

FORMULATION AND EVALUATION OF ANTI DANDRUFF HAIR GEL

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ABSTRACT

Itching, flaking and irritation of the scalp are the hallmarks of dandruff, a common scalp condition. Microbial imbalance, fungal infection, and other environmental factors are the primary causes. The creation and assessment of a topical anti-dandruff gel with avocado oil and ketoconazole are the main objectives of this study. While avocado oil aids in hydrating and calming the scalp, the function of ketoconazole is an antifungal agent and inhibits the growth of *Malassezia* species. Carbopol was used as a gelling agent in conjunction with other excipients to create the gel. To guarantee the gel's efficacy and safety in treating dandruff, its physical characteristics, pH, viscosity, spreadability, and stability were assessed. The evaluation results showed that F2 formulation was optimal with pH 6.8, white to off white colour, with 0.918 density and highest viscosity (6800cP), indicating better solubility, consistency, and overall acceptability compared to F1 and F3.

KEYWORDS: Soothes itchy scalp, Reduces irritation, Balances scalp microbiota, Oil control, Non-greasy, Non-sticky.

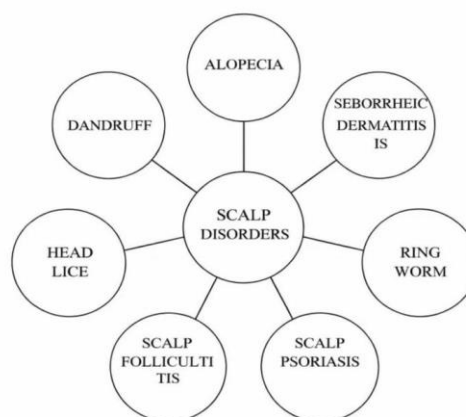
INTRODUCTION

Among human skin sections, the scalp is distinct. Its skin layer is thick, contains many sebaceous glands, and has a high follicular density. A hair pH is 3.67 but scalp pH is 5.5. Together with the warm, dark environment of the scalp, the presence of these glands increases the risk of parasitic disorders like *Pediculus capitis* and mycotic infections such as Seborrheic dermatitis and dandruff. Anomalies of the scalp are very important in society even when they do not result in severe physical illness or morbidity. The psychological impact of hair and scalp diseases on human civilizations is higher.^[1] Greying and other minor hair changes can have an effect on a person's confidence and sense of self. *Pediculus capitis* and *tinea capitis* are two instances of scalp conditions brought on by bacterial and fungal invasion. There are several kinds of scalp problems, some of which are common and some of which are rare.

Among these are

- Alopecia is the loss of hair.
- Scaly, flaky, and itchy skin are symptoms of dermatitis seborrheic, an inflammation of the scalp.
- Scalp folliculitis is an inflammation of the hair follicles on the scalp.

- The shedding of dead skin cells causes dandruff.
- Some conditions may be idiopathic, while others have a known cause. Personal hygiene depends on the treatment of these illnesses.^[2]



Classification of scalp disorders^[3]

Dandruff: The Anglo-Saxon word "dandruff" is a compound of "tan," which means "tetter," and "doff," which means "dirty." "Thus, dandruff is 'itch-dirt'."

Furfuraceous, capitis, and pityriasis simplex are other names for this condition. Regardless of gender or race, dandruff is confined to the scalp and affects approximately 50% of postpubescents. From a medical perspective, this scalp issue could seem minor. It may, however, constitute a persistent aesthetic disturbance that is frequently the source of pruritus. Given that it frequently gets worse in the winter, Dandruff sufferers may see seasonal changes in their condition.^[4]

Definition: A common scalp condition, dandruff manifests as itchy and flaky white to yellowish scales. It is brought on by corneocytes, which have a strong capacity for cohesiveness and form clusters. Since sebaceous glands are at their most active at this time, dandruff has been found to mostly occur between adolescence and middle age.^[5]

Dandruff signs and symptoms

- The fragments' presence
- Scalp itching
- Scalp redness.
- severe scalp itching
- Scaling and reddening of skin patches.^[6]

The reasons might be categorized as

a) microbial

b) non-microbial

Microbial factors:

a) fungal infection

The most prevalent cause of dandruff is *Malassezia furfur*. Dandruff can be brought on by the fungus *Malassezia* in one of two ways.

