polyacrylamide (PAAm), and hyaluronic acid (HA), among others (44). The properties of the hydrogel, such as its swelling behavior, mechanical strength, and biocompatibility, can be tuned by modifying the polymer composition, crosslinking density, and other parameters (45).

II. METHOD OF PREPARATION

- ➢ Dissolve 0.5 g of curcumin powder in 5 mL of ethanol or methanol to make a concentrated solution.
- ➢ Dissolve 2 g of PVA in 100 mL of distilled water by heating the solution to 70-80°C while stirring.
- ➢ Mix the curcumin solution with the PVA solution thoroughly.
- ➢ Add 0.1 mL of glutaraldehyde dropwise into the mixture with continuous stirring to crosslink the polymer chains and form a hydrogel.
- ➢ 5 Stir the mixture for 10-15 minutes until gelatin is complete.
- ➢ Wash the hydrogel several times with distilled water to remove any residual crosslinking agent.
- ➢ Air dry the hydrogel in a sterile environment.

Several methods of preparing curcumin hydrogel.

1. Physical crosslinking method-

Physical crosslinking method is a widely used technique for the preparation of hydrogels that utilizes natural polymers and non-toxic crosslinking agents. In this method, a gel is formed through the physical crosslinking of a natural biopolymer such as gelatin or chitosan with a suitable crosslinking agent.

The process involves dissolving the natural biopolymer in distilled water to obtain a homogeneous solution with a concentration of around 2-3% w/v. The pH of the solution is then adjusted to the desired value using a suitable buffer, such as phosphate buffer or acetate buffer. The solution is then heated to a temperature above the biopolymer's gelation temperature, forming a solution (47-49).

A suitable physical crosslinking agent, such as Pluronic F127, is then added to the sol and stirred well. The physical crosslinking agent could also be in the form of temperature, ionic strength or light. The sol will start to gel as the physical crosslinking reaction takes place. Stirring is done for around 30 minutes to ensure complete crosslinking (50).

Finally, the hydrogel is transferred to a suitable container and allowed to dry in a sterile environment. The resulting hydrogel has excellent mechanical properties, and it can be used for various biomedical applications. The physical crosslinking method is a simple, cost-effective, and efficient method of preparing

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hydrogels that does not require the use of harmful chemicals or complicated procedures(51).

2. Chemical cross-linking method -

Chemical crosslinking is a widely used method for preparing hydrogels that involves the formation of covalent bonds between polymer chains to form a gel network. Here is a description of the chemical crosslinking method for hydrogel preparation: (52-55).

- ➢ Dissolve the polymer in a suitable solvent to obtain a homogeneous solution. The concentration of the polymer should be around 10-15% w/v.
- ➢ Add a suitable crosslinking agent, such as N,N'-methylene is(acrylamide), to the polymer solution.
- ➢ Add a suitable initiator, such as ammonium persulfate, to the solution and stir well. 4.Transfer the solution to a mold and polymerize the solution by heating it to a suitable temperature for a specified time.
- ➢ After polymerization, the hydrogel is washed with water and dried in a sterile environment.
- ➢ The resulting hydrogel has good mechanical properties and can be used for various biomedical applications.
- ➢ Chemical crosslinking is a versatile method of preparing hydrogels that offers greater control over the mechanical and chemical properties of the hydrogel. However, it requires the use of potentially harmful chemicals and involves more complicated procedures.

3. Ionic gelation method

Ionic gelation is a commonly used method for the preparation of hydrogels that involves the crosslinking of a natural polymer with a suitable ionic crosslinking agent. Here is a description of the ionic gelation method for hydrogel preparation: (58-60).

- ➢ Dissolve the natural polymer, such as chitosan, in an acidic solution, such as acetic acid, to obtain a homogeneous solution. The concentration of the polymer should be around 1-2% w/v.
- ➢ Add a suitable ionic crosslinking agent, such as sodium tripolyphosphate, to the polymer solution while stirring vigorously.
- ➢ The crosslinking agent reacts with the polymer to form a hydrogel.
- ➢ After crosslinking, the hydrogel is washed with water and dried in a sterile environment.

4. Inverse gelation method

The inverse gelation method is a commonly used technique for preparing hydrogels that involves the crosslinking of a water-soluble polymer with a crosslinking agent in an organic solvent. Here is a brief description of the inverse gelation method for hydrogel preparation:

- ➢ Dissolve the water-soluble polymer, such as polyethylene glycol (PEG), in an organic solvent, such as dichloromethane, to obtain a homogeneous solution. The concentration of the polymer should be around 10-15% w/v.
- ➢ Add a suitable crosslinking agent, such as diisocyanate, to the polymer solution while stirring vigorously.
- ➢ The crosslinking agent reacts with the polymer to form a hydrogel.
- ➢ After crosslinking, the hydrogel is washed with water to remove any residual solvent and dried in a sterile environment.
- ➢ The resulting hydrogel has good mechanical properties and can be used for various biomedical applications.
- ➢ The inverse gelation method is a versatile method of preparing hydrogels that offers greater control over the mechanical and chemical properties of the hydrogel. However, it requires the use of potentially harmful organic solvents and involves more complicated procedures.

