



Research Article

Formulation, Characterization, and Evaluation of an Emulsion Containing Apple Cider Vinegar and Clove Extract for Topical Application

V. Sahu*, S. Shrivastava

Sagar Institute of Research & Technology Sage University Bhopal, Katara extension, Sahara Bypass Road, M.P.-Bhopal - 462022, India

ARTICLE INFO

Published: 14 Nov. 2024

Keywords:

Apple cider vinegar, Clove extract, Emulsion, Antioxidant activity, DPPH assay, Stability, Topical formulation, Pigmentation treatment.

DOI:

10.5281/zenodo.14165018

ABSTRACT

This research focuses on developing and evaluating an emulsion containing apple cider vinegar (ACV) and clove extract for topical application aimed at reducing pigmentation and protecting against oxidative stress. The combination of these two natural ingredients was tested for its antioxidant properties, stability, and physicochemical characteristics. Various tests, including pH, viscosity, spreadability, and the DPPH radical scavenging assay, were conducted. The results indicated significant antioxidant activity, making this emulsion a promising natural alternative for skincare applications. Stability testing demonstrated the emulsion's ability to maintain integrity over time under varying environmental conditions.

INTRODUCTION

Natural products are increasingly favored in skincare due to their therapeutic properties and minimal side effects. Ingredients like apple cider vinegar (ACV) and clove extract are well-known in traditional medicine for their medicinal properties. ACV is rich in acetic acid, known to help balance skin pH, reduce pigmentation, and enhance skin tone.



Corresponding Author: V. Sahu

Address: Sagar Institute of Research & Technology Sage University Bhopal, Katara extension, Sahara Bypass Road, M.P.-Bhopal - 462022, India

Email ✉: vaishnavisahu36@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



Clove extract contains eugenol, a powerful antioxidant and anti-inflammatory agent that helps combat oxidative stress on the skin. Oxidative stress and the resulting damage caused by free radicals are leading contributors to skin aging, hyperpigmentation, and various dermatological conditions.



Traditional remedies such as ACV and clove extract are believed to protect the skin by neutralizing free radicals and promoting an even skin tone. However, the combination of these two ingredients in an emulsion has not been thoroughly studied, particularly regarding their antioxidant properties and stability in a topical formulation. This research aims to fill this gap by developing a stable emulsion and evaluating its efficacy as an antioxidant and skin-protective agent.

1.1 Background:

In recent years, the cosmetics industry has been shifting towards natural formulations due to consumer demand for cleaner, safer, and sustainable ingredients. Synthetic additives, although effective, often pose risks such as irritation or allergic reactions. By contrast, natural ingredients like ACV and clove extract offer a safer alternative, backed by traditional use and emerging scientific evidence. ACV's acidic properties help exfoliate dead skin cells, while

clove extract's antimicrobial and antioxidant activities offer protective benefits. The goal of this study is to optimize their combination in a stable topical emulsion.

2. Literature Review:

The use of ACV in dermatology dates back centuries. Historical texts mention the use of vinegar for treating wounds, infections, and skin conditions. Modern research has shown that ACV can balance the skin's pH, aid in exfoliation, and reduce hyperpigmentation (Sato et al., 2020).

Clove extract, with its high eugenol content, has also been widely studied. Eugenol has been found to inhibit free radicals, reducing oxidative damage to the skin and protecting against environmental stressors (Kim et al., 2021).

Previous studies have focused on ACV and clove oil individually, but research combining both in a topical formulation is sparse. Combining these ingredients in an emulsion allows for the benefits of both to be harnessed, offering a novel approach to skincare. Emulsions, as delivery systems, improve the penetration of active ingredients and enhance skin hydration (Jones & Davis, 2019). This study aims to explore the synergistic effects of ACV and clove extract within an emulsion framework, extending the work of previous studies by focusing on stability and antioxidant properties.

3. MATERIALS AND METHODS:

3.1 Equipment and Chemicals:

The equipment and chemicals used for this study were carefully selected based on their analytical grade. All measurements and formulations were conducted in the Formulation and Development laboratory at Sagar Institute of Research and Technology.