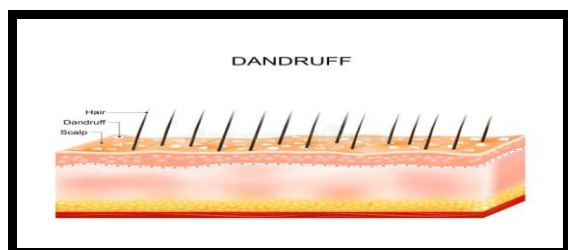


Diagram of dandruff

b) Bacterial infection

Unbalanced ratios of *Propionibacterium acnes* and *Staphylococcus epidermidis* the two important bacterial scalp may be the cause of dandruff. In these investigations, dandruff scalps were linked to a higher prevalence of *Staphylococcus* species. Furthermore, Dandruff exhibited a higher ratio of *Malassezia* to *Propionibacterium* and *Propionibacterium* to *Staphylococcus* than healthy controls, indicating an imbalance in the bacterial and fungal communities.^[8]

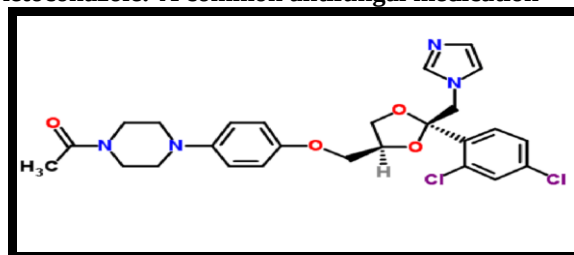
Non-microbial factors

The non-microbial cause of dandruff is well understood. The use of certain cosmetic products, frequent combing, excessive shampooing, dust, and debris can all lead to

dandruff, while excessive sun exposure has been connected to scalp desquamation.

- damage to the scalp Corneum stratum
- Lipids and Dandruff
- dry scalp.
- Oily or irritated skin
- Dandruff rating
- Hair and dandruff
- Other scalp conditions include psoriasis, eczema.^[9]

Ketoconazole:-A common antifungal medication



Structure of ketoconazole^[17]

There are various kinds of fungal infections that ketoconazole is used for. Fungal skin illnesses such as cutaneous candidiasis, tinea, pityriasis versicolor, seborrheic dermatitis, and dandruff are treated topically with it. Topical ketoconazole is also used to treat dandruff, a kind of seborrheic dermatitis itself. In other parts of the body, possibly via lowering skin-levels of the fungus *Malassezia furfur*. The mostpopular antifungal drug is ketoconazole. With doses ranging from 0.25 to 2%, it is frequently used in shampoos to treat fungal infections.^[11]

Anti-fungle activity of ketoconazole

A broad-spectrum antifungal medication called ketoconazole is used to treat fungal infections brought on by yeasts and dermatophytes like *Candida* and *Malassezia*. By preventing the synthesis of ergosterol, a crucial part of the fungal cell membrane, it exhibits potent antifungal activity. The lack of ergosterol weakens and damages the fungal cell membrane, causing cellular contents to leak out and the fungal cells to die. For the treatment of fungal skin infections, seborrheic dermatitis, and dandruff, ketoconazole is frequently found in anti-dandruff shampoos, creams, and hair gels.

b) Zinc pyrithione: The most popular antifungal drug is used to treat dandruff in a variety of formulations. Seborrheic dermatitis and dandruff can both be successfully treated with zinc pyrithione. It is antimicrobial. Other medicinal uses include treating psoriasis, eczema, fungus, and dry skin. For antifungal properties, shampoos often include 0.5–2% ZPT.^[12]

c) Climbazole: This antifungal drug, which is relatively new, is frequently used either alone or in combination. Human fungal skin infections are treated with climbazole, a topical antifungal medication, including eczema, seborrheic dermatitis, and dandruff. These seem to be essential for dandruff development.

