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FORMULATION AND EVALUATION OF HERBAL ANTIBACTERIAL CREAM FROM SOLANUM XANTHOCARPUM EXTRACT

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ABSTRACT

Herbal formulations have gained popularity due to their efficacy, minimal side effects, and eco-friendly nature. This study focuses on the formulation and evaluation of an antibacterial cream containing Solanum xanthocarpum methanolic extract. The plant is known for its potent antibacterial properties, which make it an excellent candidate for topical applications. The cream was formulated using natural ingredients, and its physicochemical properties, stability, and antibacterial efficacy were assessed. The antibacterial screening was conducted against *Staphylococcus aureus* and *Escherichia coli* to evaluate its effectiveness. The results indicated that the cream exhibited significant antibacterial activity, making it a promising natural alternative for antibacterial applications.[1]

Herbal creams have antibacterial activity because they contain plants with antimicrobial properties. These creams can treat infected skin.

How herbal creams work : 1) Damage cell membranes: Herbs can damage the cell walls and membranes of bacteria. 2) Inhibit protein and nucleic acid synthesis: Herbs can inhibit the synthesis of proteins and nucleic acids in bacteria. 3) Increase osmotic pressure: Herbs can increase the osmotic pressure inside bacteria.[2]

KEYWORD: Solanum Xanthocarpum, Antibacterial, Antioxidant, Antifungal, Antimicrobial, Natural Cream.

INTRODUCTION

Herbal medicine has been utilized for centuries in treating various skin infections. *Solanum xanthocarpum*, a medicinal plant from the Solanaceae family, possesses potent antimicrobial, anti-inflammatory, and antioxidant properties. The increasing resistance of bacteria to synthetic antibiotics has driven interest in herbal-based alternatives. This study aims to formulate and evaluate an antibacterial cream incorporating *Solanum xanthocarpum* methanolic extract and assess its effectiveness against common bacterial pathogens.

Skin diseases often stem from factors such as poor hygiene, overcrowded living conditions, malnutrition, lack of access to clean drinking water, and high temperatures combined with humidity. Conventional treatments typically involve antibiotics, steroids, and sulfonamides. However, these medications are frequently inaccessible to people living in remote areas and are associated with side effects like skin thinning (Atrophy), visible blood vessels (Telangiectasia), abnormal hair growth (Hirsutism), and allergic skin reactions.

Indigenous medicinal plants have long served as a vital source of therapeutic agents, and even today, nearly 50% of newly developed drugs are derived from plant-based compounds. Acknowledging the therapeutic potential of native plants, the World Health Organization (WHO) recommended in its 1997 guidelines that effective, locally available plants be used as drug alternatives. The organization also emphasized that research and information sharing on medicinal plants could significantly advance scientific understanding and reduce reliance on importedpharmaceuticals.

Skin infections are primarily caused by pathogens like Staphylococcus aureus and Escherichia coli. The rising issue of microbial resistance to conventional antibiotics is a growing global challenge.[3] In this context, plants serve as valuable sources of bioactive compounds for new drug development, especially since they tend to be safer and carry fewer side effects. Creams, being semisolid preparations designed for external use, usually consist of two immiscible phases an oily internal phase and an aqueous external phase. This structure mirrors the emulsified nature of the skin, allowing drugs delivered in cream form to interact more effectively with the skin and penetrate biological membranes more efficiently. Herbal creams, in particular, are favored for their high efficacy and low risk of side effects.[4]

