

## To formulate and evaluate the nature's remedy for clear skin using herbal anti-acne gel of *Azadirachta indica*

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### ABSTRACT

Natural plant-based medications are prized for their efficacy, affordability, and safety. Because of its antibacterial, anti-inflammatory, and restorative qualities, neem (*Azadirachta indica*) is used extensively in traditional medicine. Excess oil, clogged pores, bacteria, and inflammation are the main causes of acne vulgaris. By lowering bacteria and calming the skin, herbal components like neem and marigold aid in the fight against acne. Nimbolide and quercetin, two active ingredients in the anti-acne gel, suppress the Cutibacterium acnes bacteria that causes acne, lessen inflammation, and stop recurrence. To guarantee a smooth texture, good spreadability, hydration, and improved absorption, the formulation also contains propylene glycol, glycerine, and Carbopol 940.

All things considered, neem-based herbal gel is a promising option for managing acne since it is a gentle, safe, and efficient substitute for synthetic acne treatments.

**Keywords:** Antibacterial, Anti-inflammatory, *Azadirachta indica*, Nimbolide, Cutibacterium, Carbopol 940, Spreadability, Propylene Glycol.

## INTRODUCTION

Plant-based products are widely utilized to prevent and treat illnesses due to their pharmacological, antibacterial, and antioxidant properties. They usually have fewer side effects and are less expensive than allopathic drugs. Neem (*Azadirachta indica*), a medicinal plant in the Meliaceae family, is widely used in traditional systems such as Ayurveda, Unani, Homeopathy, and Siddha in countries like Bangladesh, India, Nepal, and Pakistan. Neem contains active ingredients such nimbidin, limonoids, and azadirachtin in addition to phytochemicals like flavonoids, alkaloids, and terpenoids. It is used to treat a variety of conditions, including infections, skin conditions, and digestive issues. It possesses antibacterial, anti-inflammatory, antidiabetic, and immunomodulatory properties. Pilosebaceous follicles, which are typically found on the face, are the source of acne vulgaris. It is brought on by blocked skin follicles and involves four main processes: inflammation, aberrant follicular cell shedding, excessive sebum production, and colonization by *Cutibacterium acnes*. Excess oil production is caused by elevated gland sensitivity or elevated androgen levels. These variables, which are regulated by hormones, cytokines, microbiota, and other local factors, interfere with proper pore function and cause comedones and inflammatory lesions. Acne can be effectively treated using a variety of medicinal plants, including *Rubia cordifolia*, *Aloe barbadensis*, *Camellia sinensis*, *Calendula officinalis*, and *Ocimum basilicum*. Because of their accessibility and potent antibacterial and anti-inflammatory qualities, *Azadirachta indica* (neem) and *Tagetes erecta* (marigold) are among the most utilized. Neem is rich in azadirachtin, nimbin, and nimbidin, whereas marigold has flavonoids and carotenoids that are useful against skin infections. Adolescents frequently suffer from acne vulgaris, a persistent inflammatory illness that frequently leaves scars and causes psychological suffering. Despite their effectiveness, contemporary treatments including hormone therapy, retinoids, and antibiotics can have negative side effects such irritation, resistance, and relapse. A way of managing acne that is safer and more natural is provided by herbal alternatives [1, 2].

## PLANT PROFILE OF *AZADHIRACHTA INDICA*

Native to India, neem (*Azadirachta indica*) is extensively distributed in tropical and subtropical areas and has important therapeutic uses. Alkaloids, flavonoids, triterpenoids, phenolics, carotenoids, steroids, and ketones are only a few of the bioactive substances it contains. Along with other significant components including nimbin, salannin, volatile oils, and meliantriol, azadirachtin (A–G forms), particularly azadirachtin E, is the most active chemical.

**Distribution:** Originally from East India and Burma, this plant is now found in many tropical and subtropical areas, including as Southeast Asia, Africa, and the Americas. It is widely grown and naturalized in many nations, including Pakistan, Sri Lanka, Thailand, Indonesia, and others. It grows naturally in the Siwalik Hills and dry forests of southern states of India up to 700 meters above sea level [3, 4].