d) Clotrimazole: Clotrimazole has broad action against the majority of Trichophyton, Epidermophyton, and Microspore strains in vitro. Regarding tinea versicolor, tinea pedis, tinea corporis, tinea cruris, and cutaneous candidiasis, clotrimazole is a great treatment. Formulations typically contain 1% concentration.^[13]

Treatment of the symptoms

a) Salicylic acid: This keratinolytic drug gets rid of hyperkeratotic, scaly skin. Cell-to-cell attachment in corneocytes is inhibited. In anti-dandruff products, this ingredient is frequently used. Salicylic acid is frequently found in shampoos at concentrations of 1.5–6% due to its keratolytic qualities.^[14]

b) Selenium sulfide: By inhibiting Malassezia, selenium sulfide may reduce dandruff instead of having an anti-proliferative effect. However, it does have an impact on cell turnover. On follicular and epidermal cells, it has cytostatic and anti-seborrheic actions. Selenium sulfide, which has antifungal qualities, is commonly found in shampoos at concentrations of 1–2.5%.^[15]

Formulations: The drugs on the above list can be used in a number of formulations, such as lotions, shampoos, gels, creams, and applications.

Shampoos: These formulas are used to remove oily residues from prior hair care products, sweat, sebum, desquamated corneocytes, and other environmental contaminants from the scalp.

• Gel

Advantages of topical gel

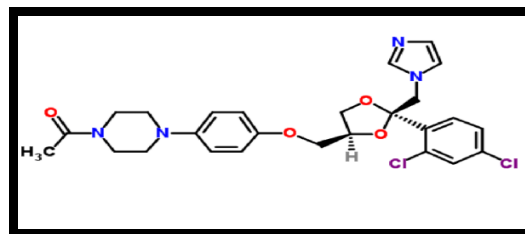
- Avoiding first-pass metabolism.
- Economical and easy to use.
- Increased pharmacological and pharmacological reactions.
- Improve patient compliance.



Topical gel

Disadvantages of Topical gel

- Certain drugs do not travel through the skin very well.
- The likelihood of allergic reactions.
- It is only appropriate to receive drugs whose effects necessitate extremely low
- Certain skin locations where parental control is less effective may be treated with it.^[16]



DRUG AND EXCIPIENT PROFILE

Ketoconazole

IUPAC name

-cis-1-acetyl-4-[4-[[2-(2,4-dichlorophenyl)-2-(1H-imidazol-1-ylmethyl)-1,3-dioxolan-4-yl] [phenyl] methoxy] Piperazine.

Category: antifungal

Solubility: soluble in ethanol, very slightly soluble in ether, and moderately soluble in water.

Structure of ketoconazole^[17]

Application in pharmaceutical formulation: An antifungal medication called ketoconazole is used to treat fungal and yeast infections. It is available orally and topically.

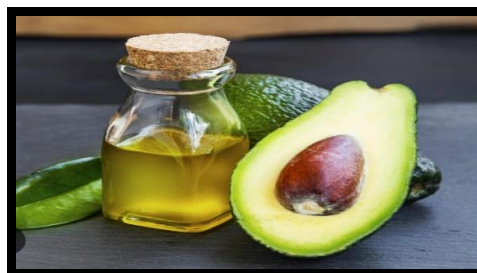
Avocado oil

Biological name: Persea americana.

