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Effectiveness Analysis Of Corn Silk Ointment As A Broad-Spectrum Antibiotic

Aisyah Susiana[a], Rini Amriani[a,*], Iin Anisa Azzahra Irfan[a], Hanif Semar Gemilang[a], Zulva Putri Anggita Miolo[a], Miftah Riska Awaliyah[b]

[a]Veterinary Medicine Study Program, Faculty of Medicine, Hasanuddin University, Jl. Perintis Kemerdekaan Km. 10, Makassar, 90245, Indonesia
[b]Pharmacy Department, Faculty of Pharmacy, Hasanuddin University, Jl. Perintis Kemerdekaan Km. 10, Makassar, 90245, Indonesia

[*]corresponding author: riniamriani@unhas.ac.id

Abstract

Antibiotic resistance has become a major challenge in wound management, prompting the need for alternative treatments that are both safe and effective. Corn silk (Zea mays L.), a widely available agricultural byproduct, is rich in phenolic compounds known for their anti-inflammatory and wound-healing properties. This study aimed to evaluate the antibacterial effectiveness of corn silk extract-based ointments against Staphylococcus aureus and Escherichia coli, two bacteria commonly associated with wound infections. Corn silk was extracted using the maceration method with 70% ethanol, and the resulting thick extract underwent phytochemical screening. The extract was formulated into ointments at concentrations of 5%, 7%, and 9%, which were then evaluated for their physical characteristics, including organoleptic properties, homogeneity, spreadability, adhesiveness, and pH. Antibacterial activity was assessed using the kirby bauer method, with Bioplacenton® as the positive control. Statistical analysis was performed using One Way ANOVA with IBM SPSS® 25 and Graph Prism® 8. Results indicated that the 7% concentration ointment exhibited the largest inhibition zone, outperforming other concentrations and the positive control, suggesting significant antibacterial activity. Furthermore, all ointment formulations met physical quality standards, ensuring their suitability for topical use. These findings highlight the potential of corn silk extract-based ointments as effective alternatives for managing bacterial skin infections, particularly at a 7% concentration. By utilizing agricultural waste, this study not only addresses sustainability issues but also provides a promising solution to the growing problem of antibiotic resistance. Further research is recommended to explore the underlying mechanisms and expand its applications in clinical settings.

Keywords: *Corn Silk, Bacteria, Antibiotic, Ointment*

Introduction

A wound is damage to living tissue such as a cut, laceration, burn, or fracture (Winkler, 2021). Between 2011 and 2019, a total of 11,915 stray animals, including dogs, cats, cows, and goats, were injured in traffic accidents across the city, according to data from the

Nagpur Municipal Corporation (Chakraborty, 2019). Injuries to farm animals can also occur at any time, especially if maintenance management is poor. Hard cage floor conditions, sharp surfaces, and rough transportation can cause wounds that need to be treated immediately so that healing is rapid and wounds do not worsen (Medion Ardhika Bakti, 2023).

The wound healing process is a complex cellular mechanism that aims to restore continuity to damaged tissue, and the success of this healing is strongly influenced by the presence of infection (Fauziah and Soniya, 2020). Bacterial infections in wounds can slow down or even inhibit the healing process. Some microbes, such as *Staphylococcus aureus* and *Escherichia coli*, often cause nosocomial infections of the skin, which worsen wound conditions (Sayogo et al., 2017). To treat such bacterial infections, antibiotics are often used as the primary therapy (Amalin et al., 2024).

One of the commonly used solutions in wound care is neomycin sulfate, a topical antibiotic that is effective in preventing and managing bacterial infections in the wound area. However, the use of this antibiotic must be done wisely, as irrational use can lead to antibiotic resistance (Rahimah et al., 2023). With the development of bacterial resistance to various types of antibiotics, this problem actually worsens the mortality rate due to bacterial infections, which is increasing along with the spread of resistance (Sayogo et al., 2017).