### Taxonomical Classification of Neem [5, 6]

Domain	Eukaryota
Kingdom	Plantae (Plants)
Subkingdom	Angiospermae (Flowering Plant)
Division	Mangnoliophyta
Class	Mangnoliopsida
Subclass	Polypetalae
Order	Sapindales
Suborder	Rutinae
Family	Maliaceae
Tribe	Malioideae
Genus	Azadirachta
Species	indica



**Figure no. 1 Neem Plant**

**Morphological Part Used [7]**

Part	Medicinal Use
Leaf	Leprosy, eye problem, intestinal worms, anorexia, Acne, epistaxis, biliousness and skin ulcers.
Bark	Analgesic, alternative and curative of fever.
Flower	Bile suppression, elimination of intestinal and phlegm.
Fruit	Piles, intestinal worms, urinary disorder, epistaxis, phlegm, eye problem, diabetes and leprosy
Twig	Cough, asthma, piles, phantom tumors, intestinal worms, diabetes, spermatorrhoea and obstinate urinary disorder.
Gum	Scabies, wounds, ulcers and skin diseases.
Seed	Leprosy and intestinal worms
Oil	Leprosy and intestinal worms Root, bark, leaf, flower Blood morbidity, biliary afflictions, itching, skin ulcer.

**Table no. 1**

**Microscopic and Organoleptic Characteristics of Neem [8, 9]**

<b>Part</b>	<b>Stem Bark</b>	<b>Leaf</b>	<b>Flower</b>
Colour	Rusty grey (external), yellowish (internal)	Yellowish green	Pale yellow, white
Odour	Characteristics	Indistinct	Honey Scented
Taste	Bitter	Bitter	Bitter
Size	Little bit curved to flat, but it varies as per the age of tree	Length: 7- 8.5cm; Width: 1-1.7cm	Length:5-6cm; Width: 8-11cm
Shape	Rough Surface (external); Foliaceous (internal)	Lanceolate, serrate, acute	Drooping panicles
	<b>Fruit</b>	<b>Seed</b>	<b>Seed oil</b>
Colour	Green (initially); Yellowish brown, Chocolate (mature)	Brown (external), Creamish (internal)	Yellow to brown
Odour	Characteristics	Aromatic/garlic (when crushed)	Garlic
Taste	Sweet to semi-sweet pulp	Bitter	Bitter
Size	Length: 0.5-2cm; Width: 0.5-2cm Thickness: 0.6-0.9cm	Length: 10-15cm; Width: 3-5cm Thickness: 3-4cm	–
Shape	Oval to nearly round shaped	Irregular	–

**Table no. 2**

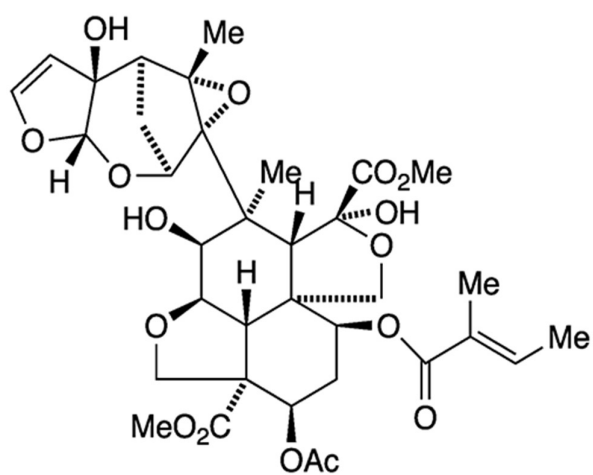
**Phytochemistry of Neem [10, 11, 12, 13]**

Active constituents are present in different part of *Azadirachta indica*.

