

**FORMULATION AND EVALUATION OF ACETONE FREE
NAILPOLISH REMOVING WIPES CONTAINING ETHYL ACETATE
AND SELECTED NATURAL SKIN CONDITIONING AGENT****Shilpa Shyam^{*1}, Fathimathul Hasna², Kadheeja Arif², Kadeejathul Kubra²,
Fathimath Jaseera P. M.²**

¹Associate professor, Department of Pharmaceutics, Malik Deenar College of Pharmacy
Seethangoli, Kasaragod Kerala India.

²Student, Department of Pharmaceutics, Malik Deenar College of Pharmacy Seethangoli,
Kasaragod Kerala India.

Article Received: 25 August 2026, Article Revised: 15 September 2026, Published on: 05 October 2026

***Corresponding Author: Shilpa Shyam**

Associate professor, Department of Pharmaceutics, Malik Deenar College of Pharmacy Seethangoli, Kasaragod Kerala
India.

Doi: <https://doi-doi.org/101555/ijrpa.3340>

ABSTRACT

Nail polish removers are cosmetic preparations used to remove nail polish from the nail plate by dissolving or redissolving the film-forming components of nail polish. Acetone is one of the most commonly used nail-polish-removing solvents; however, frequent use may contribute to nail dryness and irritation. Acetone-free removers containing solvents such as ethyl acetate have therefore gained attention as alternative formulations. Ethyl acetate is an effective organic solvent used in nail polish and nail-polish-remover preparations. Aloe vera is a natural cosmetic ingredient associated with moisturizing and skin-conditioning properties. Vitamin E is a lipid-soluble antioxidant widely used in cosmetic formulations. Orange oil provides a pleasant citrus aroma and contains volatile terpenes, particularly limonene. Caprylic/capric triglycerides are lightweight emollient ingredients used in cosmetics for skin conditioning and emolliency. The proposed nail-polish-removing wipe combines ethyl acetate as the principal solvent with aloe vera, vitamin E, orange oil and caprylic/capric triglycerides as conditioning and sensory ingredients. The formulation is intended to provide convenient nail-polish removal while reducing the dry feel associated with solvent exposure. However, because aloe vera gel is generally water-containing while ethyl acetate and the lipid ingredients belong predominantly to organic/oil phases,

compatibility, phase stability, solvent evaporation, preservative requirements and wipe saturation must be evaluated carefully. Therefore, the proposed formulation represents a suitable basis for laboratory development and evaluation of acetone-free nail-polish-removing wipes.

KEYWORDS: Nail polish remover, Ethyl acetate, Aloe vera, Vitamin E, Orange oil, Caprylic/capric triglyceride, Acetone-free, Nail wipes.

INTRODUCTION

Nail cosmetics are widely used for improving the appearance of the fingernails and toenails. Nail polish consists of film-forming polymers, resins, plasticizers, solvents and pigments that produce a continuous colored film over the nail plate. Nail polish removers are preparations designed to remove this film by redissolving the resin and other components deposited on the nail plate. Acetone is traditionally the most widely used solvent for this purpose. However, repeated exposure to nail-polish removers may contribute to dryness of the nail and surrounding skin. Acetone-free preparations commonly use solvents such as ethyl acetate, butyl acetate or ethyl lactate.^[1-3]

The development of convenient nail-polish-removing wipes provides an alternative to conventional liquid removers applied using cotton or tissue. A pre-saturated wipe allows the required quantity of remover to be delivered directly to the nail surface and reduces the need for a separate cotton pad. Nail-polish removal pads and wipes are therefore attractive because of their portability, ease of application and reduced handling.

Ethyl acetate is an important solvent used in nail-polish and nail-polish-remover preparations. The Cosmetic Ingredient Review safety assessment reported its use in nail polish, nail-polish removers, basecoats and other manicuring preparations.^[4]

Although solvent efficiency is the primary requirement of a nail-polish remover, the surrounding skin and cuticle may experience dryness after repeated exposure to solvents. The incorporation of conditioning ingredients may therefore improve the sensory and cosmetic properties of the product. Aloe vera, vitamin E and caprylic/capric triglycerides can provide moisturizing or emollient functions, while orange oil can provide a pleasant citrus aroma.

Aloe vera is frequently used in cosmetic preparations and has been investigated for its moisturizing and skin-conditioning effects. Vitamin E is a lipid-soluble antioxidant extensively used in cosmetic and dermatological preparations. Caprylic/capric triglycerides are used as skin-conditioning agents and emollients in cosmetic formulations.^[5-8]

The present review discusses the scientific basis and formulation considerations for developing nail-polish-removing wipes containing **ethyl acetate, aloe vera gel, vitamin E, orange oil and caprylic/capric triglycerides**.