Antibiotic resistance has become a global issue, including in Indonesia. Increasing antibiotic resistance demands more judicious control of antibiotic use and improved sanitation to reduce the risk of bacterial infections (Nasrun et al., 2023). By 2030, antibiotic use in animals is expected to increase by 67% or 105,500 tons (Kurnianto and Syahbanu, 2022). The high rate of antibiotic resistance triggers an urgent need to find effective and safe antibacterial alternatives.

The development of antibacterial drugs derived from natural materials is needed to reduce the incidence of antibiotic resistance (Pratiwi et al., 2023). One of the natural materials that have antimicrobial activity is corn silk. Corn silk has long been utilized in traditional medicine because it is rich in beneficial ingredients, such as alkaloids, flavonoids, steroids, tannins, and saponins (Fajrina et al., 2021). The antimicrobial activity of ethanol extract of corn silk (*Zea mays* L.) has been investigated and showed effective results. The extract is effective against bacteria that cause urinary tract infections and fungi that cause vegetable damage (Abirami et al., 2021).

As antibiotic resistance increases, efforts to find alternative treatment methods are becoming increasingly important. The use of natural ingredients in the form of ointment preparations can be one practical solution for the treatment of skin infections caused by bacteria (Pratiwi et al., 2023). Therefore, this study aims to evaluate the effectiveness of ointments made from corn silk extract (*Zea mays* L.) as an alternative treatment for wound infections caused by *Staphylococcus aureus* and *Escherichia coli*. This research is expected to contribute in the development of safer therapy and more effective topical therapies, while reducing reliance on synthetic antibiotics that risk causing resistance.

Materials and Methods

Materials and Equipment

The materials used were distilled water, aluminum foil, sulfuric acid (H_2SO_4), test bacteria (*Eschericia coli* and *Staphylococcus aureus*), blank disc, cotton swab, concentrated hydrogen chloride (HCl), cotton, parchment paper, filter paper, chloroform, ammonia solution, agar medium, mice, methanol, sodium chloride (NaCl) 0.85%, nipasol, plastic wrap, corn silk

(*Zea mays* L.), dragendroff reagent, mayer reagent, wagner reagent, Bioplacenton® ointment, magnesium powder, and vaselin flavum.
The equipment used are stirring rod, 250 mL beaker glass, blender, maceration bottle, petri dish, porcelain dish, 250 mL erlenmeyer, 25 mL measuring cup, incubator, vernier, watch glass, refrigerator, mask, mortar, analytical balance, object glass, round ose, oven, heater, water bath, pH meter, knife, ointment pot, tube rack, rotary evaporator, gloves, spatula, syringe, stamper, test tube, and analytical balance.

Research Procedure

Sample Collection

Corn silk samples were taken in Jeneponto Regency, South Sulawesi. The samples taken were fresh corn silk as much as 1 kg.

Sample Preparation Stage

Corn silk that has been collected is cleaned from dirt and washed with running water until clean. After cleaning the corn silk is dried with herbs dryer, pollinated and then extracted (Ramadani et al., 2024).

Extract Preparation

Corn silk symplisia was extracted using maceration method using 70% ethanol solvent for 5x24 hours while occasionally stirring. Then the sample was filtered using filter paper. The filtering results were then concentrated using a rotary evaporator to obtain a thick extract. The resulting corn silk thick extract was then weighed (Ramadani et al., 2024).

Phytochemical Screening

Phytochemical analysis of corn silk extract used in this test, reacted using a simple method with reagents. Phytochemical analysis carried out includes flavonoid, alkaloid, steroid, tannin, saponin, and phenolic tests (Aulyawati et al., 2021).

Ointment Preparation

The ointment material that will be used is thick corn silk extract which is formed to make as many formulations as possible with different concentrations of 5%, 7%, and 9%. The ointment base used is vaselin flavum. Each ingredient needed was weighed according to the formulation. Next, the mortar and stamper were heated with hot water until the outer mortar wall felt hot. Then, vaselin flavum was immediately added and stirred using a stamper. Slowly add corn silk extract and stir until homogeneous. Next, nipasol is added and then homogenized (Rawung et al., 2020).

