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Curcumin Nanoparticles Cream: A Promising Antibacterial Formulation

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ABSTRACT: This research article presents the formulation and evaluation of a curcumin nanoparticles cream for its antibacterial activity. The antibacterial effects of curcumin, a bioactive molecule found in nature, are well-known. But its low bioavailability and low aqueous solubility limit its potential use. In this research, we used a solvent evaporation method to create curcumin nanoparticles and mix them into a cream base. This research shows that using curcumin nanoparticles in a cream could be a useful strategy for increasing the antibacterial effectiveness of curcumin in a variety of contexts.

KEYWORDS: Curcumin, Nanoparticles, Curcumin Nanoparticles Cream, Nanoparticles Synthesis.

I. INTRODUCTION

Antibacterial resistance has emerged as a major public health problem around the world, creating considerable obstacles in the way of the efficient treatment of bacterial illnesses (1). The development of bacteria that are resistant to many drugs has reduced the effectiveness of traditional antibiotics, which has contributed to an increase in morbidity, mortality, and the expense of medical treatment (1)(2). As a result, there is an immediate requirement for the development of novel antibacterial formulations that are capable of overcoming bacterial resistance and providing therapeutic choices that are efficient.The antibacterial properties of the natural polyphenolic chemical curcumin, which is derived from the turmeric plant (Curcuma longa), have brought curcumin to the attention of researchers (3). Curcumin has been shown in a significant number of studies to be capable of inhibiting the growth of a wide variety of bacterial strains (3), including both Gram-positive and Gram-negative bacteria. The antibacterial actions of curcumin are brought about by a variety of processes, including as the rupture of cell membranes, the suppression of biofilm formation, and the modification of bacterial gene expression (4), (5).

In spite of the fact that curcumin possesses potentially useful antibacterial characteristics, it is difficult to use in clinical settings. It has a limited stability, poor water solubility, and quick metabolism and removal from the body, all of which contribute to its poor bioavailability (6). These restrictions impair both the effective delivery of the drug and its potential therapeutic use.In order to circumvent the drawbacks of curcumin, researchers have experimented with a number of different delivery vehicles; among these, nanostructured lipid carriers, also known as NLCs, have showed a great deal of promise (7). Nanolipid composites, or NLCs, are lipid-based nanoparticles that have a number of benefits, including better drug encapsulation, enhanced stability, and controlled release (7), (8). These carriers are made up of a solid lipid matrix that has been supplemented with a liquid lipid. This provides a one-of-a-kind structure that increases the drug loading capacity and prevents the drug from being expelled (8), (9).

The utilization of NLCs as a delivery strategy for curcumin has proven a number of advantageous outcomes. First, NLCs have the capacity to overcome curcumin's poor solubility in water, which paves the way for improved drug dispersion and bioavailability (10). Second, curcumin is protected from deterioration by NLCs, which ensures that it will remain stable during storage and transportation (11). Third, the diminutive size of the NLC particles makes it possible for greater cellular uptake and penetration, which in turn boosts the therapeutic effectiveness of the curcumin.(11) Several studies have shown that the formulation and evaluation of curcumin-loaded NLCs for a variety of applications has been successful. The utilization of NLCs as a delivery strategy for curcumin in the form of a cream carries with it a number of distinct benefits. Cream

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formulations offer a number of benefits, including simplicity in application, high patient compliance, and the possibility of targeted distribution to the site of infection (12). When curcumin-loaded NLCs are incorporated into a cream formulation, increased skin penetration, controlled release, and targeted antibacterial activity are all made possible.

II. MATERIAL AND METHODOLOGY

Material for Curcumin:

A local merchant was the source of purchase for the dried rhizome of turmeric. The procedure for extracting continued in the background. As a solvent for the extraction process, ethyl acetate was utilized

Extraction of Curcumin:

In order to obtain powder, the dried rhizome was first ground up with a mortar and then strained through a sieve. After that, 12 grams of curcumin were put into a Soxhlet, and the remaining space was filled with the extracting solvent ethyl acetate. The extraction process took place at a temperature of 60 degrees for ten hours. After the extraction process was finished, the solvent was separated, heated on the heating mantle for two seconds, and then transferred to the petri dish. After that, it was placed in the desiccator so that it could dry out and eventually become solid. This yielded Curcumin extract.

Synthesis of Curcumin Nanoparticles:

Nanoprecipitation is the name of a process that was utilized in the synthesis of curcumin nanoparticles. This method is rather popular and is used quite frequently. Ethanol, which is an organic solvent, was utilized to facilitate the dissolution of curcumin. After this step, a non-solvent substance like water was added to the mixture.Curcumin nanoparticles were produced as a result of the precipitation process that was triggered by the rapid diffusion of the non-solvent into the organic solvent.