REVIEW OF LITERATURE

1. **Madnani and Khan (2012)** reviewed nail cosmetics and described different types of nail-polish removers. Acetone-free removers may contain ethyl acetate, butyl acetate or ethyl lactate. The authors also discussed the drying effects associated with nail-polish removers and the use of fatty materials as conditioning ingredients. ^[1]
2. **Dinani and George (2019)** reviewed nail cosmetics from a dermatological perspective and discussed the benefits and complications associated with nail cosmetic procedures. The review emphasized the importance of recognizing irritation, allergic reactions and other nail-related complications associated with cosmetic use. ^[2]
3. **Tyagi and Singal (2024)** described nail-polish removal as a process involving redissolution of the resin deposited on the nail plate. The authors noted that acetone-free removers may contain ethyl acetate and butyl acetate, while fatty materials may act as occlusive moisturizers. ^[3]
4. **Elder and Cosmetic Ingredient Review Expert Panel (1989)** evaluated the safety of ethyl acetate and butyl acetate in cosmetic applications. Ethyl acetate was reported to be used in nail polish, nail-polish removers and manicuring preparations and was concluded to be safe under the assessed cosmetic conditions of use. ^[4]
5. **Dal'Belo et al. (2006)** investigated cosmetic formulations containing Aloe vera extract and found improvements in stratum-corneum hydration with formulations containing the extract. The findings support the use of Aloe vera as a moisturizing ingredient in cosmetic formulations. ^[5]
6. **Surjushe et al. (2008)** reviewed Aloe vera and its applications in cosmetology and dermatology. Aloe vera contains several biologically active constituents and is widely used in cosmetic preparations. ^[6]
7. **Thiele et al. (2005)** reviewed the use of vitamin E in cosmetic and clinical dermatology. Vitamin E is a lipophilic antioxidant and has been incorporated into numerous cosmetic and skincare formulations. ^[7]
8. **Fiume et al. (2022)** reviewed the safety of triglycerides used in cosmetics. Triglycerides are commonly used as skin-conditioning agents, emollients, occlusive agents and, for some ingredients, solvents or viscosity-increasing agents. ^[8]

9. González-Mas et al. (2019) reviewed volatile compounds in Citrus essential oils and described the chemical composition of citrus oils, which are particularly rich in volatile terpenoid compounds. ^[9]

10. Dosoky and Setzer (2018) reviewed the biological activities and safety considerations of Citrus essential oils and described their applications in pharmaceutical, cosmetic and other preparations. ^[10]

11. Bråred Christensson et al. (2009) investigated the oxidation of fragrance terpenes such as limonene. The study demonstrated that oxidation can increase the irritating potential of limonene, emphasizing the importance of appropriate storage and protection of citrus oil-containing formulations from excessive air exposure. ^[11]

12. Thiele and Ekanayake-Mudiyanselage (2007) reviewed vitamin E in human skin and described its physiological and cosmetic relevance, including antioxidant and skin-barrier-related functions. ^[12]

13. Keen and Hassan (2016) reviewed vitamin E in dermatology and described it as a fat-soluble antioxidant commonly used in cosmetic products. ^[13]

14. Cosmetic Ingredient Review Expert Panel (2018) assessed tocopherols and tocotrienols used in cosmetics and concluded that the evaluated ingredients are safe under their present cosmetic conditions of use. Tocopherols were reported to function as antioxidants and skin-conditioning agents. ^[14]

15. Dilip et al. (2023) examined nail-polish removers as a case study in green chemistry and toxicology education. The study emphasized that ingredients and routes of exposure should be considered when evaluating the safety of nail-polish-remover products. ^[15]

16. Javaid et al. (2025) systematically reviewed dermatological conditions associated with different nail cosmetics. The review highlighted the importance of safe use of nail cosmetic products and awareness of adverse skin and nail outcomes. ^[16]

NAIL POLISH REMOVING WIPES

Nail-polish-removing wipes are pre-saturated nonwoven materials containing a nail-polish-removing formulation. They are designed to provide direct contact between the solvent and the nail-polish film. The solvent penetrates and softens the polymeric film, allowing the polish to be removed mechanically using the wipe.

Compared with conventional liquid nail-polish removers, wipes can provide portability, convenience and controlled application. They are particularly useful for travel and quick cosmetic nail maintenance.