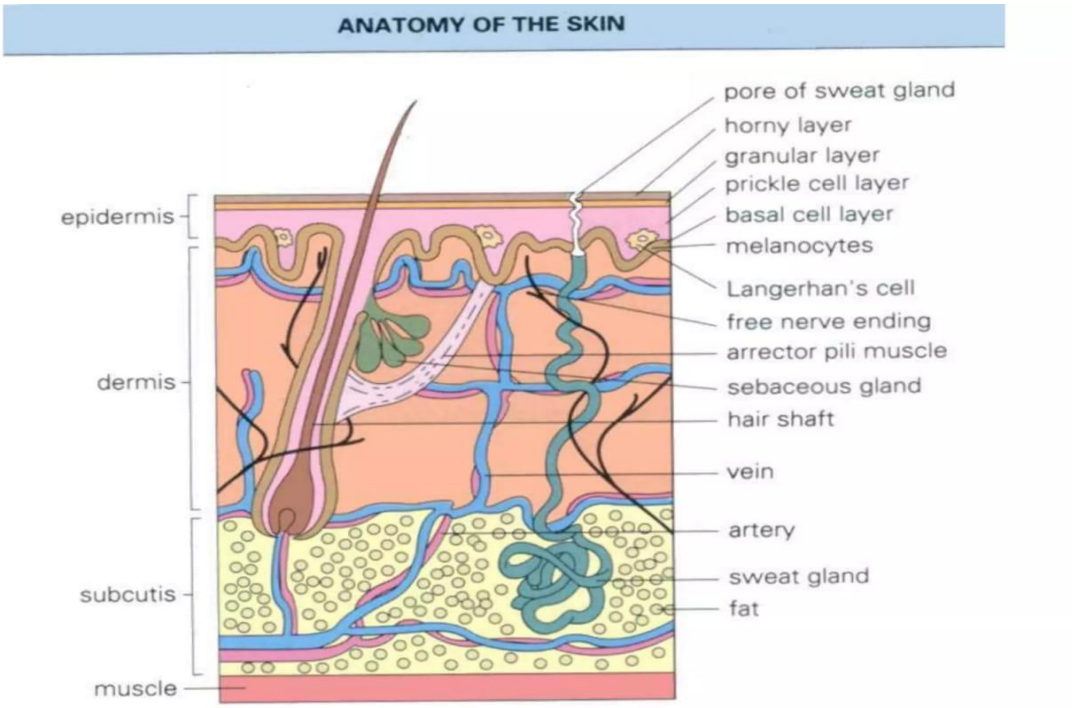

Fig. 1: Anatomy of skin.[5]

Natural defenses of the skin

- Temperature less than 37^0 C
- Dry: Usual infection sites are wet areas: Skin folds, Armpit, Groin
- Keratin
- Skin sloughing
- Sebum: Low pH, High lipid content
- Sweat: - Low pH, High salt,
- Lysozyme & toxic lipids
- Skin-associated lymphoid tissue (SALT)
- Resident microflora (Mainly Gram positives)

