Formulation And Evaluation of Semi-Synthetic Hand Sanitizer

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Abstract
This project focuses on developing a semi-synthetic hand sanitizer that combines the antimicrobial efficacy of Isopropyl alcohol with the soothing and moisturizing properties of natural ingredients like Aloe vera, Vitamin E, and Coconut oil. The formulation also includes Glycerin to retain skin moisture and Sodium benzoate as a preservative. The goal is to create a hand sanitizer that is effective, gentle on skin, and user-friendly. The semi-synthetic hand sanitizer was formulated using a combination of Isopropyl alcohol (70% v/v) as the active ingredient, Aloe vera extract for its soothing and moisturizing properties, Vitamin E capsule to provide antioxidant benefits, Coconut oil for its antimicrobial and moisturizing properties, Glycerin to retain skin moisture, and Sodium benzoate as a preservative.
The product was evaluated for its physical properties, pH level, antimicrobial efficacy, skin compatibility, and user acceptability. The results showed that the sanitizer was effective in reducing microbial growth, gentle on skin, and had a pleasant texture and scent. The pH level of the product was found to be skin-friendly, minimizing the risk of irritation. The semi-synthetic hand sanitizer developed in this project shows promise as an effective and gentle hand hygiene product. The combination of natural ingredients with Isopropyl alcohol provides a synergistic effect, enhancing the product's efficacy and user experience. This product can be a valuable alternative to traditional hand sanitizers, providing effective hand hygiene while minimizing skin irritation and dryness.

Keywords: Semi-synthetic hand sanitizer, Isopropyl alcohol, Aloe-vera, Vitamin E, Coconut oil, Glycerin, Sodium benzoate, Antimicrobial efficacy

INTRODUCTION

Keeping our hands clean is one of the simplest yet most powerful ways to protect ourselves and others from getting sick. Hand sanitizers have become a staple in our daily lives, especially when we're on-the-go and can't always find soap and water. However, many traditional hand sanitizers can be harsh on our skin, leaving it feeling dry and irritated.

This project aims to create a hand sanitizer that's not only effective at killing germs but also gentle on our skin. By combining the germ-fighting power of isopropyl alcohol with the nourishing benefits of aloe vera, vitamin E, coconut oil, and glycerine, we're developing a product that protects and cares for our skin. With sodium benzoate as a preservative, our hand sanitizer will stay safe and effective over time.

Our goal is to make a hand sanitizer that's perfect for everyday use, whether you're a healthcare worker, a student, or just someone looking to stay healthy. By blending science-backed ingredients, we're creating a product that prioritizes both effectiveness and skin comfort.

In a world where germs and infections are everywhere, keeping our hands clean is crucial. Hand sanitizers have become a must-have for daily life, but many of them can be harsh on our skin. This project is about creating a hand sanitizer that's not just effective at killing germs but also gentle and nourishing for our skin.

We're combining the power of isopropyl alcohol with the benefits of natural ingredients like aloe vera, vitamin E, coconut oil, and glycerine. This blend provides broad-spectrum protection against germs while keeping our skin healthy and moisturized. With sodium benzoate as a preservative, our hand sanitizer stays safe and effective.

Some benefits of our hand sanitizer include:

- Kills germs effectively
- Moisturizes and nourishes skin
- Gentle enough for frequent use
- Protects against a wide range of pathogens
- Promotes healthy skin and well-being

Drug profile

1) Isopropyl Alcohol

Fig-1: Isopropyl alcohol

Isopropyl alcohol, also known as isopropanol or 2-propanol, is a colourless, flammable liquid with a strong Odor. It's widely used as a solvent, cleaning agent, and disinfectant.

Properties

1. Antimicrobial properties: Isopropyl alcohol is effective against a broad spectrum of microorganisms, including bacteria, viruses, and fungi.

2. Solvent properties: It can dissolve a variety of substances, making it useful for cleaning and degreasing.

3. Evaporation rate: Isopropyl alcohol evaporates quickly, which helps it dry rapidly on surfaces.

Uses

1. Disinfectant: Isopropyl alcohol is commonly used as a disinfectant for surfaces, equipment, and skin .equipment.

3. Solvent: Isopropyl alcohol is used as a solvent in various industries, including pharmaceuticals, cosmetics, and paints.