Table 1. Corn Silk Extract Ointment Dosage Formulation

Formulation	Concentration		
	5%	7%	9%
Corn silk extract	1,25 g	1,75 g	2,25 g
Nipasol 0,1%	0,025 g	0,025 g	0,025 g
Vaselin flavum	Ad 25 g	Ad 25 g	Ad 25 g

Ointment Evaluation

a. Organoleptic tests carried out include texture, color, and odor which are observed visually using human senses (Badia et al., 2022).
b. The homogeneity test is carried out by applying ointment to a piece of glass which must show a homogeneous arrangement (Badia et al., 2022).
c. The ointment spreadability test is carried out by weighing 0.5 g of ointment and then placing it in the center of the preparation glass. On top of the ointment is placed a

cover glass and weight, let stand for 1 minute and recorded the spread area (Badia et al., 2022).

d. The adhesion test was carried out by placing 0.5 g of ointment between the object glass. Then the object glass is pressed with a load for 5 minutes. Mounted object glass on the test tool, the load is then released (Badia et al., 2022).

e. The pH test is carried out using a pH stick dipped in 0.5 g of ointment (Badia et al., 2022).

Antibiotic Resistance Test

a. Staphylococcus aureus

The test method used is the kirby bauer method. The antibiotic resistance test of *Staphylococcus aureus* bacteria begins with the preparation of mannitol salt agar (MSA) media which is inoculated with chicken bumble foot samples and incubated at 37 °C for 24 hours to identify *Staphylococcus aureus.* After that, preparation of mueller hinton agar (MHA) media to be inoculated using a sterile cotton swab with a suspension of S. aureus bacteria that has been obtained. Resistance tests were carried out by placing discs that had been soaked according to the treatment of table 2 above the inoculation of *Staphylococcus aureus* bacterial suspensions. Incubate for 24 hours at 37 °C. The zone of inhibition was measured using a caliper (Magvirah et al., 2019).

b. *Eschericia coli*

The antibiotic resistance test for *Escherichia coli* bacteria begins with the preparation of EMBA media which is inoculated with fecal samples containing Escherichia coli and incubated at 37 °C for 24 hours to produce metallic green colonies as an indicator of *Escherichia coli*. After that, preparation of MHA media to be inoculated with bacterial suspensions according to the 0.5 McFarland standard. The resistance test was carried out by placing the soaked disc according to the treatment of table 2 above the inoculation of *Escherichia coli* bacterial suspension. Incubate for 24 hours at 37°C. The zone of inhibition was measured using a caliper (Diniarti et al., 2022).

Table 2. Treatment Groups of Antibiotic Resistance Test of Corn Silk Extract

Group	Treatment
G0	blank disc
G1	contains a disc of ointment with neomycin sulfate
G2	contains 5% corn silk extract disc
G3	contains 7%corn silk extract disc
G4	contains 9% corn silk extract disc

Statistical Analysis

Test data collected from each test were tabulated and analyzed statistically. Data analysis used One Way ANOVA with the IBM SPSS® 25 and Graph Prism® 8.

Results and Discussion

Corn silk extracted as much as 684 grams macerated with 70% ethanol and obtained a thick extract of 79.98 grams, with a percentage yield of 11.69%. The thick extract obtained was then tested qualitatively for phytochemicals to see the content of compounds present in the thick extract of corn silk. Based on the test results, corn silk extract is stated to contain flavonoids, alkaloids, steroids, phenolic compounds, tannins, and saponins because it gives positive results in the test using reagents (Aulyawati et al., 2021).