The effectiveness of a wipe depends on several factors, including the solvent concentration, solvent evaporation rate, wipe material, saturation level, contact time and nature of the nail polish. The formulation should maintain sufficient solvent availability during application while avoiding excessive leakage from the package.

INGREDIENTS

1. Ethyl Acetate

Ethyl acetate is an organic ester commonly used as a solvent in cosmetic products. It is a colorless, volatile liquid with a characteristic fruity odour. It has good solvent properties for many components used in nail-polish formulations.



Role in nail-polish-removing wipes

- Main nail-polish-removing solvent
- Helps dissolve or redissolve the nail-polish film
- Provides rapid removal action
- Suitable for acetone-free remover systems
- Volatile and therefore facilitates relatively rapid drying

Ethyl acetate is specifically documented as a solvent in nail-polish and nail-polish-remover preparations. [4]

Advantages

- Effective solvent for conventional nail polish
- Acetone-free alternative
- Rapid evaporation

- Established cosmetic use

Limitation

Ethyl acetate is volatile and flammable and should therefore be handled away from ignition sources. Excessive or repeated exposure may contribute to dryness or irritation. ^[4]

2. Aloe Vera Gel

Biological source: *Aloe barbadensis* Mill. (syn. *Aloe vera*)

Family: Asphodelaceae

Aloe vera is a succulent plant widely used in pharmaceutical, dermatological and cosmetic preparations. The inner leaf gel contains a high proportion of water and polysaccharides along with other constituents.



Role in the formulation

- Skin-conditioning agent
- Moisturizing component
- Helps improve the sensory properties of the formulation
- May reduce the dry feel associated with solvent exposure

A clinical cosmetic study found that Aloe vera extract-containing formulations increased stratum-corneum water content, supporting its use in moisturizing cosmetic preparations. ^[5]

Benefits

- Moisturizing
- Skin conditioning
- Soothing cosmetic effect
- Plant-derived ingredient
- Widely used in cosmetic formulations

Important formulation consideration

Ordinary Aloe vera gel is usually **water-rich**. Ethyl acetate is an organic solvent, while orange oil and caprylic/capric triglyceride are predominantly lipophilic ingredients. Therefore, direct mixing of ordinary Aloe vera gel with a high-ethyl-acetate formulation may result in phase separation or instability.

For this reason, a **low-water Aloe vera extract or a properly solubilized/emulsified Aloe vera system** may be more suitable for development. Compatibility should be established experimentally before finalizing the formulation.

3. Vitamin E

Chemical name: Tocopherol/Alpha-tocopherol

Molecular formula of alpha-tocopherol: C₂₉H₅₀O₂



Vitamin E is a lipid-soluble antioxidant widely used in cosmetic and dermatological products.

Role in the formulation

- Antioxidant
- Skin-conditioning agent
- Helps protect lipid components from oxidative deterioration
- Provides a conditioning effect to the nail and surrounding skin

Vitamin E has been used extensively in cosmetic dermatology and is recognized for antioxidant and skin-conditioning functions. [7,12–14]

Benefits

- Antioxidant activity
- Skin conditioning

- Lipid-soluble
- Compatible with many oil-containing cosmetic systems
- Useful in nail and cuticle-care concepts

4. Orange Oil



Biological source: *Citrus sinensis* (L.) Osbeck

Family: Rutaceae

Orange oil is generally obtained from the peel of sweet orange. Citrus essential oils contain volatile compounds, with limonene being one of the major constituents of many citrus oils. [9,10]

Role in the formulation

- Provides pleasant citrus fragrance
- Contributes volatile solvent/solubilizing properties
- Gives the formulation a botanical cosmetic character
- May improve consumer acceptability

Citrus essential oils are widely used in cosmetic and pharmaceutical preparations because of their characteristic aroma and biological properties. [9,10]

Benefits

- Pleasant fragrance
- Plant-derived ingredient
- Contains volatile terpenes
- Provides a botanical aspect to the formulation

Precaution

Orange oil commonly contains limonene, and limonene can undergo oxidation during storage. Oxidized limonene has greater potential for irritation and contact allergy than the non-oxidized compound. Therefore, orange oil should be protected from excessive heat, air and light, and the final product should be packed appropriately. ^[11]

5. Caprylic/Capric Triglycerides

Common name: Caprylic/Capric Triglyceride (CCT)

Chemical nature: Mixed triglycerides derived from caprylic and capric fatty acids

Caprylic/capric triglyceride is a lightweight lipid ingredient commonly used in cosmetic preparations. It is used primarily as an emollient and skin-conditioning ingredient.