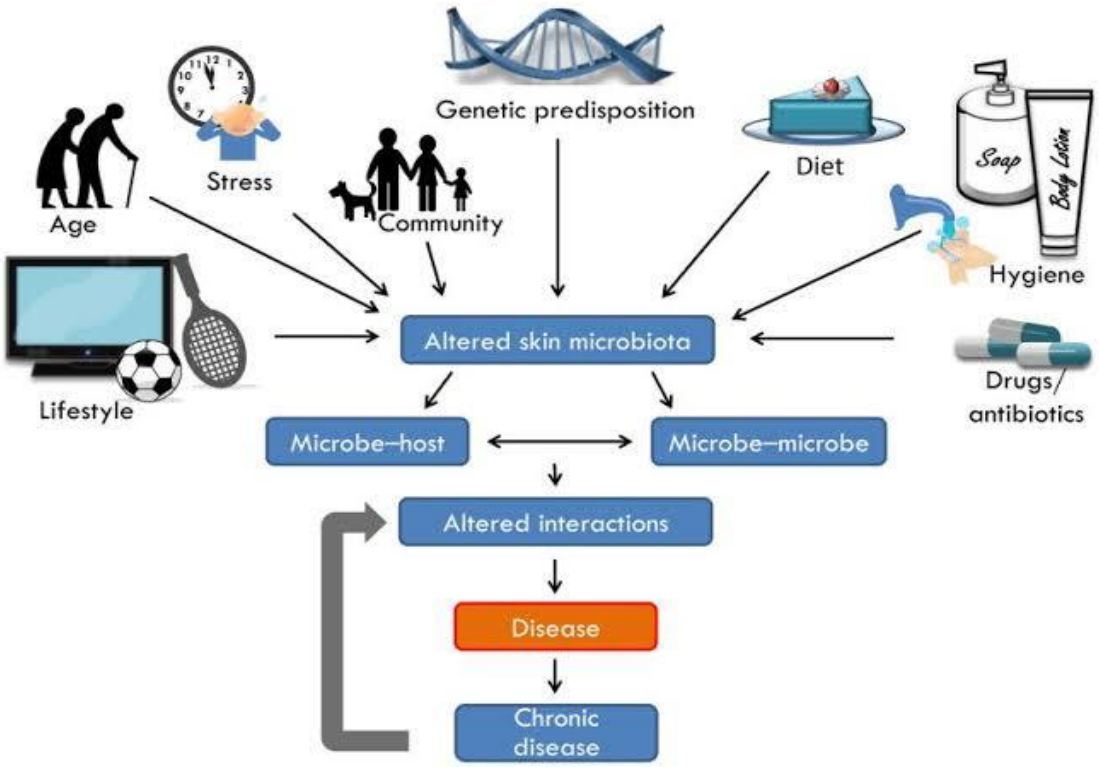

Fig. 2: Predisposing factors of bacterial skin infections.[6]

Route of infection

1) Skin (Pores, Hair follicles).
2) Wounds (Scratches, Cuts, Burns).
3) Insect & animal bites.

Staphylococcal infection

A staphylococcal infection, often called a staph infection, is caused by a group of bacteria known as *Staphylococcus*. There are over 30 types of these bacteria, but the one that most often causes infections in people is *Staphylococcus aureus*. These bacteria can lead to a variety of infections, especially on the skin.

Staph infections commonly show up on the skin and can cause problems like boils, blisters, and redness. They can appear anywhere on the body, including the face, especially around the mouth and nose. These infections often look like pimples red, swollen, and filled with pus. Sometimes they ooze fluid, and people may mistake them for insect bites or ingrown hairs.

Here are some common signs of a staph skin infection

- **Boils and Abscesses:** Painful lumps under the skin that are red and sore.
- **Cellulitis:** Red, swollen, and painful skin, usually just beneath the surface.

- **Folliculitis:** Small, sore bumps that form around hair follicles.
- **Impetigo:** Blisters or sores filled with fluid that break open and leave a yellow or brown crust.
- **Paronychia:** Infection around the fingernails or toenails, especially in the skin folds.

Fig. 3: Staphylococcus skin infection related symptoms.[7]

Staph infections (Staphylococcal infections)

Staph skin infections usually begin with tender, red, and warm spots on the skin. As the infection develops, these areas may start to leak pus or other fluids, and the redness can spread. In some cases, the infection may cause open sores. Staph bacteria spread easily, especially when they enter the skin through cuts or wounds. The pus from an infected area is also contagious, and touching it or using contaminated objects like towels or clothing can spread the bacteria.

To help prevent staph infections

- Practice good hygiene.
- Keep cuts and scrapes clean and covered.
- Wash your hands and body regularly.
- Don’t share personal items like towels or razors.

E. coli Infections

An *E. coli* skin infection occurs when the bacteria, normally found in the intestines, enter the body through a break in the skin like a cut, scrape, or wound. While *E. coli* helps with digestion in the gut, it can cause infections when it gets into the skin.

Symptoms of an *E. coli* skin infection include

- Red, swollen, or warm skin
- Pain in the infected area
- Pus or fluid leaking from the wound
- Fever in some cases

How infections happen

These infections often occur when wounds aren't cleaned properly. They're more common in hospital settings or in people with weakened immune systems.

Common types of *E. coli* skin infections

1. **Cellulitis** – A red, swollen, and painful skin infection caused when bacteria enter through a cut or wound and spread under the skin.
2. **Abscess** – A swollen, painful lump under the skin filled with pus. *E. coli* can be one of the bacteria responsible for these deeper infections.
3. **Wound infections** – After surgery or injury, *E. coli* can infect the wound, leading to swelling, redness, and pus.