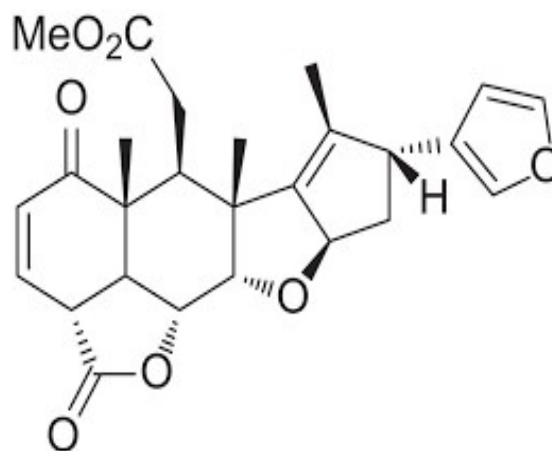
<b>Part/Product</b>	<b>Chemical Present</b>
Leaves	Glucoside of quercetin, Glucoside of kaemferol Quercetin, Quercetin-3-galactoside(Hperin), Rutin, Isorhamnetin, Rhamnoside of quercetin, Quercitin, Nimbolide, Vilasinin, Nimbinene, 6-deacetyl nimbinene, Nimbolide Nimocinol(6 $\alpha$ -hydroxyazadirone), $\beta$ -sitosterol, $\beta$ -sitosterol- $\beta$ -D-glucoside, Neem leaf glycoprotein
Trunk	Sugiol, Nimbiol, Nimbin, Nimbinin, Nimbolin a, Nimbolin b
Bark	Sugiol, Nimbiol, Nimbin, Nimbinin, Deacetylnimbin, Nimbinene, 6-deacetyl nimbinene, Nimbolide, Sugiol, Nimbiol
Flowers	Kaemferol, Quercetin, Myricetin, Melicitrin, Quercetin-3-galactoside (hperin), Kaemferol3- glucoside (astragalin), $\beta$ -sitosterol- $\beta$ -D-glucoside, $\beta$ -sitosterol
Oil	Nimbin, Nimbinin, Nimbidic acid (salannic acid), Salannin, Meliantriol, Azadirone
Fruit	5-hydroxy-methyl furfural, Nomolin, Nimolicin, 17-Hydroxy-azadiradione, 17 $\beta$ -Hydroxyazadiradione, 17-Epi-azadiradione

**Table no. 3**

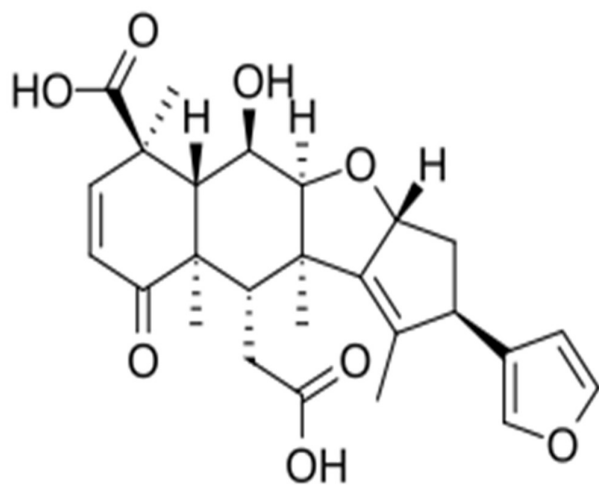
Phytochemical Structures



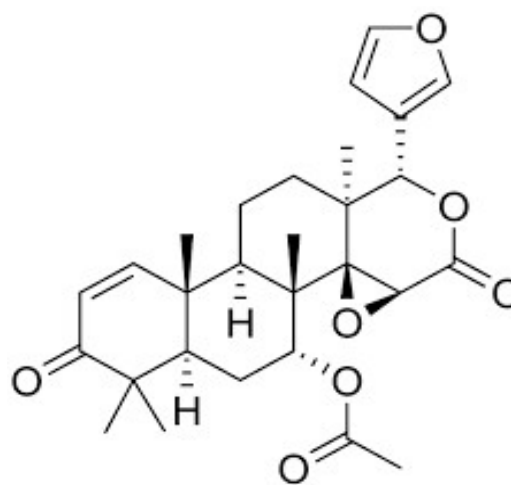
Azadirachtin



Nimbolide



Nimbin



Gedunin

## PROCEDURE

### Extraction Process of *Azadirachta indica* (Neem) Leave)

1. Fresh leaves of Neem (*A. indica*) collected.
2. Leaves of neem is cleaned with the help of distilled water to remove the foreign material or dust particle from the leaves.
3. Allow to dry the leaves under the shade.
4. After completely drying the leaves were coarsely grinded.
5. Take 25g of powdered neem and add 250ml of 95% ethanol for 3-4 days.
6. The mixture is stirred with the help of sterile glass rod after every 12hr.
7. The mixture is filtered with the help of muslin cloth.
8. By the help of water bath, the solvent was removed under reduce pressure at a temperature of less than 50 °C.
9. After removal of the solvent it leaving a dark green residue.
10. Then the residue is stored in air tight container for the preparation of gel [14, 15, 16].

## PROCEDURE FOR THE SCREENING OF PHYTOCHEMICAL

### ➤ Mayer's Test

Dissolve sample in a little 2% HCL, then add 1-2 drops of mayer's reagent.