Genus: Persea Mill

Family: Laureace

Category: anti-dandruff or anti-fungal

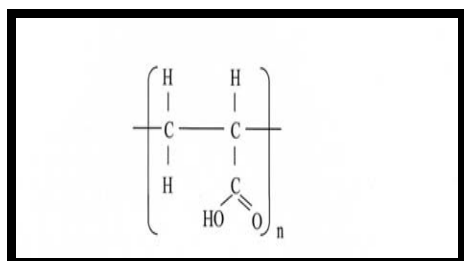


Mechanisms of avocado oil

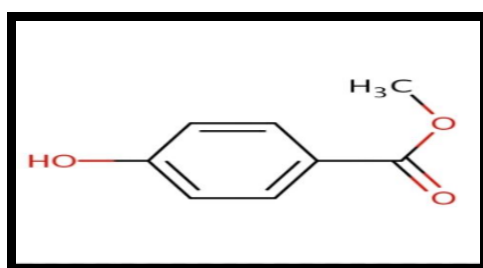
Avocado oil^[18]

Avocado oil in hair gel works by moisturizing and nourishing the scalp and hair due to the presence of essential fatty acids, vitamins A, D, and E. It helps improve hair smoothness, reduces dryness and frizz, strengthens hair roots, and protects the scalp from damage through its antioxidant and anti-inflammatory properties.

Uses. Prevents hair loss, restores damaged hair, prevent premature gray hair, reduce inflammation on the scalp, and combat dandruff.



EXCIPIENT PROFILE

Carbopol 934**Common Name:** Carbomer**Synonyms:** Polyacrylic acid polymer, carboxy-vinyl polymer, carboxy polyethylene, and Carbopol.**IUPAC NAME:** 2-Propenoic acidStructure of carbopol^[19]**Solubility and Stability**

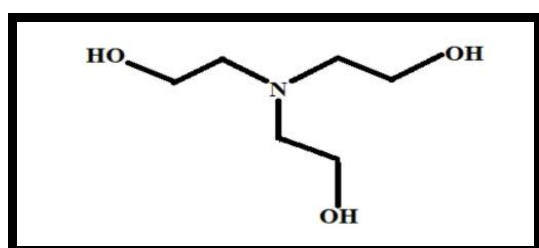
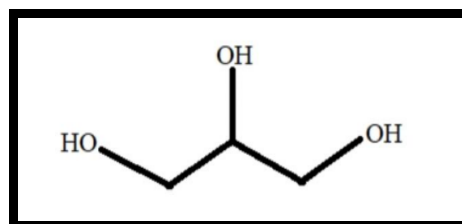
Carbomers are stable, hygroscopic substances that do not lose their effectiveness when heated to temperatures below 140°C for up to two hours. Conversely, excessive heat can cause discoloration and decreased durability. Glycerol, ethanol, and water all dissolve it.

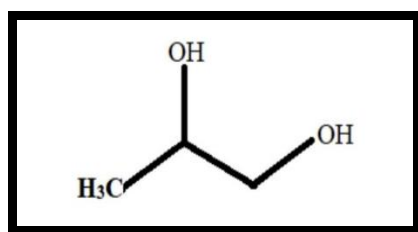
Application

Carbomers are commonly used as stabilizing or viscosity-increasing agents in liquid or semisolid pharmaceutical compositions. Topical, rectal, and ocular therapies can be accomplished with creams, gels, and ointments.

