E-ISSN: 2788-9270
P-ISSN: 2788-9262
www.pharmajournal.net
NJPS 2025;5(1): 42-45
Received: 21-03-2025
Accepted: 24-04-2025

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Formulation of herbal cream using ethanolic extracts of *Azadirachta indica* leaves and cinnamon bark

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Abstract
Skin infections can be quite troublesome, especially as bacteria become more resistant to usual treatments. This study explores a natural solution-a herbal moisturizing cream made with a water-in-oil emulsion. It includes extracts from neem leaves and cinnamon bark, both known for their ability to fight germs, reduce inflammation, and protect the skin. The researchers checked the cream's look, pH, how easily it spreads, thickness, uniformity, and stability. They found it to be smooth, easy to spread, pleasantly scented, and stable over time without separating. When applied, it helps keep the skin moisturized and forms a protective barrier. Overall, the herbal cream is safe, effective, and a good option for caring for skin health.

Keywords: Herbal creams, moisturizer, *Azadirachta indica*, *Cinnamomum verum*

Introduction
Skin infections caused by bacteria and fungi are a growing health concern, particularly in underdeveloped and developing countries with high population density, humidity, and inadequate hygiene conditions [1]. The increasing resistance of pathogens to conventional antimicrobial agents has led researchers to explore alternative treatments derived from natural sources [2, 3]. Skin infections pose a significant challenge due to the emergence of drug-resistant strains. These infections can lead to prolonged hospital stays and increased healthcare costs. Fortunately, medicinal plants offer a promising solution [4]. They contain bioactive compounds with antimicrobial, anti-inflammatory, and wound-healing properties. One such plant is Azadirachta indica, commonly known as neem. Neem has been used in traditional medicine for centuries and boasts an impressive array of bioactive compounds. These compounds have shown efficacy against various bacterial and fungal pathogens, making neem a valuable resource in the fight against skin infections [5,6]. *Cinnamomum verum* (cinnamon), a member of the Lauraceae family, is widely used for its aromatic properties and therapeutic potential. Cinnamon bark contains cinnamaldehyde, eugenol, and flavonoids, which exhibit antimicrobial, antioxidant, and anti-inflammatory activity [7]. These compounds make cinnamon a suitable component in topical formulations for skin care and infection control. Topical creams are semi-solid formulations intended for localized treatment of the skin or mucous membranes. Among the two common types—oil-in-water (o/w) and water-in-oil (w/o)—the latter is particularly effective for hydrophobic ingredients like plant extracts. W/o emulsions provide superior moisturization by forming an oily barrier on the stratum corneum, reducing trans epidermal water loss and enhancing the penetration of active compounds [8]. The objective of this study is to formulate and evaluate a herbal moisturizing cream using ethanolic extracts of *Azadirachta indica* leaves and *Cinnamomum verum* bark. The aim is to develop a stable, skin-compatible, and effective cream for topical use with antimicrobial and moisturizing benefits.

2. Materials and Methodology
2.1 Materials
Liquid Paraffin, White Beeswax and Borax were purchased from Central Drug House, New Delhi. *Azadiracha indica* and Cinnamon Bark were obtained from herbal garden of institute.

2.1.1 Liquid Paraffin
Petroleum jelly acts as a protective barrier on the skin's surface, locking in moisture and shielding it from dryness. Its emollient properties make it an effective skin lubricant, providing soothing relief and hydration.

By creating a gentle, non-irritating layer, petroleum jelly helps to calm and comfort dry, irritated skin, making it a popular solution for skin care and protection.

2.1.2 White beeswax
Beeswax is a product made from the honey comb of the honey bee and other bees. Beeswax carries antiviral, anti-inflammatory, and antibacterial properties that are essential infighting chapped skin and bacterial infections that tend to affect us most in the dry, winter months. It forms a protective wall by sealing in moisture in our skin without smothering and clogging up the pores.