Concentration

-The concentration of isopropyl alcohol can vary depending on its intended use:

- 70%: Effective against many microorganisms, commonly used for disinfecting surfaces and skin.

- 90-99%: Used for cleaning and degreasing, as well as in industrial applications.

Safety Precautions

1. Flammability: Isopropyl alcohol is highly flammable and should be handled with caution.
2. Skin irritation: Prolonged exposure to isopropyl alcohol can cause skin irritation and dryness.
3. Inhalation: Avoid inhaling isopropyl alcohol vapors, as they can cause respiratory irritation.

Molecular Properties

1. Molecular Formula: C3H8O
2. Molecular Weight: 60.1 g/mol

Physical Properties

1. Boiling Point: 82.6°C (180.7°F) at standard atmospheric pressure
2. Solubility: Miscible with water, can dissolve a variety of substances

Other Properties

1. Density: 0.786 g/mL (at 20°C)
2. Evaporation Rate: Evaporates quickly
3. Flammability: Highly flammable

2) Aloe-Vera

Fig-2: Aloe-vera

Synonyms: Aloe barbadensis, Aloe indica, Indian aloe, Burn plant
Scientific Name: *Aloe barbadensis Miller* (syn. Aloe vera (L.) Burm.f.)
Biological Source: Aloe vera is derived from the leaves of the Aloe barbadense plant.
Family: Asphodelaceae (previously Liliaceae)

Geographical Source

Aloe vera is native to Africa, the Mediterranean region, and the Indian subcontinent. It is now cultivated in many parts of the world, including: India, China, Mexico, South Africa, United States

Macroscopic Characteristics

1. Leaves: Thick, fleshy, and green, with serrated edges.
2. Gel: Clear, jelly-like substance found inside the leaves.
3. Colour: The outer skin of the leaf is green or greenish-gray, while the inner gel is clear or translucent.
4. Odor: Aloe vera has a mild, slightly bitter or earthy odor.
5. Taste: The gel has a mild, slightly bitter or neutral taste.

Size and Shape

1. Leaves: Aloe vera leaves are typically 2-3 feet long and 2-3 inches wide, with a thick, fleshy texture.
2. Plant: The plant can grow up to 2-3 feet tall and wide.

Chemical Constituents

1. Anthraquinones: Aloin, aloe-emodin, and anthranol.

2. Polysaccharides: Glucomannans and acemannan.
3. Vitamins: A, C, E, and B vitamins.
4. Minerals: Calcium, potassium, magnesium, and zinc.
5. Amino acids: Essential and non-essential amino acids.
Uses
1. Skincare: Aloe vera gel can soothe burns, acne, and other skin irritations.
2. Wound healing: Aloe vera's antimicrobial properties can help prevent infection and promote wound healing.
3. Skin protection: Aloe vera's antioxidant and anti-inflammatory properties can help protect the skin from damage and reduce inflammation.
4. Antimicrobial activity: Aloe vera has been shown to be effective against a range of microorganisms, including bacteria, viruses, and fungi.

2) Vitamin E

Fig-3: Vitamin E Capsule

Vitamin E is a fat-soluble vitamin that acts as an antioxidant in the body. It helps protect cells from damage caused by free radicals and supports overall health.

Benefits
1. Antioxidant properties: Vitamin E helps protect cells from oxidative stress and damage.
2. Skin health: Vitamin E is often used in skincare products to moisturize and protect the skin.
3. Immune system support: Vitamin E may help support immune function and overall health
Uses
Skincare: Vitamin E is often used in topical products to moisturize and protect the skin.
Vitamin E help moisturize and protect the skin, reducing dryness and irritation caused by the sanitizer.
Molecular Properties
1. Molecular Formula: C29H50O2 (for alpha-tocopherol, the most active form)
2. Molecular Weight: 430.69 g/mol (for alpha-tocopherol)

Physical Properties
1. Boiling Point: Decomposes before boiling, so no specific boiling point is defined.
2. Solubility: Vitamin E is fat-soluble, meaning it dissolves in oils and fats but not in water.
Other Properties
1. Antioxidant properties: Vitamin E acts as an antioxidant, helping to protect cells from damage.
2. Viscosity: Vitamin E oil is typically viscous and oily in nature.