Methyl Paraben**Common Names**

Methyl-Para-hydroxybenzoate, Methylparaben, Methyl hydroxybenzoate,

Synonym:-E218; methyl ester of 4-hydroxybenzoic acid.**Molecular formula:** C₈H₈O₃.**Weight in molecules:**-152.15 g/mol**Category of function:**-antimicrobial preservative.Structure of methyl Paraben^[20]**Point of melting:**-125–128 °C**solubility:**-Almost insoluble in mineral oil, 1 in 60 glycerin, 1 in 2 ethanol, and 1 in 5 propylene glycols.Structure of glycerine^[21]**Glycerine****Trade names and synonyms:**-Trihydroxy propane, 1,2,3-propanetriol, glycerol, glycol alcohol, and anhydrous glycerin.**Chemical formula:** -C₃H₈O₃**Functional Category:**- wetting agent**Application in Pharmaceutical formulation:**-It functions As a solvent, emollient, medicinal, and sweetening agent.**Polyethylene Glycol****Description:** polyethylene glycol is viscous, colorless, and nearly odorless. It has an unpleasant taste very similar to that of glycerin.**Synonym:**- Carbowax, Macrogol**Chemical Name /IUPAC Name:**-poly(oxyethylene).**Chemical formula:**- C₂nH₄n+2O_n+1structure of polyethylene glycol^[22]**Molecular Weight:**-76.09g/mol**Density:**-1.038g/cm³ at 200°C**Melting point:**--59°C**Boiling point:**- 188°C**Viscosity** :-viscosity at 20°C, 58.1 mpas**Solubility:**- Glycerin, ethanol (95%), acetone, and chloroform, and moisture all react with the chemical. Some essential oils will dissolve in ether; however, it is incompatible with light mineral oil and fixed oil compounds. Ether is soluble at a 1:6 ratio.**Triethanolamine****Common Name:** -Triethanolamine, Trolamine, Trolamine.**Synonyms:**- Tealan, TEA, tris(hydroxyethyl)amine, trihydroxy triethylamine, and triethyl olamine.**Empirical Formula:**- C₆H₁₅NO₃.**Weight in molecules:**-149.19 g/mol.**Functional Category:**- Emulsifying agent; alkalizing agent.

Structure Of Triethanolamine^[23]

PH-10.5.

The boiling point is 335 °C.

Use in the formulation of pharmaceuticals

Triethanolamine is frequently utilized in the creation of topical medication formulations, especially emulsions. Additionally, triethanolamine is utilized to make injectable solutions and salts for topical analgesics. It is also used in sunscreen compositions.

• MATERIALS AND METHODS

Selection of drug and excipient: Excipients, chemicals or reagents, drug, and the tools utilized for the experiment are mentioned below.

Material: The drugs and substances utilized in this experiment are listed in the table below. Analytical-grade substances and medications were acquired via purchase or gift sample.

Table 1.1: list of drug and Excipients.

Sr.no	Name of Ingredient	ROLE
1.	Ketoconazole	Anti-fungal action
2.	Avocado oil	Reduces itching and irritation Moisturizes the scalp
3.	Propylene glycol	Humectant, solvent
4.	Methyl paraben	Preservative
5.	Carbopol	Gelling agent
6.	Triethanolamine	Neutralizing agent
7.	Distilled water	Solvent

Method:- Studies on Preformulation

In order to identify the medicine, Preformulation experiments were conducted using tests for physical appearance, melting point, partition coefficient, solubility profile, and qualitative evaluation.

Preformulation study of drug

a) Organoleptic characteristics

A small amount of drug is placed in an easily visible vial and inspected in a well-lit environment. Its nature, color, and consistency were examined.

b) Odour:- a barely detectable amount of drug was utilized to smell for scent.

c) Melting point: The point at which something melts a capillary tube that has been sealed at one end is filled with enough dry powder to create a 2.5 -- 3.5 mm column in the tube's bottom. The powder is then moderately tapped on a solid surface to pack it down as tightly

as possible. The normal operating procedure is followed when using the equipment.

d) Solubility: The drug's solubility was tested by using several solvents.

Formulation of topical gel containing ketoconazole and avocado oil

Glycerin, polyethylene glycol, and a determined amount of methylparabens were quickly dissolved in water on a beaker using a mechanical stirrer. The Carbopol940 was then gently poured to the beaker containing the liquid above while being stirred. In a separate beaker, the ketoconazole medicine was dissolved in water and mixed with the aforementioned solution. To neutralize the solution, triethanolamine solution was added gradually while being stirred continuously until the gel formed.

Next, a predetermined quantity of avocado oil was applied.

Table 1.2: formulation of topical gel.