Mechanism of action of antibacterial cream for skin infections

1. **Surface application**

- The cream is applied to the infected skin area, which may show signs like redness, swelling, or pus due to bacterial presence.

2. **Penetration into skin layers**

- The cream penetrates through the outermost layer of the skin (Stratum corneum) and into the epidermis where bacteria reside.

3. **Action on bacteria**

- Active ingredients in the cream (e.g., mupirocin, fusidic acid) target bacterial cells.
- They either:

Disrupt the bacterial cell wall, causing it to break apart.

Inhibit protein synthesis, stopping bacterial growth and replication.

4. **Healing and Anti-inflammatory Effect**

- As bacteria are eliminated, inflammation decreases.
- Skin begins to regenerate, restoring its normal appearance

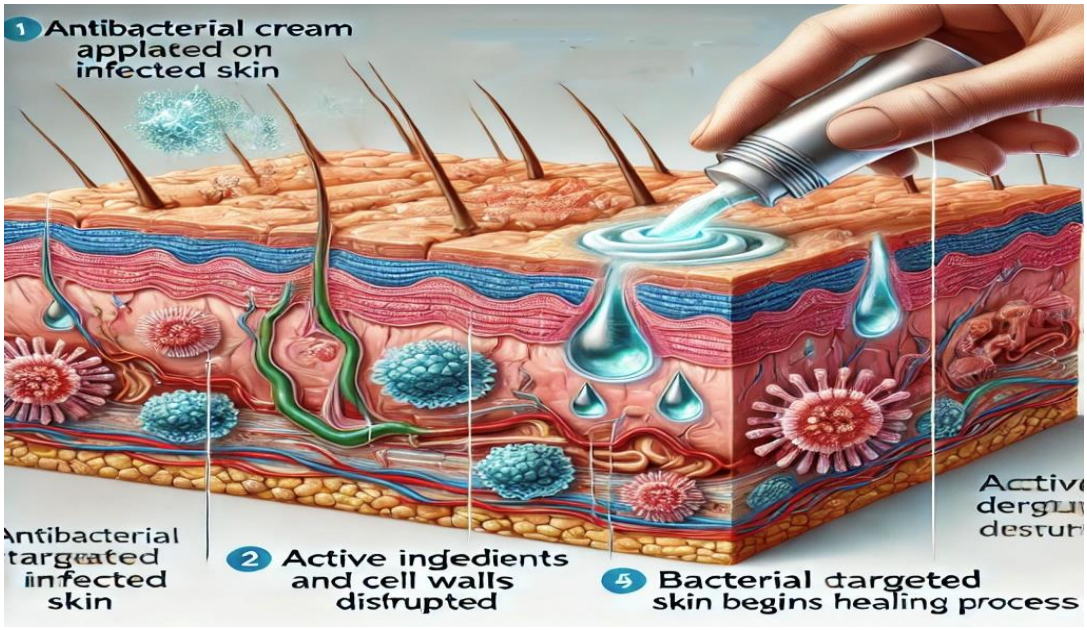

Fig. 4: Antibacterial cream applied on skin surface.

Herbal cream

Herbal cream is primarily a water-in-oil type of emulsion. It contains mainly natural substances derived from herbal plants that offer health benefits and nutritional value without any toxic or adverse effects. The cream bases, ingredients, and preparation methods used for both herbal and synthetic creams are generally similar. However, in herbal creams, plant extracts are used in place of active pharmaceutical ingredients.

AIM AND OBJECTIVE

Aim

Formulation And Evaluation of A Herbal Antibacterial Cream From Solanum Xanthocarpum Extract.

Objectives

1) To Promote Natural Wound Healing.
2) To Formulate a Skin-Friendly Product.
3) To Validate Safety and Effectiveness.
4) To Fight Bacteria Naturally.
5) To Help Wounds Heal Faster.
6) To Be Gentle on Skin.
7) To Make Sure It’s Safe and Works Well.