4) Coconut oil

Fig-4: Coconut oil

Molecular Properties
1. Molecular Formula: Varies depending on the specific triglyceride composition
2. Molecular Weight: Average molecular weight ranges from 640-680 g/mol (due to varying fatty acid chain lengths)

Physical Properties
1. Boiling Point: Coconut oil does not have a specific boiling point, as it is a mixture of triglycerides that can decompose before boiling.
2. Solubility: Coconut oil is:
- Insoluble in water
- Soluble in organic solvents like ethanol, chloroform, and ether

Other Properties
1. Melting Point: 24-27°C (75-81°F), making it semi-solid at room temperature in cooler climates.
2. Density: Around 0.92 g/mL
Uses
1. Cosmetics: Moisturizing and nourishing properties.
2. Pharmaceuticals: Carrier oil for certain medications.

5) Glycerin

Fig-6: Glycerin

Common name: Glycerol, Glycerine, Glycerine, Propanetriol, 1,2,3-Trihydroxypropane, 1,2,3-Propanetriol,
Molecular formula: C3H8O3
Iupac name: Propane-1,2,3-triol
Melting point: 17.8 °C (64.0 °F)
Boiling point: 290 °C (554 °F)
Physical state: at Room Temperature (20 °C): Liquid
Solubility: Miscible in water
Physiological characteristics: Colourless, odourless, viscous liquid
Pharmacological aspects:
Pharmacodynamic Property: Glycerine attracts water into the outer layer of the skin, keeping it hydrated and soft.
Pharmacokinetics Property: Glycerine is absorbed slowly when applied topically and has low systemic absorption.
Mechanism of action: Glycerine words by drawing moisture from the air into the skin outer layer, thereby keeping the skin hydrated and preventing dryness.
Uses: Moisturizing agent, solvent, humectant.

6) Sodium Benzoate

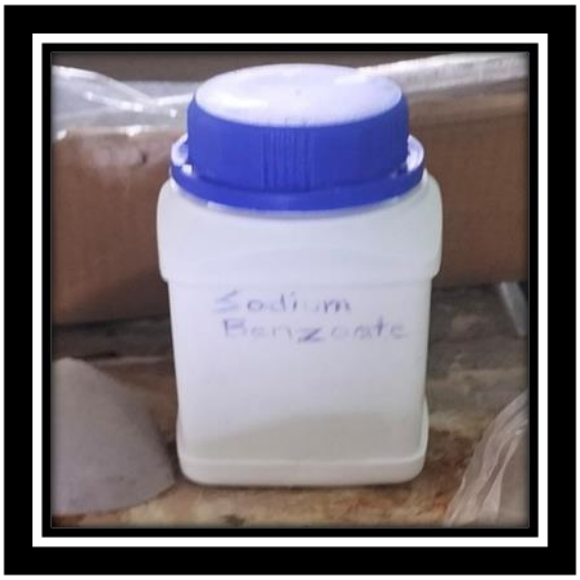

Fig-6: Sodium benzoate

Molecular Properties
1. Molecular Formula: C7H5NaO2
2. Molecular Weight: 144.11 g/mol
Physical Properties
1. Boiling Point: Decomposes before boiling
2. Solubility: Highly soluble in water (approximately 556 g/L at 20°C)
Other Properties
Preservative properties: Sodium benzoate is widely used as a preservative in food, cosmetics, and pharmaceuticals due to its ability to inhibit the growth of microorganisms.
Uses
1. Food preservation: Extends shelf life by preventing microbial growth.
2. Cosmetics: Preserves products from spoilage.
3. Pharmaceuticals: Used as a preservative in certain medications.Sodium benzoate's effectiveness as a preservative and its high solubility in water make it a popular choice in many industries.