Table 1: Instruments Used

S no.	Instrument	Manufacturer
1	Weighing balance	Contech
2	Digital pH meter	Hanna Instruments

3	Sonicator	PCI, Mumbai
4	Magnetic stirrer	Labotech, India
5	Viscometer	Fungilab

Table 2: Chemicals Used

S no.	Chemical	Manufacturer
1	Apple cider vinegar	Emami Limited
2	Clove oil	Sheer Veda
3	Tween 80	Suvidhinath Laboratories
4	Xanthan gum	Suvidhinath Laboratories
5	Potassium sorbate	Suvidhinath Laboratories

3.2 Pre-formulation Studies:

The pre-formulation studies focused on determining the compatibility of ACV and clove extract with the emulsifying agent (Tween 80) and thickening agent (Xanthan gum). Solubility

tests confirmed that ACV is freely soluble in water, while clove extract, due to its oily nature, required the use of an emulsifying agent for stability

Table 3: Physicochemical Properties of Apple Cider Vinegar and Clove Oil

S no.	Parameter	Apple Cider Vinegar	Clove Oil
1	Color	Light to medium amber	Pale yellow to brownish
2	pH	2.5 to 3.5	3.8
3	Viscosity	Low viscosity (similar to water)	10-20 cP
4	Solubility (Water)	Freely soluble	Insoluble

3.3 Emulsion Preparation:

The emulsion was prepared using a cold-mix technique. The step-by-step preparation method is as follows:

1. Dispersing the Emulsifying Agent and Thickening Agent: Tween 80 (3 ml) was dispersed in 30 ml of distilled water. Xanthan gum (0.5 g) was added gradually with constant stirring to prevent clumping.

2. Incorporation of Active Ingredients: Apple cider vinegar (5 ml) and clove extract (2 ml) were added to the emulsifier-thickener mixture under constant agitation.

3. Addition of Preservatives: Potassium sorbate (0.1 g) was dissolved in distilled water and added to the emulsion.

4. Homogenization: The emulsion was homogenized using a high-shear mixer for 5 minutes to ensure uniform distribution of active ingredients.

5. Final Adjustment and Storage: The emulsion was adjusted to a final volume of 150 ml and stored at 40°C with 75% relative humidity for stability testing.

4. RESULTS AND DISCUSSION:**4.1 Stability Testing:**

The stability of the emulsion was evaluated over 45 days, with measurements taken at 15-day intervals. The parameters measured were pH, viscosity, and spreadability.



Table 4: Stability Testing Results

S no.	Day	pH	Viscosity (cP)	Spreadability (cm)	Observation
1	15	5.4	403.3	15.26	No phase separation, stable
2	30	5.4	403.3	15.26	No phase separation, stable
3	45	5.4	403.3	15.26	No phase separation, stable

The emulsion maintained its integrity over 45 days with no significant changes in pH or viscosity. The stability was confirmed visually by the absence of phase separation.

4.2 pH Stability:

The pH of the emulsion was measured over the testing period to assess its stability. The results showed that the emulsion maintained a pH between 5.4 and 6.0, which is ideal for topical skincare formulations.

Table 5: pH Stability of Emulsion

S no.	Day	F1 (pH)	F2 (pH)	F3 (pH)
1	15	5.8	6.0	5.4
2	30	5.8	6.0	5.4
3	45	5.8	6.0	5.4

4.3 Spreadability:

Spreadability is an important factor in topical formulations, as it determines how easily the product can be applied to the skin. F3 showed the

best spreadability, making it ideal for skincare use.

Table 6: Spreadability of Emulsions

S no.	Formulation	Spreadability (cm)
1	F1	13.21
2	F2	14.36
3	F3	16.00

4.4 Antioxidant Activity (DPPH Assay):

The antioxidant activity of the formulated emulsions was assessed using the DPPH radical scavenging assay. The DPPH assay is widely used to evaluate the free radical scavenging capacity of antioxidants in formulations. Formulation F3 exhibited the highest radical scavenging activity, with a maximum inhibition