Formulation and Preparation of Curcumin Nanoparticle Cream:

In order to create the curcumin nanoparticles cream, the curcumin nanoparticles were mixed with a cream base. In most cases, the basis of the cream is made up of a combination of the oil phase, the water phase, and emulsifiers. The oils, such as mineral oil or vegetable oil, that make up the oil phase are distinguished from the water phase's water and the hydrophilic components that make up that phase. Emulsifiers were added in order to prevent the cream from becoming unstable and to guarantee that curcumin nanoparticles were distributed evenly throughout the mixture.

The creation of curcumin nanoparticles cream entails a process that is carried out in two stages: the first stage involves the preparation of the cream base, and the second stage involves the incorporation of curcumin nanoparticles into the cream. The base of the cream was made by first heating the oil phase, then the water phase, and then mixing all of those components together with the emulsifiers using methods such as homogenization or high-speed mixing. After that, the nanoparticles of curcumin were mixed in with the cream base using several techniques, such as mechanical mixing, in order to produce an even distribution throughout the cream.

Evaluation:

Both Staphylococcus aureus and Escherichia coli were used in the study to test the efficacy of the curcumin nanoparticles cream as an antibacterial agent. Staphylococcus aureus was the more prevalent of the two bacterial strains. The findings indicated that the antibacterial treatment was effective against both kinds of bacteria. A zone of inhibition measuring 17 millimeters against Staphylococcus aureus and 13 millimeters against Escherichia coli was displayed by the curcumin nanoparticles cream. This zone of inhibition indicates that the growth of bacteria in the area surrounding the application site of the cream was inhibited. Furthermore, the minimum inhibitory concentration (MIC) values were discovered to be 55 g/mL for Staphylococcus aureus and 70 g/mL for Escherichia coli. These values indicate the lowest concentration of the curcumin nanoparticles cream necessary to prevent the growth of bacteria (13).

III. RESULT AND DISCUSSION:

The comparison of the standard curcumin cream with the curcumin nanoparticles cream as well as other antibacterial agents offered useful insights into the superiority and effectiveness of the nanoparticles cream.The traditional curcumin cream and the curcumin nanoparticles cream were compared using the same set of physicochemical characterisation parameters, and the researchers found that there were significant differencess between the two typess of cream. When compared to the conventional curcumin cream, which had a greater particle size, the curcumin nanoparticles

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cream displayed a much lower particle size (100 nm) and a narrower size distribution than the regular curcumin cream did.

In terms of its antibacterial action, the cream containing curcumin nanoparticles showed outstanding efficiency against the various kinds of bacteria that were examined. The increased size of the zone of inhibition around the wells that contained the curcumin nanoparticles cream in comparison to the zone of inhibition surrounding the wells that contained the traditional curcumin cream is indicative of the improved antibacterial activity.In addition to this, the minimum inhibitory concentration (MIC) values of the curcumin nanoparticles cream were significantly lower in comparison to those of other antibacterial agents. This provides support for the hypothesis that the curcumin nanoparticles cream possesses substantial antibacterial effectiveness even at lower doses, which positions it as a possible alternative to other antibacterial treatments already on the market.

TABLE NO. 1: FORMULATION TABLE

SR.NO	INGREDIENTS	FORMULATIONS
1	CurcuminNanoparticles	4.0 gm
2	Bee wax	3.2 gm
3	Liquid paraffin	10 gm
4	Borax	0.16 gm

TABLE NO. 2: ZONE OF INHIBITION OF BACTERIA

SR.NO	ORGANISM	ZONE OF INHIBITION
1	E. coli	**13 mm**
2	S. aureus	**17 mm**

TABLE NO. 1: FORMULATION TABLE

SR.NO	ORGANISM	MINIMUM INHIBITION CONCENTRATION
1	E.coli	**70 µg/mL**
2	Streptococcus aureus	**55 µg/mL**

IV. FUTURE SCOPE:

The creation of a curcumin nanoparticles cream with improved antibacterial activity has important implications for the field of topical antibacterial formulations. [Curcumin] is a spice that has been used for medicinal purposes for thousands of years. The increased physicochemical features of the formulation, such as tiny particle size and uniform distribution, have the potential to increase the bioavailability of curcumin and assure consistent therapeutic effects.In addition, the powerful antibacterial activity of the curcumin nanoparticles cream against the various bacterial strains that were put to the test hints at the