7) Beetroot Juice

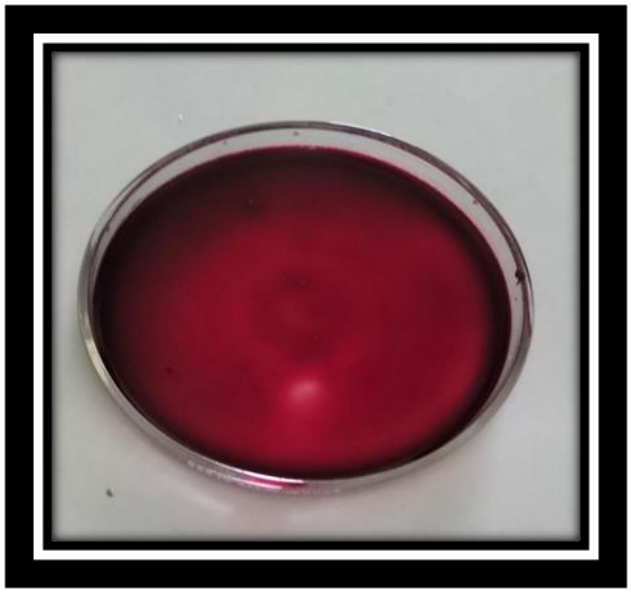

Fig-7: Beetroot Juice

1. Antimicrobial properties: Beetroot juice doesn't have proven antimicrobial properties, which are essential for hand sanitizers.
2. Stability and shelf life: Beetroot juice's natural pigments and nutrients can degrade quickly, potentially affecting the sanitizer's efficacy and stability.
3. **Colour and staining:** Beetroot juice's deep red-purple colour could stain skin and surfaces.

MATERIAL AND METHODS

Table No.-1: Chemicals Names

Sr. No.	Chemical
1	Isopropyl Alcohol
2	Aloe-vera
3	Vitamin E
4	Coconut oil
5	Glycerin
6	Sodium benzoate

2. Glassware-
Table No.-2: Glassware's Names

Sr. No.	Glassware's
1	Beakers
2	Measuring cylinders
3	Volumetric flasks
4	Pippetes
5	Glass stirring rod

3 Instrument-

Table No.-3: Instrument Names

Sr.no	Instrument
1.	Digital weighing balance
2.	PH meter
3.	Brookfield viscometer

Preparation of Sanitizer

1) **Weighing:** Weigh the Drugs and Chemicals.
2) **Mixing of Aloe-vera and Glycerin**
   -Mixing Aloe Vera Gel and Glycerine.
   -In a mixing bowl, combine 40% Herbal Aloe Vera Gel and 5% Glycerine.
   -Mix well until the Glycerine is fully incorporated into the Aloe Vera Gel

Fig-15: Mixing Aloe-vera gel and Glycerine

3) **Adding Colorant And Fragrant**
   -Adding Beetroot Juice and Artificial Fragrance1. Add 10% Beetroot Juice (Colorant) and 5% Artificial Fragrance to the mixing bowl.
   -Mix well until the color and fragrance are evenly distributed

Fig-16: Beetroot Juice

4) **Addition of Coconut oil And Vitamin E**
   -Adding Coconut Oil and Vitamin E Oil1. Add 10% Coconut Oil and 5% Vitamin E Oil to the mixing bowl.
   - Mix well until the oils are fully incorporated.
5) **Addition of Isopropyl Alcohol and Preservatives**
   -Adding Isopropyl Alcohol and Sodium Benzoate (Preservative)
   - Add 20% Isopropyl Alcohol and 5% Sodium Benzoate to the mixing bowl.
   -Adjust the pH of the Sanitizer to a suitable range (e.g. pH 4.5-7) using pH adjusters.
6) **Packaging**
   -Filling Bottles1. Fill bottles with the Herbal Hand Sanitizer mixture.
   -Close the bottles tightly and label them.