Role in the formulation

- Emollient
- Skin-conditioning agent
- Helps reduce the dry feel associated with solvent use
- Provides a smooth sensory feel
- Can act as a carrier for oil-soluble ingredients

Cosmetic safety assessments of triglycerides report their use primarily as skin-conditioning agents, including emollient and occlusive functions. ^[8]

Benefits

- Lightweight emollient
- Improves skin feel
- Oil-compatible
- Useful in cosmetic formulations
- May help counteract the unpleasant dry feel produced by repeated solvent exposure

Limitation

Excessive CCT may leave an oily residue on the nail plate and can potentially reduce the perceived speed of drying. Therefore, its concentration should be optimized experimentally.

PROPOSED FORMULATION CONCEPT

The proposed nail-polish-removing wipe contains:

Ingredient	Primary role
Ethyl acetate	Main nail-polish-removing solvent
Aloe vera gel/extract	Moisturizing and skin conditioning
Vitamin E	Antioxidant and conditioning agent
Orange oil	Fragrance and supplementary solvent
Caprylic/capric triglyceride	Emollient and skin-conditioning agent
Nonwoven wipe	Carrier material

The formulation should be developed after preliminary compatibility studies. Because Aloe vera gel introduces an aqueous component into an otherwise predominantly organic/lipid system, the formulation may require a suitable solubilization or emulsification strategy. A low-water Aloe vera ingredient is preferable for an uncomplicated solvent-rich wipe.

ADVANTAGES

1. Provides an **acetone-free nail-polish-removing system**.
2. Ethyl acetate provides the principal nail-polish-removing action.
3. Convenient and portable dosage form.
4. Pre-saturated wipes eliminate the need for separate cotton pads.
5. Aloe vera provides a moisturizing/skin-conditioning concept.
6. Vitamin E provides antioxidant and conditioning properties.
7. Caprylic/capric triglyceride provides an emollient effect.
8. Orange oil provides a pleasant citrus aroma.
9. The formulation combines a functional solvent with cosmetic conditioning ingredients.
10. The concept is suitable for laboratory formulation and comparative evaluation.

Acetone-free nail-polish removers containing ethyl acetate are already recognized in the nail-cosmetic literature. Therefore, the project should emphasize **formulation development and evaluation of the specific combination**, rather than claiming that ethyl acetate itself is novel.

[1-4]

DISADVANTAGES AND LIMITATIONS

1. Ethyl acetate is volatile and flammable.
2. Excessive solvent exposure may cause dryness or irritation.
3. Aloe vera gel may be incompatible with a high-organic-solvent system because of its water content.
4. Excessive caprylic/capric triglyceride may produce an oily residue.
5. Orange oil contains limonene, which may undergo oxidation during storage.
6. Oxidized citrus terpenes may have increased irritation or sensitization potential.
7. The formulation may require optimization of solvent-to-conditioning-agent ratios.
8. Aqueous Aloe vera gel may increase the need for preservation if sufficient water is present.
9. Wipes must be packaged in airtight, solvent-compatible packaging to reduce evaporation.
10. Stability studies are required before considering the formulation suitable for long-term storage.

METHOD OF PREPARATION

Step 1: Preparation of the solvent phase

Take the required quantity of ethyl acetate in a clean, dry, closed mixing vessel. Add orange oil slowly and mix gently until uniform.

Step 2: Addition of oil-soluble ingredients

Add vitamin E and caprylic/capric triglyceride gradually to the solvent phase with gentle mixing.

Step 3: Addition of Aloe vera

A **low-water/solvent-compatible Aloe vera extract** should preferably be used. Add it slowly while mixing and observe the formulation for cloudiness, precipitation or phase separation.

If ordinary Aloe vera gel is used, a separate compatibility study should first be performed rather than adding it directly to the final batch.

Step 4: Compatibility observation

Observe the mixture for:

- Phase separation
- Precipitation
- Change in colour
- Change in odour

- Excessive viscosity
- Non-uniformity

Step 5: Wipe preparation

Cut suitable nonwoven wipe material into uniform pieces of predetermined size.

Step 6: Saturation

Apply a predetermined quantity of the formulation uniformly to each wipe. Avoid excessive saturation that could cause leakage or insufficient saturation that could reduce nail-polish-removal efficiency.

Step 7: Packaging

Immediately place the saturated wipes into airtight, solvent-resistant individual sachets or suitable sealed containers to minimize solvent evaporation.

Step 8: Storage

Store the prepared wipes in a cool, dry place away from direct sunlight, heat and ignition sources.