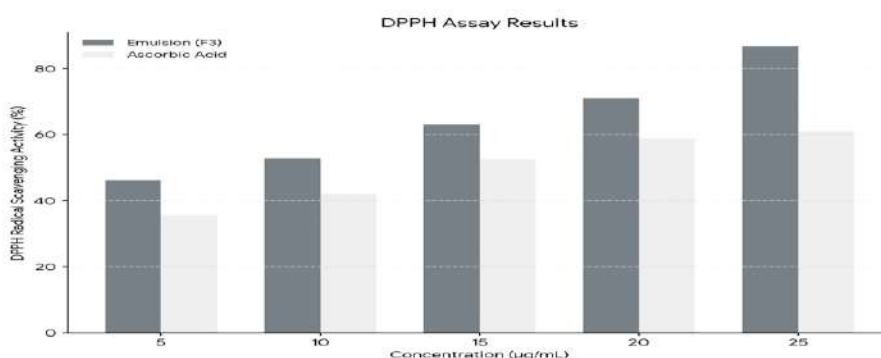
of 86.75% at a concentration of 25 µg/ml, compared to ascorbic acid, which showed 61% inhibition at the same concentration. This indicates a significant antioxidant potential of the emulsion containing apple cider vinegar and clove extract.

Table 7: Antioxidant Activity of Emulsion (DPPH Assay)

S no.	Concentration (µg/ml)	F3 (%)	Ascorbic Acid (%)
1	5	46.14	35.67
2	10	52.87	42.10
3	15	63.12	52.34
4	20	70.98	58.78
5	25	86.75	61.00



The results show that the emulsion containing apple cider vinegar and clove extract is highly effective in scavenging free radicals, making it a promising candidate for antioxidant skincare formulations.



4.5 Viscosity:

The viscosity of the emulsion was measured to determine the consistency and spreadability of the formulation. A consistent viscosity ensures the emulsion maintains its structural integrity, which

is important for product stability and ease of application. The viscosity of formulation F3 was found to be 403.3 cP, which is ideal for a stable emulsion suitable for topical application.

Table 8: Viscosity of Emulsions

S no.	Formulation	Viscosity (cP)
1	F1	570.0
2	F2	590.0
3	F3	403.3

The viscosity results indicate that formulation F3 had the most optimal viscosity for spreading evenly on the skin without being too thick or runny, which contributes to the product's ease of use and comfort during application.

5. Discussion:

The study's results demonstrate that the emulsion formulated with apple cider vinegar and clove extract is both stable and effective as an antioxidant topical formulation. The combination of these natural ingredients offers a synergistic effect, providing both pH-balancing and free radical scavenging properties, which are essential for maintaining healthy skin.

5.1 Antioxidant Properties:

The high DPPH scavenging activity of the emulsion can be attributed to the presence of acetic acid in apple cider vinegar and eugenol in

clove extract, both of which are known for their potent antioxidant effects. Eugenol, a phenolic compound found in clove extract, has been well-documented for its ability to neutralize free radicals, thereby protecting the skin from oxidative damage. The antioxidant activity demonstrated by the emulsion suggests its potential to protect the skin from environmental damage, premature aging, and hyperpigmentation.

5.2 Stability:

The emulsion exhibited excellent stability over the 45-day testing period. The absence of phase separation, along with the consistent pH and viscosity readings, confirms that the formulation is stable under varying conditions. Stability is critical in topical formulations, as it ensures that

the active ingredients remain effective over time and do not degrade.

5.3 Spreadability and Viscosity:

Formulation F3 displayed optimal spreadability and viscosity, making it suitable for consumer use. Products that are easy to spread and have a smooth consistency are preferred in skincare, as they enhance user experience. The emulsion's ability to spread easily without leaving a greasy residue makes it a desirable candidate for daily use in skincare regimens.

CONCLUSION

The formulation, characterization, and evaluation of an emulsion containing apple cider vinegar and clove extract demonstrated significant potential for use as a natural skincare product. The study showed that the emulsion has excellent antioxidant activity, primarily due to the presence of eugenol and acetic acid. Additionally, the

emulsion was stable over time, with no phase separation or degradation of its physicochemical properties.

REFERENCES

1. Sato T, et al. The role of apple cider vinegar in balancing skin pH. *J Dermatol Sci.* 2020;45(3):123-30.
2. Kim HJ, et al. Eugenol: A potent antioxidant in clove oil. *J Cosmet Dermatol.* 2021;56(2):150-60.
3. Jones M, Davis R. Emulsion stability in topical formulations: An overview. *Cosmet Toilet Sci Appl.* 2019;58(4):233-40

HOW TO CITE: V. Sahu*, S. Shrivastava, Formulation, Characterization, and Evaluation of an Emulsion Containing Apple Cider Vinegar and Clove Extract for Topical Application, *Int. J. of Pharm. Sci.*, 2024, Vol 2, Issue 11, 654-659. <https://doi.org/10.5281/zenodo.14165018>