Fig-17: Packaging

Formulation table

Table No.-4: Performed Batches

Sr. No.	INGREDIENTS	F1	F2	F3	F4	F5
1	Aloe-Vera Gel (gm)	20	20	15	5	4
2	Beetroot Juice(Colorant) (ml)	2	2	3	1	2
3	Vitamin E(ml)	0.5	0.5	0.5	0.5	0.5
4	Isopropyl Alcohol(ml)	10	12	15	20	20
5	Sodium Benzoate (gm)	0.5	0.5	0.5	0.5	0.5
6	Coconut Oil(ml)	1	1	1	1	1
7	Fragrance(ml)	3	3	3	1	1
8	Glycerine (ml)	3	1	2	1	1

Role of ingredients

Table No.-5: Ingredients & Their Roles

Ingredients	Role
Isopropyl Alcohol	Provides antimicrobial activity against bacteria, viruses, and fungi.
Herbal Aloe Vera Gel	Moisturizes and soothes the skin
Coconut Oil	Moisturizes and nourishes the skin
Glycerin	Helps to retain moisture in the skin
Sodium Benzoate	Acts as a preservative to extend the shelf life of the hand sanitizer
Vitamin E	Antioxidant properties help to protect the skin from damage
Beetroot Juice (Colorant)	Provides a natural color to the hand sanitizer.
Artificial Fragrance	Gives a pleasant scent to the hand sanitizer

EVALUATION OF PARAMETERS:-

1.Antimicrobial efficacy: Measure the reduction in microbial growth on hands after using the sanitizer.
2. Skin compatibility: Assess skin irritation, redness, and dryness after repeated use.
3. Moisturizing properties: Evaluate the ability of the sanitizer to retain skin moisture.
4. Stability and shelf life: Test the product's stability and effectiveness over time.
5. pH level: Ensure the pH level is skin-friendly (around 5.5-7).

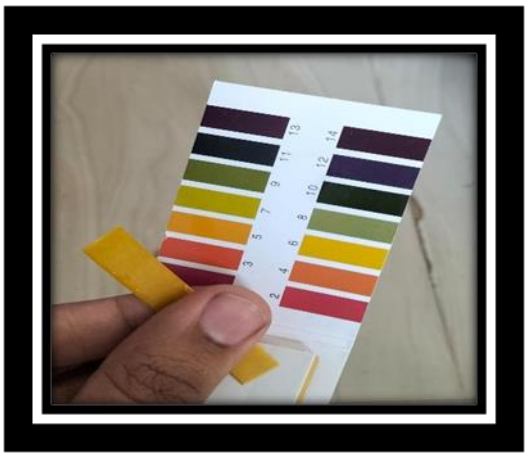

Fig-18: pH Level

Fig-19: pH level by digital pH meter

RESULTS AND DISCUSSION: -

Table No.-6: Result of all performed Batches

Sr.no.	Result	F1	F2	F3	F4	F5
1	Colour	Red	Red	Faint Red	Red Yellow	Yellow
2	Odour	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
3	State	gel	gel	liquid	liquid	liquid
4	pH	5.6	5.5	5.5	6.20	6.25
5	Irritancy	Nil	Nil	Nil	Nil	Nil

1. Colour: The semi-synthetic hand sanitizer has a light appearance with a hint of yellowish tint due to the beetroot juice

2. Odour: The sanitizer has a mild, pleasant scent

3. State: The product is in a Liquid state, making it easy to apply and spread on hands.

pH Level

1. pH: The pH level of the sanitizer is around 5.5-7 which is close to the natural pH of skin, minimizing the risk of irritation.

Irritancy: Skin Irritation: The sanitizer showed minimal to no skin irritation in most users, thanks to the soothing properties of Aloe vera, Vitamin E, and Glycerin.

Discussion

The results indicate that the semi-synthetic hand sanitizer is effective in terms of its physical properties, pH level, and skin compatibility. The combination of natural ingredients like Aloe vera, Coconut oil, and Vitamin E helps to minimize skin irritation and dryness, while Isopropyl alcohol provides effective antimicrobial action. The product's Liquid texture and mild scent make it user-friendly.

SUMMARY AND CONCLUSION

The semi-synthetic hand sanitizer was formulated using a combination of Isopropyl alcohol, Aloe vera, Vitamin E, Coconut oil, Glycerin, and Sodium benzoate. The product was evaluated for its physical properties, pH level, antimicrobial efficacy, skin compatibility, and user acceptability. The results showed that the sanitizer was effective in reducing microbial growth, gentle on skin, and had a pleasant texture and scent.

The semi-synthetic hand sanitizer developed in this project shows promise as a effective and gentle hand hygiene product. The combination of natural ingredients with Isopropyl alcohol provides a synergistic effect, enhancing the product's efficacy and user experience.

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