EVALUATION OF NAIL POLISH REMOVING WIPES

The prepared wipes can be evaluated using the following parameters:

1. Appearance

The colour, texture, uniformity and general appearance of the formulation and wipe should be observed.

2. Odour

The odour should be evaluated for acceptability and any unpleasant change during storage.

3. Wipe wetness

The degree of saturation and uniform distribution of the formulation throughout the wipe should be assessed.

4. Nail-polish removal efficiency

Apply a standardized nail-polish film to glass slides or artificial nail plates. Allow the polish to dry completely and use the wipe under standardized conditions.

The time required for complete removal can be recorded.

Removal time = Time required to remove the standardized nail-polish film completely.

5. Residue test

After removal, the nail surface should be examined for visible oily or coloured residue.

6. Weight uniformity

The weight of individual saturated wipes can be compared to determine consistency of formulation loading.

7. Stability study

The formulation should be observed during storage for changes in:

- Colour
- Odour
- Phase separation
- Leakage
- Solvent loss
- Wipe dryness
- Nail-polish removal performance

8. Compatibility study

Compatibility between ethyl acetate, Aloe vera, orange oil, vitamin E and caprylic/capric triglyceride should be assessed before final formulation.

9. Skin/nail compatibility

Only an appropriately approved and supervised cosmetic-compatibility evaluation should be conducted. The formulation should not be claimed to be hypoallergenic or dermatologically safe without appropriate evidence.

SIGNIFICANCE OF THE PROPOSED FORMULATION

The proposed formulation combines a well-established nail-polish-removing solvent with cosmetic conditioning ingredients. Ethyl acetate provides the primary removal action, whereas Aloe vera, vitamin E and caprylic/capric triglyceride are included to provide a skin-conditioning concept. Orange oil provides fragrance and a botanical component.

The formulation is particularly relevant to the development of convenient acetone-free nail-polish-removing wipes. However, the inclusion of conditioning ingredients should not be interpreted as eliminating the drying or irritant potential of the solvent. Published dermatological literature indicates that fatty materials in nail-polish removers may provide moisturizing effects, but they do not necessarily completely overcome solvent-associated dehydration. ^[3]

DISCUSSION

Nail-polish-removing wipes represent a convenient alternative to conventional liquid nail-polish removers. The major functional requirement is efficient removal of the nail-polish film. Ethyl acetate is suitable for this purpose because it is an established solvent used in acetone-free nail-polish removers. [1-4]

The addition of Aloe vera, vitamin E and caprylic/capric triglyceride is intended to improve the cosmetic character of the product. Aloe vera has been investigated for its moisturizing effects in cosmetic formulations, while vitamin E is widely used as an antioxidant and skin-conditioning ingredient. [5-7,12-14]

Caprylic/capric triglyceride provides an emollient component. Triglycerides are widely used in cosmetics as skin-conditioning ingredients, and their safety has been evaluated by the Cosmetic Ingredient Review Expert Panel. [8]

Orange oil provides a pleasant fragrance and a plant-derived component. Citrus essential oils contain volatile terpenes such as limonene. However, oxidation of limonene can increase its irritating and sensitizing potential, making appropriate packaging and storage important. [9-11]

A major challenge in the proposed formulation is the presence of conventional Aloe vera gel in a formulation dominated by ethyl acetate and lipophilic ingredients. This problem can be addressed by selecting a low-water Aloe vera ingredient or developing a suitable solubilized system. The final formulation should therefore be selected based on experimental compatibility, stability and nail-polish-removal performance rather than solely on the theoretical benefits of individual ingredients.

CONCLUSION

Nail-polish-removing wipes containing **ethyl acetate, Aloe vera, vitamin E, orange oil and caprylic/capric triglyceride** represent a promising formulation concept for an acetone-free cosmetic nail-care product. Ethyl acetate serves as the principal nail-polish-removing solvent, while Aloe vera, vitamin E and caprylic/capric triglyceride provide moisturizing, antioxidant and emollient/conditioning functions. Orange oil contributes a pleasant citrus aroma and a botanical component.

The combination has potential for development as a convenient pre-saturated wipe; however, formulation compatibility is a major consideration, particularly because conventional Aloe vera gel contains substantial water whereas ethyl acetate is an organic solvent. Therefore, the use of a low-water Aloe vera extract or an appropriately designed solubilized system is

preferable. The final formulation should undergo compatibility, stability, nail-polish-removal efficiency, residue, wipe saturation and appropriate safety/compatibility evaluations.

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