Fig. 5: solanum xanthocarpum flower.[8]

Fig. 6: Solanum xanthocarpum fruit.

Synonyms

Bhuiringni, Kantakaari, Ringani, Vankuda, Solanum Virginicum L.

Biological source

Leaves, Fruits, Flowers, Seeds. This is a green perennial herb widely found in india.

Family

Solanaceae.

Geographical source

Solanum xanthocarpum originates from South Asia and is commonly found in nations like India, Pakistan, Nepal, and Sri Lanka. It thrives in diverse habitats, including dry sandy soils, wastelands, and cultivated fields. The plant's geographical source influences its chemical composition and pharmacological properties, with variations observed among different geographical regions.

Solanum xanthocarpum, also known as Kateli or Bhachkatiya, is an herbaceous plant found in various regions of India and Southeast Asia. It thrives in hot and dry environments, growing to a height of 2-3 meters. Its fruits are white or yellow in color and appear from May to June, measuring approximately 1-3 centimetres. The plant is characterised by its zigzag like stems with plentiful branches and somewhat woody bases.[9]

Chemical constituents

The plant is rich in many ingredients like alkaloids, phenolics, flavonoids, sterols, saponins and their glycosides and also carbohydrates, fatty acids, tannins and amino acids.[10]

Uses

Solanum xanthocarpum has a long history of traditional use in various indigenous medicine systems, including Ayurveda, Unani, and Siddha. It is employed for the treatment of respiratory disorders, gastrointestinal ailments, skin diseases, and reproductive disorders. The plant is also used as a diuretic, antipyretic, and anthelmintic agent. Traditional formulations and remedies containing Solanum xanthocarpum are described, highlighting its cultural and medicinal significance.

MATERIALS AND METHODES

Collection of plant

SX were collected from Rahuri, District – Ahilyanagar, State – Maharashtra, India.

Processing of plant materials

The collected plant materials were first thoroughly washed under running water to eliminate any soil and unwanted debris. After cleaning, they were chopped into smaller pieces and dried in the shade to preserve their natural properties. Once fully dried, the plant samples

were ground into a fine powder using a grinder mill. The powdered materials were then stored in airtight polythene bags to be used later for chemical analysis.[11]

Fig. 7: Powder of S. Xanthocarpum.

Extraction method

50 gm of powdered sample were extracted with methanol (1L) using a soxhlet extractor. Pooled extracts were filtered though whatman No 1 filter paper and concentrated by evaporating the solvents under reduced pressure in evaporator.[12]

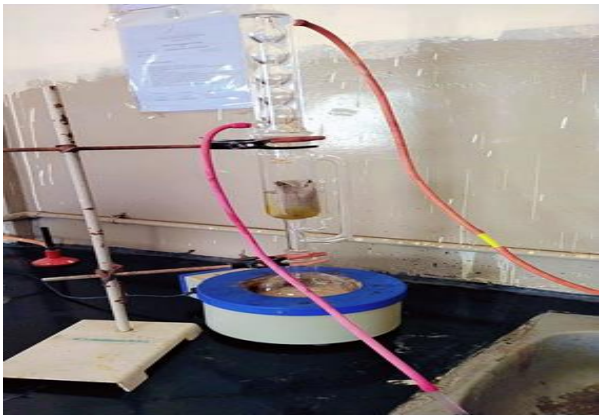

Fig. 8: Soxhlet apparatus.

Fig. 9: SX plant Extract.

Phytochemical analysis

1. Test for alkaloids

Mayers test: To a few ml of filtrate, two drops of mayers reagent were added though the wall of the test tube. A white or creamy prepcipitate indicates the test as positive.

Wagner's test: Few drops of Wagner's reagent were added into 2 to 3 ml extract. Formation of reddish brown precipitate indicates the presence of alkaloids.

2. Test for flavonoids

NaOH tests: 2-3 ml. of extract and few drops of sodium hydroxide solution were added into a test tube. Formation of intense yellow colour that became colourless on addition of few drops of dilute HCl indicates the presence of flavonoids.