Ingredients	F1	F2	F3
Ketoconazole	1gm	1gm	1gm
Avocado oil	0.5ml	1ml	1.5ml
Carbopol	0.5gm	1gm	1.5gm
Polythene glycol	5ml	5ml	5ml
Glycerine	5ml	5ml	5ml
Methyl paraben	0.15mg	0.15mg	0.15mg
Triethanolamine	5ml	5ml	5ml
Water	qs	qs	qs
Total weight	15gm	15gm	15gm

Evaluation of topical gel formulation

Examined were the created topical gel's physical characteristics, including color, appearance, pH, viscosity, and Spreadability. In addition, its stability and in vivo skin irritation were investigated.

a) physical characteristics: The prepared topical gel's color, and odor were assessed optically.^[24]

b) Washability: The effectiveness of water washing was evaluated physically after compositions were applied to the skin's surface.^[25]

c) Spreadability: The amount that a gel spreads when applied to the skin or other affected region is referred to as Spreadability.^[26]

d) Clarity: After thorough scrutiny against a black and white backdrop, all of the recently created gel formulations were found to be free of scattered particle matter. Regardless of where it was discovered, the formulation's clarity is visually tested against a clear background.^[27]

e) Homogeneity: To make sure they were all uniform, the gels were visually examined after they had set in the container. Aggregates and their appearance were inspected.^[28]

f) measurement of ph:- The pH of several formulations was measured using a digital pH meter. A gram of gel was immersed in 100 milliliters of distilled water for two hours. The pH of each mixture was determined three times.^[29]

g) viscosity of determination: The viscosity of the produced gels at room temperature was measured using a Brookfield viscometer with spindle number six. The spindle was turned at different rpms while measurements were being made in order to examine the effect of shearing force on viscosity.^[30]

● RESULT AND DISCUSSION SELECTION OF EXCIPIENTS

Carbopol, a polymer, is an excellent film gelling agent since It dissolves instantly in alcohol and water. The

plasticizer used is polyethylene glycol. Gels are a non-greasy, cost-effective, and patient-friendly dosing form.

Pre-formulation studies

Drug's Organoleptic properties

The look of drug and colour, Odour organoleptic characteristics was examined, as indicated in table 7.1. Characterization of drugs.

Table 1.3: characteristics of gel.

Properties	F1	F2	F3
Colour	White	Turbid White	Milky White
Odour	Characteristics	Mild Pleasant	Pleasant odour
Apperance	Smooth and homogeneous gel	Clear smooth gel	Homogeneous glossy gel
Texture	Non-gritty	smooth	soft

Table 1.4: Characterization of avocado oil.

Sr.no	Properties	Observation
1	Colour	Green to greenish yellow
2	Odour	Characteristics
3	Apperance	Liquid
4	Texture	Smooth,soft

Melting Point

The melting Point was determined by using capillary method.

The melting Point is-149°C, and practical yield 148 to 152°C.

Solubility:-Solubility of given components.

Table 1.5: soluble For Ketoconazole.

Solvent	Solubility
Dichloromethane	Freely soluble
Chloroform and methanol	Solible
Ethanol 95 %	Springly soluble
Water	Partially soluble

Table 1.6 Measurement Of PH.

PH	F1	F2	F3
1	6.1	6.8	7.0

Table 1.7 viscosity.

Readings	Sample	Viscosity	Temprature
Batch 1	Avocado oil	6900cP	25°C
Batch 2	Avocado oil	6800cP	24°C
Batch 3	Avocado oil	6600cP	25°C
Average	Avocado oil	6800cP	25°C

REFERENCE

1. Dias MF, Loures AF, Ekelem C. Hair cosmetics for the hair loss patient. Indian Journal of Plastic Surgery, 2021 Dec 27: 507-13.
2. Narshana M, Ravikumar P. An overview of dandruff and novel formulations as a treatment strategy. Int J Pharm Sci Res, 2018 Feb 1; 9(2): 417-31.