2.1.3 Borax
Borax is a naturally occurring mineral with various applications in household and personal care products. Its chemical name is sodium tetraborate decahydrate, and it's often used in skincare and cleaning formulations. Borax serves as a pH buffer, ensuring product stability, and its mild antiseptic properties make it beneficial for skin care and hygiene applications. It's commonly found in products like cleansers, shampoos, creams, and bath bombs, where it helps maintain product effectiveness and provides gentle care for the skin.

2.1.4 Neem (*Azardirachtaindica*)
Azadirachta indica,commonly known as neem, margosa Botanical Name–*Azadirachta indica* has attracted worldwide prominence in recent years, owing to its wide range of medicinalproperties. Its taxonomic position is as follows:
Neem oil is a rich source of bioactive compounds, offering numerous health benefits. Its unique blend of ingredients makes it an effective solution for skin issues and a potent insect repellent. Neem oil's diverse properties include antimicrobial, anti-inflammatory, and immune-boosting effects, making it a valuable ingredient in traditional medicine [9, 10].
Neem oil contains fatty acids which build collagen, promote wound healing and maintainthe skin's elasticity. Neem oil has a high content of essential fatty acids. They keep the site moist and give a soft texture to the skin during the healing process.

2.1.5 Cinnamon
Cinnamomum verum, commonly known as Cinnamon, Botanical Name–*Cinnamomum verum, Cinnamomum zeylanicom* has attracted worldwide prominence in recent years, owing to its wide range of medicinal properties. Its taxonomic position is as follows:
Cinnamon contains cinnamaldehyde, eugenol, linalool, and various polyphenols. These compounds exhibit a range of medicinal effects. It is known for its anti-inflammatory, antioxidant, anti-microbial, anti-diabetic, and cardio-protective properties. The essential oils in cinnamon stimulate blood flow and reduce inflammation, supporting tissue repair and healing. Its antioxidant properties protect cells from oxidative stress, while its anti-microbial effects help prevent infections. Cinnamon extracts have been shown to reduce bacterial and fungal growth. Clinical studies have demonstrated that cinnamon can reduce markers of inflammation and improve metabolic health, making it valuable in both traditional and modern medicine [12, 13].

2.2 Methodology
2.2.1 Preparation of Cinnamon and *Azadirachta indica* Leaf Extracts
The leaves of *Azadirachta indica* (Neem) were collected, washed with distilled water and air dried under shade for 24 hours after which it was further dried in the oven at 60°C for 72 hours. The Neem leaves were then ground into a fine powder using a laboratory mill. A 150-gram sample of the powdered leaves was extracted with 1.5 liters of 95% ethanol using a Soxhlet apparatus for a period of 72 hours. Cinnamon bark was cleaned and coarse grinding to enhance surface area. A specific quantity was then immersed in 70% ethanol within a sealed glass container, left at room temperature for 72 hours, and periodically shaken to facilitate extraction. Ethanol extracts bioactive compounds like cinnamaldehyde, eugenol, and phenolics. After maceration, the mixture was filtered to separate the liquid extract. For a concentrated extract, the filtrate was evaporated at low temperature using a rotary evaporator under vacuum at 37 °C, and the residue was oven-dried at 40 °C. The final extract was stored in amber containers under refrigeration.

2.2.2 Formulation of the Herbal Cream using the extracts
In a controlled environment, beeswax and white soft paraffin were combined and heated in a water bath at a temperature of 70 degrees Celsius. Borax was mixed with water and the temperature of the solution was raised to 70 degrees Celsius. The extracts were then dissolved in the borax solution. The aqueous extract mixture, combined with borax, was slowly incorporated into the oil phase under continuous stirring. The mixture was then gently agitated while cooling. This process was uniformly applied to all formulations. Once cooled, the cream was filled into jars, labeled accurately, and stored in a controlled environment at 25 °C. [11].