Table 3. Phytochemical Screening Results of Corn Silk (Aulyawati et al., 2021)

Chemical Content	Reagent	Qualitative Parameters	Result
Flavonoids	Mg powder + HCl	Brick redd	Positive
Alkaloids	Mayer	White precipitate	Positive
	Wagner	Red precipitate	Positive
	Dragendroff	Brown precipitate	Positive
Steroids	Lieberman Burchard	Red	Positive
Phenolic	$FeCl_3$	Purple	Positive
Tannins		Blackish brown	Positive
Saponins	Shaken + HCl	Permanent foam	Positive

Formulation and Evaluation of Corn Silk Ointment Preparation

The thick corn silk extract produced was then formulated in the form of 5%, 7%, and 9% concentration ointment preparations. After formulating the ointment preparation, the physical properties of the ointment preparation were evaluated. This test is to ensure that the ointment preparation produced has met the characteristics of the physical properties of a good ointment preparation (Rawung et al., 2020).

a. Organoleptic Test

Table 4. Organoleptic Test Results

Physical Properties	5% concentration	7% concentration	9% concentration
Color	Brown	Brown	Brown
Smell	Characteristic odor of extract corn silk	Characteristic odor of extract corn silk	Characteristic odor of extract corn silk
Shape	Semi-solid	Semi-solid	Semi-solid

Organoleptic tests are carried out by observing the shape, color, and smell of the ointment preparation. The criteria for a good ointment preparation are semi-solid shape, color and distinctive odor of the sample (Rawung et al., 2020). The results of organoleptic testing (**Table 4**) show that the formulations of the three concentrations of corn silk extract ointment meet the criteria of a good ointment.

b. Homogeneity Test

Table 5. Homogeneity Test Results

Formulation	Homogeneity Observation
5% Concentration Ointment	Homogeneous
7% Concentration Ointment	Homogeneous
9% Concentration Ointment	Homogeneous

The homogeneity test is characterized by the absence of lumps in the application results, an even structure, and has a uniform color from the starting point of the application to the end point of the application (Rawung et al., 2020). Ointment base and corn silk extract ointment preparations at concentrations of 5%, 7%, and 9% in this test have good homogeneity and it can be concluded that this ointment preparation is homogeneous.

c. pH test

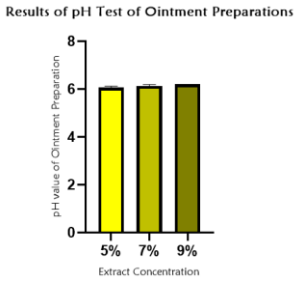

Fig. 1 pH of Corn Silk Extract Ointment

The pH test is to determine the nature of the ointment in irritating the skin with the pH value requirement for topical preparations which is 4.5 - 6.5 (Rawung et al., 2020). The results showed that only the pH of 5% and 9% concentration ointments were significantly different. This indicates that the concentration of the extract affects the pH value of the ointment, but all three ointment formulations meet the pH value requirements for topical preparations and will not cause irritation when applied to the skin.

d. Spreadability Test

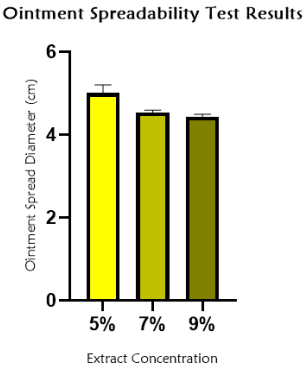

Fig. 2 Spreadability Test Results

This test aims to see the spreadability of ointment preparations on the skin, where an ointment should have good spreadability to ensure satisfactory drug delivery. The requirement for ointment spreadability is 3-5 cm (Susanti et al., 2022). The results show that there are significant differences in all ointment preparations where the concentration of corn silk extract affects the diameter of the ointment distribution. All three ointment formulations meet the requirements of good spreadability with 5% concentration having the highest average spread diameter.

e. Adhesion Test

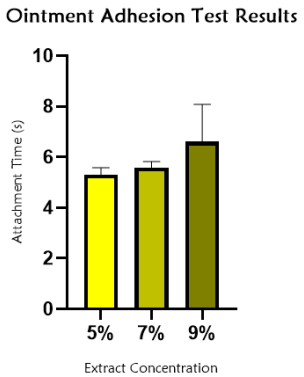

Fig. 3 Adhesion Test Results

Testing the adhesion to determine the ability of the ointment to adhere to the skin, the requirement for the adhesion test on topical preparations is not less than 4 seconds (Badia et al., 2022). The results showed that there was no significant difference in the adhesion time of each ointment, indicating that the concentration of the extract did not affect the length of the ointment's adhesion time. All three ointments met the criteria of good adhesion time because they had an adhesion time of more than 4 seconds with 9% concentration having the longest adhesion time.