Pew's tests: Zinc powder was added into 2-3 ml. extract, followed by drop wise addition of con. HCl. Formation of purple red or cherry colour indicates the presence of flavonoids.

3. Test for glycosides

Glycosides test: 1 ml water was added into the small amount of extract and shaked well. Then aqueous solution of NaOH was added. The appearance of yellow colour indicates the presence of glycosides.

Keller-Killani test: Glacial acetic acid was added into 2 ml. extract and one drop 5% FeCl3 and conc. H2SO4. Reddish brown colour appears at the junction of the two liquid layers and the upper layer of bluish green indicates the presence of glycosides.

4. Test for Tannins and Phenolic compounds

Ferric chloride tests: 0.5 ml of FeCl3 (w/v) solution was added into 2 ml of test solution, formation of an intense colour indicates the presence of phenols.

Lead acetate test: Few drops of 10% lead acetate solution were added into 5 ml of extract. Formation of yellow or red precipitate indicates the presence of tannins.

5. Test for Sterols and Triterpenoids

Salkowski test: 1 ml of extract was mixed with 2ml of chloroform. About 3ml of Conc. H2SO4 was added carefully from the side of the test tube. Reddish Brown colouration at the interface indicated the presence of triterpenoids.

H2SO4 test: To 1ml of extract 6-7 drops of concentrated H2SO4 was added from the side wall of the test tube. The appearance of red colour indicated the presence of steroids.

6. Test for carbohydrates

Fehling test: 1ml of filterate is boiled on water bath with 1ml each of fehling solution A and B. A red ppt indicates the presence of sugar.

Benedicts test: To 1ml of filtrate, 1ml of Benedict reagent is added and heated on a boiling water bath for 2 minute. Red ppt indicates the presence of sugar.

7. Test for Proteins and Amino acids

Ninhydrin test: Crude extract when boiled with 2ml of 0.2% solution of ninhydrin, Violet colour appeared suggesting the presence of aminoacid and proteins.

Xanthoprotein test: In 2 ml of extract, 3 drops of nitric acid were added by the side of the test tube followed by addition of 40% NaOH. Appearance of yellow colour indicates the presence of proteins and free amino acids.

8. Test for saponins

Foam test: The extract was diluted with 20 ml of distilled water and was shaken in a graduated cylinder for 15 minutes. A 1 cm layer of foam indicates the presence of saponins.[12]

Table 1: Extract test results.

Sr. No	Test	Observation
1	Test for alkaloids : Mayers test: Wagner's test	 White precipitate Reddish brown ppt
2	Test for flavonoids : NaOH tests: Pew's tests:	 Colourless Red colour
3	Test for glycosides: Glycosides test: Keller-Killani test:	 Yellow colour Upper layer of bluish green
4	Test for Tannins and Phenolic Compounds: Ferric chloride tests: Lead acetate test:	 Intence colour Yellow ppt
5	Test for Sterols and Triterpenoids: H2SO4 test:	 Red colour
6	Test for carbohydrates: Fehling test:	 Red ppt
7	Test for Proteins and Amino acids: Xanthoprotein test:	 Yellow colour
8	Test for saponins: Foam test:	 1cm layer of foam

Procedure

Base cream contains water and oil phases. Both phases were mixed at same temperature 65^0C. In order to prepare the cream, different amount of ingredients were incorporated together, and then 0.3 gms of herbal extract was added.[13]

Formulation table

The compositions and amounts of the formulation ingredients are as shown in table.[13]

Sr. no.	Ingredients	F1 (gm)	F2 (gm)	Uses
1	Stearic acid	1	1	Moisturizer
2	Spermaceti	0.5	0.5	Emollient
3	Cetyl alcohol	0.5	0.5	Stabilizer
4	Glycerin	0.5	0.5	Humectant
5	Triethanolamine	0.2	0.2	Ph adjuster
6	Water q.s.	10	10	Solvent
7	S.X. extract	0.3	0.6	Antibacterial