Table 1: Formulation Table of Herbal Cream

Ingredients	Quantity (%w/w)			
	Formulation Code			
	F1	F2	F3	F4
Neem extract	8	-	8	-
Cinnamon extract	-	5	4	-
White soft paraffin	45	50	52	45
Beeswax	10.67	19.67	17	19.67
Borax	0.85	0.83	2.83	2.83
Water q.s.	29.5	30.5	30.5	30.5

2.2.3 Evaluation Methods of Herbal Cream
a) **Organoleptic Characteristic:** The formulations were inspected visually for their appearance, colour and odour.
b) **Measurement of pH:** The pH was measured using a pH meter, which was calibrated before each use with standard buffer solutions at pH4,7,9. The electrode was inserted into the sample 10 minutes prior to taking the reading at room temperature.
c) **Viscosity:** Viscosity measurements were conducted using a Brookfield Viscometer (DV-I PRIME, USA). The formulations were tested at rotational speeds of 0.3, 0.6, and 1.5 rpm. The viscosity values were calculated by multiplying the dial readings with the corresponding factor specified in the viscometer's catalogue.

d) Spreadability: Spreadability was evaluated by measuring the time taken for two glass slides to slide apart when a gel sample was placed between them under a specified load. The test involved placing an excess amount of gel between the slides, applying a 70g weight to achieve uniform thickness, and recording the time required for the slides to separate. Spreadability was measured using the formula

S=M.L/T Unit – g cm/sec

Where,
M=wt. tied to upper slide,
L = length of glass slides,
T=time taken to separate the slides.

e) Stability: To assess the drug and formulation stability, stability studies were done according to ICH guidelines. The stability studies were carried out as per ICH guidelines. The cream filled in bottle and kept in stability chamber maintained at 40±2°C/75±5%RHforthreemonths. At the end of studies, samples were analyzed for the physical properties, pH and viscosity

f) After feel: The cream's performance was evaluated based on its emolliency, slipperiness, and residue left after application, providing insights into its texture and usability.

g) Irritancy study: Marked an area of 1sq.cm on the left-hand dorsal surface. The cream was applied to the specified area and time was noted. Irritancy, erythema, edema was checked, if any, for regular intervals up to 24hrs and reported.

3. Results and Discussion

3.1 Evaluation of the Formulated Creams

The cream formulation, enriched with Cinnamon and Neem extracts, exhibits promising effectiveness, showcasing the potential benefits of these natural ingredients in skincare applications. The results indicate that the cream containing a balanced combination of Neem and Cinnamon (8:4) or simplified to (4:2) exhibits superior performance compared to creams with individual extracts.

The results of the physical evaluations of the formulated creams showed that all the formulations had a smooth appearance and were uniformly mixed with little lumps or gritty texture. They had an agreeable odour (no pungent or irritating smell). Formulations containing the extracts showed slightly light brown color.

The pH values of the herbal cream formulations were as follows: F1 (9.5), F2 (5), F3 (5.4), and F4 (6.6). These values were assessed to determine the compatibility of the creams with skin pH. A high pH value, indicating alkalinity, may disrupt the skin's natural pH balance, potentially leading to adverse skin reactions such as rashes while a pH value lower than that of the skin would be termed too acidic for the skin. This can also lead to sensitivity problems and hyper reaction. A pH value of 5.5 is the ideal pH for pharmaceutical products for skin application [18]. The formulation with only Cinnamon extract had a pH of 5.0, closer to the skin's natural pH. The high pH value of F1 cream (9.5) is likely due to the Neem extract, as the formulation with only Neem had a similar pH. Adding 0.2% citric acid could help adjust the pH, acting as a preservative and enhancing skin compatibility and stability, but its compatibility with the active ingredients needs confirmation.

The viscosity of the four cream formulations was assessed using a Brookfield Viscometer with Spindle No. 4 at 50 RPM and 25 ± 1°C. The results showed that all formulations had viscosity values within the acceptable range of 22 to 32 cP, indicating suitable consistency and spreadability for topical use. Formulation F1, containing neem extract, showed a viscosity of 24 cP, while F2, formulated with cinnamon extract, displayed a slightly higher viscosity of 28 cP. The combined extract formulation, F3 (neem + cinnamon), exhibited the highest viscosity at 32 cP, which may be attributed to synergistic interactions between the phytoconstituents of both extracts. The base formulation F4, without any active extract, had a viscosity of 22 cP and served as a control. These results confirm that the incorporation of herbal extracts did not negatively affect the physical consistency of the cream and, in some cases, improved the overall viscosity profile, enhancing the cream's stability and applicability.