Antibiotic Resistance Test

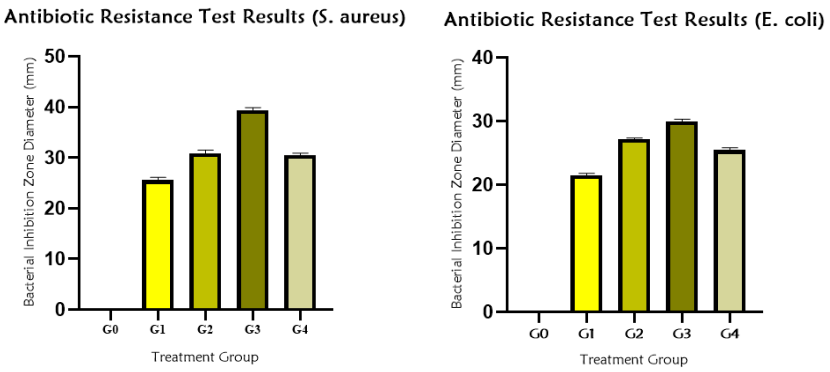

Fig. 4 Diameter of Zone of Inhibition against *S. aureus* and *E. coli* Bacteria

The method used to see antibacterial activity is kirby bauer method (Nurhayati et al., 2020). This method was carried out with the aim of seeing the ability of corn silk extract ointment preparations with varying concentrations in inhibiting the growth of *S. aureus* and *E. coli* after a 24-hour incubation period at 37°C. A material is said to have antibacterial activity if the diameter of the inhibition formed is greater than or equal to 6 mm (Magvirah et al., 2019). The test results using *S. aureus* and *E. coli* bacteria showed that all treatments gave significantly different results, but 5% ointment and 9% ointment were not significantly different. The 7% ointment proved to be significantly different from the other groups and most effective in inhibiting *S. aureus* and *E. coli*. All treatments can be said to have antibacterial activity with 7% ointment as the best preparation. However, it can be seen that corn silk extract ointment even in low concentrations had excellent antibacterial activity and was able to exceed the positive control with Bioplacenton®.

Antibacterial activity testing was significantly reduced at 9% ointment concentration. This means that corn silk extract has an influence on antibacterial activity. Supposedly with increasing concentration, the antibacterial activity will show an increase, but it turns out that at 9% extract there is a decrease in the bacterial inhibition zone. According to Hertian et al. (2021), in natural medicine there is often a decrease in activity with increasing dose or concentration. This occurs because of the chemical compound components where these components work together to cause an effect, but with an increase in dose the number of chemical compounds contained is increasing so that adverse interactions occur which cause a decrease in effect (Hertian et al., 2021).

Conclusion

This study shows that the use of corn silk extract ointment with a concentration of 7% has an effect as an antibiotic that inhibits the growth of *S. aureus* and *E. coli* bacteria best compared to other concentrations and the positive control Bioplacenton®. Thus, the purpose of this research was to evaluate the effectiveness of various concentrations of corn silk extract

ointment in inhibiting *S. aureus* and *E. coli* bacteria, and 7% concentration was shown to provide the best healing results. These findings can serve as a basis for the development of ointment products that prevent bacterial infection in wound healing more effectively in the future.

Conflict of Interest

We certify that there is no conflict of interest with any financial, personal, or other relationships with individuals or organizations that could influence the material presented in the manuscript titled "Effectiveness Analysis of Corn Silk Ointment as a Broad-Spectrum Antibiotic".

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