3. Gupta AK, Foley KA. Management of scalp disorders. J Cutan Med Surg, 2015; 19(3): 221-234.
4. Ranganathan S, Mukhopadhyay T. Dandruff: the most commercially exploited skin disease. Indian journal of dermatology, 2010 Apr 1; 55(2): 130-4.
5. Rudramurthy SM, Honnavar P, Dogra S, Yegneswaran PP, Handa S, Chakrabarti A. Association of Malassezia species with dandruff. Indian Journal of Medical Research. 2014 Mar 1; 139(3): 431-7
6. Xu Z, Wang Z, Yuan C, Liu X, Yang F, Wang T, Wang J, Manabe K, Qin O, Wang X, Zhang Y. Dandruff is associated with the conjoined interactions between host and microorganisms. Scientific reports, 2016 May 12; 6(1): 24877. <https://www.dreamstime.com/illustration/human-scalp.html>
7. Murphrey MB, Miao JH, Zito PM. Histology, Stratum Corneum, 2022 Nov 14.
8. Piérard-Franchimont C, Xhaufaire-Uhoda E, Piérard GE. Revisiting dandruff.
9. International journal of cosmetic science, 2006 Oct; 28(5): 311-8.
10. <https://share.google/HS8bxg8c5xFvBp2mS>
11. Richter E, Wick A, Ternes TA, Coors A. Ecotoxicity of climbazole, a fungicide contained in antidandruff shampoo. Environmental toxicology and chemistry, 2013 Dec; 32(12): 2816-25.
12. Shiva Sirohi and Mohd. Mujahid. Formulation, evaluation and characterization of climbazole gel for the treatment of fungal infection. Int. J. Pharm. Pharm. Sci, 2023; 5(2): 20-31.
13. Johnson ES, Chang DW, Schwartz JR, Blume-Peytavi U, Henry JP, Caterino TL, Talley AL. Enhanced piroctone olamine retention from shampoo for superior anti-dandruff efficacy. International Journal of Cosmetic Science, 2023 Apr; 45(2): 236-45.

14. Supe S, Takudage P. Methods for evaluating penetration of drug into the skin: A review, 2021; (November 2019): 299–308. 23.
15. do Couto FM, do Nascimento SC, Júnior SF, da Silva VK, Leal AF, Neves RP. Antifungal activity of the piroctone olamine in experimental intra-abdominal candidiasis. Springer plus, 2016 Dec; 5: 1-4.
16. Mamgain R.K., 2000, Acne Vulgaris and its Treatment by Indigenous Drugs SK-34(Purim) and SK-235 (Clarina), The Antiseptic, (97), 3, 76-78.
17. <https://share.google/HS8bxg8c5xFvBp2mS>
18. <https://share.google/Js5XGV84pyl0qj2FB>
19. <https://share.google/aPLlFqniX6iBhgrZq>
20. <https://share.google/SrRCicYNov22nhllE>
21. <https://share.google/obGVMhfsid5iWRzeY>
22. <https://share.google/1L5X7yz1j00irWR9j>
23. <https://share.google/NffYeUiKSpzhLapVz>
24. Indian Pharmacopoeia Commission. Indian Pharmacopoeia. Ghaziabad: IPC, 2018; Vol. I: 182–184. - Physical characteristics
25. Lachman L, Lieberman HA, Kanig JL. The Theory and Practice of Industrial Pharmacy. 3rd ed. Mumbai: Varghese Publishing House, 2009; 534–536. – washability
26. Evaluation of gels (spreadability test). The Pharmapedia, 2025. Available from: <https://thepharmapedia.com> – spreadability <https://thepharmapedia.com>
27. Singh S, Singh R, Kumar M. Formulation and evaluation of topical gel: a review. J Pharm Res, 2010; 3(2): 349–353.
28. Kaur LP, Guleri TK. Topical gel: a recent approach for novel drug delivery. Asian J Biomed Pharm Sci, 2013; 3(17): 1–5.
29. Aulton ME, Taylor KMG. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. 5th ed. Edinburgh: Elsevier, 2018; 447–449.
30. Sinko PJ. Martin's Physical Pharmacy and Pharmaceutical Sciences. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2011; 480–485.