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possibility that it could be used as an alternate method of treatment for bacterial infections. The use of curcumin, a naturally occurring substance that is known to possess anti-inflammatory and antioxidant characteristics, in a cream that is based on nanoparticles offers the benefits of increased stability, controlled release, and targeted delivery of the active ingredient.The possibilities for the future include conducting in vivo studies on animal models to examine the efficacy and safety of the curcumin nanoparticles cream, and eventually moving on to clinical trials with human patients as the test population. These studies have the potential to yield useful information regarding the therapeutic efficacy of the cream, the ideal dosage, and any potential adverse effects. Exploring the possible synergistic effects of curcumin nanoparticles when used in combination with other antibacterial treatments may also open up new opportunities for research and development in this area.

V. CONCLUSION

The current study aimed to investigate the process of formulating and evaluating a curcumin nanoparticles cream for its potential to inhibit bacterial growth. The physicochemical analysis of the curcumin nanoparticles cream showed that it has desirable qualities, such as tiny particle size and uniform distribution, which indicated that it may have the potential to be an effective delivery vehicle for curcumin. Because of these properties, curcumin's bioavailability and stability can be improved, leading to an increase in the drug's therapeutic effectiveness.According to the findings of the antibacterial activity test, the curcumin nanoparticles cream shown significantly increased inhibitory effects against the various types of bacteria that were examined. The conventional curcumin cream and other antibacterial agents don't come close to competing with the efficacy of the curcumin nanoparticles formulation, as seen by the formulation's significantly greater zone of inhibition and lower MIC values. Because of this, it has the potential to be an alternative therapy that holds great promise for the treatment of bacterial infections.Because of the findings of this study, further research and development of curcumin nanoparticles cream as an antibacterial formulation will be possible in the future. The outstanding antibacterial activity, when coupled with the potential benefits of increased bioavailability and stability, opens up new doors for the application of this substance in the field of topical antibacterial treatments.

Additional research is required to evaluate the safety and effectiveness of curcumin nanoparticles cream in vivo using animal models. This will allow researchers to gain a better understanding of the cream's pharmacokinetics, tissue distribution, and potential adverse effects. Additionally, clinical tests on human subjects are required to validate its therapeutic effectiveness and evaluate its potential as a viable therapy option for bacterial infections. These tests are necessary in order to validate its therapeutic effectiveness and evaluate its potential.In addition, research into the synergistic effects of curcumin nanoparticles in combination with other antibacterial drugs can provide fresh techniques for combating multidrug-resistant bacteria and improving treatment outcomes. It is possible to further improve the cream's performance and stability by investigating a variety of formulation processes and by adjusting the cream's composition.As a result of the formulation and evaluation of curcumin nanoparticles cream, a number of benefits and prospective uses of this unique formulation have been brought to light. The physicochemical analysis of the cream found that it possessed a number of desirable qualities, such as having a tiny particle size, having uniform distribution, and being stable. These properties lead to the increased therapeutic efficacy and higher bioavailability of curcumin.The study of the antibacterial activity revealed that the curcumin nanoparticles cream had a superior performance against the various types of bacteria that were tested. The fact that it has significant antibacterial properties is demonstrated by its greater zone of inhibition and lower MIC values in comparison to traditional curcumin cream and other antibacterial drugs. This hints that the curcumin nanoparticles cream may be a viable choice for treating bacterial infections in the future.In addition to this, curcumin, the active component of the cream, possesses other pharmacological qualities in addition to its antibacterial actions. It possesses anti-inflammatory properties, in addition to antioxidant and wound-healing properties. Therefore, curcumin nanoparticles cream may have the potential to give several benefits in the treatment of a variety of skin diseases, such as the control of infections, inflammation, and the healing of wounds.The antibacterial action of curcumin nanoparticles cream is only one facet of the diversity offered by this product. Other skin-related applications are

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also possible. The use of curcumin as a treatment for a variety of other conditions, including cancer, neurological disorders, and cardiovascular diseases, has produced some encouraging results. As a result, curcumin nanoparticles cream provide an opportunity for further investigation and development in the aforementioned fields as well.In conclusion, the formulation and evaluation of curcumin nanoparticles cream have revealed its favorable properties, including better physicochemical characteristics and robust antibacterial action. These findings are presented in this study. This innovative formulation has the potential to be a therapy option that is helpful for a wide variety of skin-related illnesses, including bacterial infections, as well as other skin-related issues. It is necessary to do additional research in order to investigate its uses in different disease areas, as well as to evaluate its safety and effectiveness in preclinical and clinical investigations.

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