Evaluation of cream

1) **Physical characteristics:** The cream's color, odor, texture and physical state were evaluated.
2) **pH Measurement:** To determine the pH, 0.5 g of the cream was dispersed in 50 mL of distilled water, and the pH was measured using a digital pH meter.
3) **Skin irritation test:** The test was conducted on healthy human volunteers. For each formulation, five individuals were selected. A measured amount of 1 gram of the formulation was applied to a 2 square inch area on the back of the hand and then covered with cotton. Volunteers were instructed to return after 24 hours to check for any signs of irritation or adverse reactions.
4) **Washability:** A small quantity of the cream was applied to the hand and then rinsed with tap water to assess its washability.
5) **Viscosity:** The viscosity of the cream was measured using a Brookfield viscometer at 25 °C and 2.5 RPM.

Fig. 10: Brookfield viscometer.

6) **Spreadability:** Spreadability was evaluated based on the time required for two glass slides to separate under a specific load, with the cream layer sandwiched between them. A shorter separation time indicated better spreadability. The procedure involved placing the cream on a slide, compressing it evenly with another slide under a fixed weight, and measuring the time the upper slide took to slip off. Spreadability was calculated using the formula:

$S = m \times l/t$

Where,

S = spread ability in gm.cm/sec.

M = standard weight which is tied to or placed over the upper slide

L = length of glass slide

T = time taken in seconds.

7) **Greasiness:** Here the cream was utilised on the skin surface in the form of smear and checked if the smear was oily or grease-like.

8) **Homogeneity:** By visual and touch, the uniformity of the formulation was evaluated.

9) **After feel:** Emolliency, slipperiness, and the quantity of residue left behind after applying a predetermined amount of cream were evaluated.[14]

Table 2: Evaluation results.

Sr. No.	Parameters	Results	
		F1	**F2**
1	Colour	White	White
2	Odour	Characteristic	Characteristic
3	Irritancy	Nil	Nil
4	Washability	Easily washable	Easily washable
5	PH	6.3	6.2
6	Viscosity	48890 cp	48890 cp
7	Spreadability	Easily spreads	Easily spreads
8	Greasiness	Non greasy	Non greasy
9	Homogeneity	good	good

Fig. 11: Antibacterial Cream of SX.

Screening the antibacterial activity of methanolic extracts of solanum xanthocarpum

The antibacterial activity of the methanol extract of *Solanum xanthocarpum* was assessed using the agar-well diffusion method. Nutrient agar medium was prepared with the following ingredients: 1 g beef extract, 2 g yeast extract, 1 g sodium chloride, 5 g peptone, 20 g agar, and 1000 mL distilled water. The medium was sterilized by autoclaving at 121.6°C for 30 minutes and poured into sterile Petri dishes. Bacterial cultures was grown in nutrient broth for 24 hours.

A bacterial suspension (100 µL) was evenly spread onto the surface of each nutrient agar plate. Sterile stainless-steel cork borers were used to create wells 8 mm in diameter in the agar. These wells were filled with different concentrations of the methanol extract (30%, 50%, 70%, and 100%). A control plate containing only the solvent in the well was also prepared. The plates was incubated at 37 ± 2°C for 24 hours.

After incubation, the zones of inhibition, representing areas where bacterial growth was suppressed, were measured. The diameter of these zones, including the well, was recorded in millimeters. Measurements were taken in two perpendicular directions for all three replicates, and the average values were calculated. The percentage inhibition of bacterial growth was determined by subtracting the inhibition zone diameter of the control from that of the treated samples, using the control as the reference standard.