The assessment of cream spreadability yielded positive results. The formulated cream demonstrated good spreadability when applied topically to the skin. These findings will help future studies. The evaluation of the spreadability of herbal cream formulations F1 – 19.5 g cm/sec, F2 – 20.1 g cm/sec, F3 – 21.5 g cm/sec, and F4 – 20.8 g cm/sec, which produced stable and acceptable outcomes respectively, is a crucial component of product development. This process ends in the evaluation of the formulation's efficacy.

The stability study was carried out on four cream formulations with different herbal compositions. Formulation F1 (neem extract) and F2 (cinnamon extract) both showed good stability over 30 days, with minor changes in pH and viscosity but no phase separation. Their appearance, texture, and spreadability remained consistent, indicating reliable performance. Formulation F3, containing both neem and cinnamon extracts, showed acceptable stability with slight pH reduction and mild darkening, yet no phase separation was observed. Formulation F4, without any extract, showed the highest physical stability with minimal changes, but it lacked the therapeutic benefits of the herbal-based creams.

The skin irritancy potential of the four herbal cream formulations was assessed using the standard patch test method on human volunteers. A small quantity of each cream (approximately 0.5 g) was applied to the inner forearm of selected healthy individuals, and the area was covered with a sterile patch. The formulations were left in contact with the skin for 24 hours, after which the patches were removed and the skin was examined for any signs of irritation, such as redness, itching, inflammation, or rash.

Observations were recorded at 24- and 48-hours post-application. All four formulations — F1 (Neem extract), F2 (Cinnamon extract), F3 (Neem + Cinnamon extract), and F4 (Base cream) — showed no signs of erythema or edema, indicating no adverse skin reactions. Based on the

Table 2: Evaluation Table of Herbal Cream

S. No.	Evaluation Parameter	F1	F2	F3	F4
1	Odour	Characteristic	Characteristic	Characteristic	Characteristic
2	Colour	Light Yellow	Light Brown	Light Brown	White
3	Spreadability	19.5	20.1	21.5	20.8
4	Viscosity (Cp)	24	28	32	22
5	Ph	9.5	5	5.4	6.6
6	Stability	Stable	Stable	Stable	Stable
7	Patch Test	No Sign of Erythma, Edema or Irritation	No Sign of Erythma, Edema or Irritation	No Sign of Erythma, Edema or Irritation	No Sign of Erythmia, Edema or Irritation

Conclusion

The herbal cream was developed with consideration for the key characteristics of herbal pharmaceuticals, ensuring it met the desired standards for efficacy and safety. Prepared formulations did not demonstrate any phase separation and showed good spreadability and consistency during the period of the study. Formulation's stability parameters in regard to its visual appearance, nature, viscosity, and pH denoted that there was no appreciable change towards any of these parameters during the study period. The prepared formulations showed proper pH range that is approximately pH 5.4; hence shows that the formulations were compatible with skin secretions. The study demonstrated the good and desired physical properties of the cream formulations containing the extracts. Neem and cinnamon herbal extracts appear to serve as potential topical agents for various skin conditions and may thus be useful for treating skin disorders caused by other susceptible infectious agents. The study concludes that herbal extract-based creams can effectively serve as skin barriers, with the combination of neem and cinnamon exhibiting synergistic effects that enhance cosmetic properties and skin absorption. The F3 formulation stands out as the most promising due to its superior compatibility and effectiveness, aligning well with the overall evaluation results. Additionally, the herbal cream is enriched with antioxidants and anti-inflammatory properties, making it ideal for soothing irritated skin and promoting overall skin health. Further investigations, however, need to be carried out regarding the bioavailability and stability of the formulations.

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