III. MECHANISM OF CURCUMIN HYDROGEL

- ➢ Curcumin hydrogel is applied topically to the affected area in psoriasis.
- ➢ The hydrogel is absorbed into the skin and begins to release curcumin.
- ➢ Curcumin inhibits the activity of inflammatory cytokines, such as IL-6 and TNF-alpha.
- ➢ Curcumin also inhibits the activity of enzymes involved in inflammation, such as COX-2 and LOX.
- ➢ By reducing inflammation, curcumin may alleviate symptoms of psoriasis, such as redness, scaling, and itching.
- ➢ Curcumin may also promote wound healing by activating growth factors involved in tissue regeneration.
- ➢ The sustained release of curcumin from the hydrogel provides prolonged exposure to the affected area.

3.1 Advantages of curcumin hydrogel

1.Anti-inflammatory and antioxidant properties: Curcumin is a natural compound with potent anti-inflammatory and antioxidant properties, which can make curcumin hydrogel useful in wound healing and tissue repair

2 Biocompatibility: Curcumin hydrogel is a biocompatible material that can be used in various biomedical applications without causing adverse effects on living tissues.

3. Drug delivery: Curcumin hydrogel can be used as a drug delivery system for curcumin and other drugs, providing sustained release and controlled delivery.

4. Biodegradability: Curcumin hydrogel is biodegradable, meaning it can be broken down by biological processes in the body over time, reducing the risk of long-term accumulation or toxicity.

5. Antioxidant properties: Curcumin is also a potent antioxidant, which may help to protect skin cells from damage caused by free radicals.

6. Low toxicity: Curcumin is generally considered safe and has low toxicity, making it a potentially attractive alternative to traditional psoriasis treatments

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that may have more significant side effects.

7. **Natural origin:** Curcumin is derived from turmeric, a commonly used spice in many cultures, and is therefore considered a natural compound.

8. **Cost-effective:** Curcumin is relatively inexpensive compared to many traditional psoriasis treatments, which may make it a more accessible option for patients. (61-64)

3.2 Disadvantages of curcumin hydrogel

1. **Limited stability:** Curcumin is a highly unstable compound that can degrade rapidly under certain conditions, such as exposure to light, heat, and pH changes.

2. **Low solubility:** Curcumin has low solubility in water, which can make it challenging to incorporate into hydrogels.

3. **Variable bioavailability:** The bioavailability of curcumin can be highly variable depending on the method of administration and the formulation used.

4. **Limited mechanical strength:** Curcumin hydrogel can have limited mechanical strength, which may limit its use in certain applications.

5. **Allergic reactions:** While curcumin is generally considered safe, some individuals may be allergic to the compound. This can result in skin irritation or other adverse effects when using curcumin hydrogel.

6. **Lack of standardized formulation:** There is currently no standardized formulation for curcumin hydrogel, and the optimal formulation may vary depending on the specific characteristics of the patient and the severity of their psoriasis. This can make it difficult to compare results across studies or to ensure consistent quality of curcumin hydrogel products.

7. **Staining:** Curcumin is a bright yellow pigment that can stain clothing and skin. This can be a cosmetic concern for patients using curcumin hydrogel.

IV. EVALUATION OF CURCUMIN HYDROGEL

1. **Swelling behavior:** Swelling behavior is a crucial parameter that reflects the hydrogel's ability to absorb water and other fluids. The equilibrium swelling ratio and the swelling kinetics of the hydrogel can be measured to understand its swelling behavior (65).

2. **Mechanical properties:** The mechanical properties of hydrogels can be evaluated using different techniques such as compression testing, tensile testing, and rheometry. These tests provide information about the strength, elasticity, and deformation behavior of the hydrogel (66).

3. **Biocompatibility:** The biocompatibility of hydrogels can be assessed by evaluating its cytotoxicity, hemocompatibility, and potential for inducing inflammation or immune

4. **Reactions:** In vitro assays or in vivo studies can be used for this purpose (67).

5. **Drug release behavior:** For hydrogels used in drug delivery applications, their drug release behavior is a critical parameter to evaluate. This includes the release kinetics, mechanism, and rate of the drug from the hydrogel (68).

6. **Degradation behaviour**: The degradation behavior of hydrogels can also be evaluated to understand their stability and durability. The mass loss, mechanical properties, and changes in chemical structure over time can be measured to determine the degradation behavior. (69).

7. **Imaging techniques:** Finally, imaging techniques such as scanning electron microscopy (SEM) and confocal microscopy can be used to visualize the structure and morphology of hydrogels (70).

V. DISCUSSION AND CONCLUSION

Curcumin hydrogel shows promise as a potential treatment for psoriasis, but further research is needed to establish its efficacy and safety. Future studies should focus on optimizing the delivery system, determining the optimal dose and treatment duration, and evaluating the long-term safety and efficacy of curcumin hydrogel. Additionally, more research is needed to understand the mechanism of action of curcumin in psoriasis treatment. In conclusion, curcumin hydrogel has emerged as a promising candidate for the treatment of psoriasis, a chronic inflammatory skin disease. The potent anti-inflammatory and antioxidant properties of curcumin make it a suitable agent for managing the symptoms of psoriasis, including scaling, erythema, and inflammation. The use of curcumin hydrogel can provide sustained release of curcumin at the site of application, ensuring effective treatment with minimal systemic side effects. Furthermore, the biocompatibility and biodegradability of the hydrogel make it a safe and effective topical therapy for psoriasis. However, further research is needed to fully evaluate the efficacy and safety of curcumin hydrogel in treating psoriasis in human subjects. Nevertheless, the available preclinical evidence suggests that curcumin hydrogel holds great promise as a novel therapy for psoriasis.

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