% of growth inhibition = (Control test/Control) ×100

Control = Average diameter of bacterial colony in control

Test = Average diameter of bacterial colony in treatment sets.[11]

RESULTS AND DISCUSSION

The present study demonstrates that the methanolic extract of Solanum xanthocarpum is a potent antibacterial agent. The extract exhibited significant growth inhibition of the tested bacteria at varying concentrations (30%, 50%, 70%, 100%). It was most effective against Staphylococcus aureus, with inhibition zones of 18 mm at 100%, 15 mm at 70%, 13 mm at 50%, and 11 mm at 30%. In contrast, the extract showed the least inhibition against Escherchia Coli, with inhibition zones of 15 mm at 100%, 13 mm at 70%, 10 mm at 50% and 9 mm at 30%.

From these results, it can be concluded that the methanolic extract of S. xanthocarpum is particularly effective in inhibiting the growth of S. aureus, a significant human pathogen responsible for infections, especially in wounds. The antibacterial activity of S. xanthocarpum is likely due to the presence of bioactive compounds such as alkaloids, phenolics, and flavonoids. These phytochemicals are known for their therapeutic properties, including antibacterial, antifungal, and antioxidant effects.

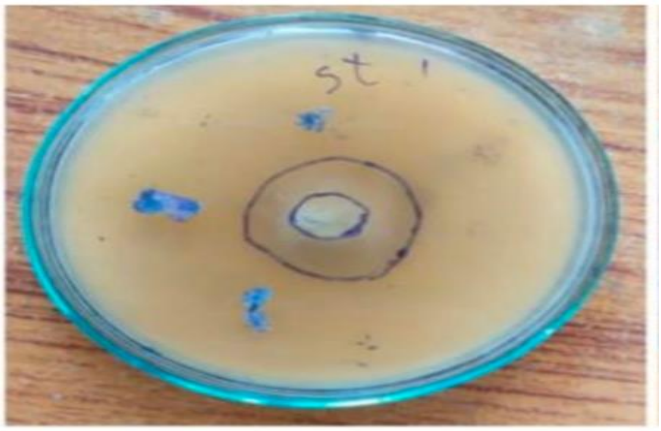

Fig. 12: Zone of inhibition against Staphylococcus aureus.

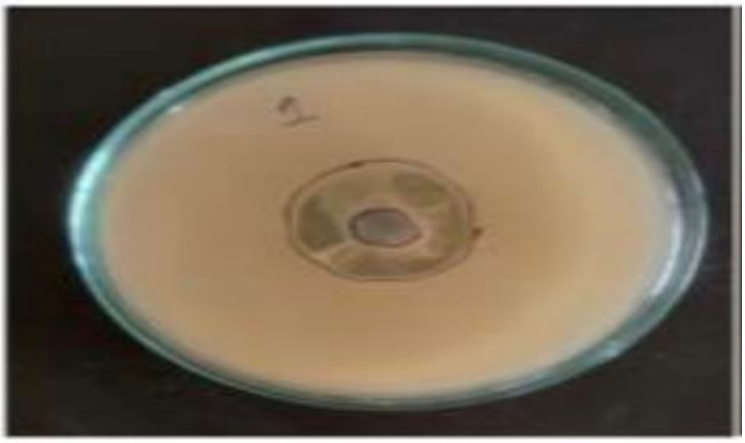

Fig. 13: Zone of inhibition against of E.coli.

Table 3: Inhibition zone diameter result.

Concentration of SX Extract (%)	Inhibition zone diameter (in mm)	
	S . aureus	E.Coli
Control	nil	nil
30	11	9
50	13	10
70	15	13
100	18	15

CONCLUSION

The methanolic extract of SX has a high concentration that inhibits S.aureus and E. Coli from growing. SX extract used in an Antibacterial cream has antibacterial property. Cream made from methanolic SX extract is safe to use. It does not show the skin irritability. This plant is rich in composition including alkaloids, phenolics, flavonoids, sterols, saponins and their glycosides, as well as carbohydrates, fatty acids, tannins, and amino acids. Antiallergy, Anti-inflammatory, Antihistamine, Hypoglycemic (blood sugar-lowering), Antibacterial, Antioxidant, Antifungal. These properties make S. xanthocarpum a significant herbal remedy with potential applications in various health issues, emphasizing the importance of integrating traditional knowledge with modern research in herbal medicine.

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