**Observe:** White/ Cream precipitate – Alkaloid present

No precipitate – Negative

### ➤ Wagner's Test

Dissolve sample in 2% HCL, take 1 ml of this solution, add 1-2 drops of wagner's reagent (iodine + potassium).

**Observe:** Reddish brown precipitate – Alkaloid present

No precipitate – Negative

### ➤ Lead Acetate Test

Take 1 ml sample (aqueous or hydro-alcoholic), add 2-3 drops of 10% lead acetate solution, then mix gently.

**Observe:** White or yellowish precipitate – positive

No precipitate – Negative

➤ **Salkowski Test**

Dissolve the sample in 2 mL chloroform, carefully add 2 mL concentrated H<sub>2</sub>SO<sub>4</sub> down the side of the test tube, allow to stand without shaking.

**Observe:** Reddish-brown or golden – yellow ring- positive

If not – Negative

➤ **Liebermann-Burchard Test**

Add 1 mL acetic anhydride to the extract, add 1–2 drops of concentrated H<sub>2</sub>SO<sub>4</sub> slowly, Observe color change.

**Observe:** Blue-green to deep green – positive

If not – Negative

➤ **Ferric Chloride Test**

Take 2 mL of the test extract, add 2–3 drops of 5% ferric chloride (FeCl<sub>3</sub>) solution, Mix gently and observe color change.

**Observe:** Blue, green, purple and black coloration – positive

If not – Negative

➤ **Benedict Test**

Take 2 mL of the extract, add 2 mL Benedict's reagent, heat the mixture in a boiling water bath for 2–5 minutes, observe any color change or precipitate.

**Observe:** Green, orange, brick-red precipitate – Positive

If not – Negative

➤ **Molisch Test**

Take 2 mL of the test extract, add 2–3 drops of Molisch reagent (α-naphthol in ethanol), carefully add 2 mL concentrated sulfuric acid down the side of the test tube to form two layers, observe the interface.

**Observe:** violet–purple ring at the interface – Positive

If not – Negative

## FORMULATION OF HERBAL GEL

### Procedure for the formulation of herbal anti-acne gel

1. Take distilled water and added to the carbopol 940.
2. Then mixed it in very high speed to obtain a uniform dispersion.
3. This dispersion was then neutralized by the gradual addition of 10% sodium hydroxide with continuous stirring until gel formation occurred.
4. The extract was incorporated into the gel using a water bath and mixed thoroughly to ensure uniform distribution.
5. Separately, methyl paraben was dissolved in propylene glycol and added to the gel with proper mixing.
6. The remaining quantity of purified water was added to make up the final volume, and the pH was adjusted dropwise with 10% sodium hydroxide.
7. Prepared formulations were filled in a suitable container and labelled accordingly [17, 18, 19, 20].

S. No.	Ingredients	Function	Quantity(%w/w)
1.	Azadirachta Indica extract	Anti- inflammatory, anti – malarial, anti- fungal, anti-bacterial, anti- oxidant, anti- viral	5g
2.	Carbopol 940 1%	Gelling agent, providing excellent viscosity control for a non-greasy, smooth, clear texture.	1g
3.	Propylene Glycol 5%	Act as humectant to hydrate skin without oiliness, non-comedogenic, fight dryness, improve texture for clearer, smoother, acne-prone complexions.	5ml
4.	Methyl paraben 0.2%		0.2g

		Inhibit microbial growth, extend the product's shelf life, ensure its safety and stability over time.	
5.	Glycerine	Act as humectant & moisturizer, non- comedogenic, skin barrier support, soothing & healing, gentle exfoliation.	7.5ml
6.	Sodium hydroxide 10%	Acts as pH adjustment, ensure product stability and efficacy.	q.s.n.
7.	Distilled water	Volume enhancer, high purity and consistency.	q.s.p.

**Table no. 3 Formulation table**

## CONCLUSION

When applied as a topical gel, neem (*Azadirachta indica*), a popular medicinal tree, has great potential for treating acne. Its therapeutic, antibacterial, and anti-inflammatory qualities aid in reducing acne lesions, regulating microbial growth, and relieving irritated skin. Herbal formulations, such as neem-based gels, are becoming increasingly popular as people choose natural medicines since they are seen to be safer and have fewer adverse effects. According to the study, neem leaf extract gel may be a safe, efficient, and easy-to-use substitute for traditional synthetic acne treatments.

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