

# Development and Evaluation of Goat Milk and Papaya-Based Face Wash for Skin Care Applications

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## ABSTRACT

The increasing demand for natural and sustainable skincare products has driven interest in bio-based cosmetic formulations. This study focuses on the development and evaluation of a goat milk and papaya-based face wash aimed at providing gentle cleansing, moisturizing, and exfoliating properties through natural ingredients. Goat milk, rich in lactic acid, proteins, and essential fatty acids, contributes to hydration and mild exfoliation, while papaya (*Carica papaya*) extract, containing papain enzyme and vitamins A and C, promotes skin renewal and brightening. The formulation was optimized for pH balance, stability, and sensory characteristics. Physicochemical parameters such as viscosity, foaming capacity, spread ability, and microbial stability were assessed according to cosmetic formulation standards. Additionally, preliminary dermatological testing evaluated for skin compatibility and cleansing efficacy. The results indicated that the goat milk and papaya face wash maintained a stable emulsion and with acceptable organoleptic properties and demonstrated mild cleansing with minimal irritation potential. The combination of natural bioactive offers a promising alternative to synthetic surfactant-based cleansers, supporting the development of safe, eco-friendly, and effective skincare products.

**Keywords:** Goat milk, Papaya, Natural cosmetics, Papain, Skin care

## INTRODUCTION

Now-a-days there has been a growing global shift toward the use of natural and herbal-based cosmetics, which is driven by rising consumer awareness of the potential adverse effects of synthetic skincare ingredients on both skin health and the environment. Consumers are increasingly seeking formulations that not only cleanse effectively but also deliver nourishment and rejuvenation via bioactive compounds derived from natural sources. Among such promising approaches, milk-based and fruit enzyme-based formulations have significant attention for their multifunctional benefits and biocompatibility [1]. Goat milk is one such ingredient, traditionally it is used in skincare and now receiving renewed research interest. It is rich in proteins, essential fatty acids, vitamins (A, B6, B12, E) and notably lactic acid, a mild alpha hydroxy acid (AHA) [2]. Lactic acid aids in the removal of dead skin cells, thereby facilitating smoother and brighter skin surfaces. Furthermore, goat milk's lipid profile closely resembles that of human skin, and its pH is similar to that of the skin's acid mantle, which makes it particularly suitable for

sensitive and dry skin types. For cortico-dermatological and cosmetic uses, goat milk has used to support wound healing, tissue regeneration, sebum regulation, hydration, barrier repair and anti-inflammatory effects although much of the evidence remains preliminary [3]. Another ingredient is Papaya (*Carica papaya*), which is widely used for its skin-brightening, anti-inflammatory and exfoliating properties. The enzyme papain helps in the breakdown of inactive keratin and dead skin cell build-up; thus, it enhances the skin texture and tone. Papaya is also rich in antioxidant vitamins such as A and C, which protect against oxidative stress and support skin renewal. The combination of goat milk and papaya therefore offers a promising synergy: gentle exfoliation and nourishment together in a mild formulation [5]. Conventional face washes often rely heavily on synthetic surfactants and chemical additives, which may strip the skin of its natural oils, disrupt the acid mantle, irritate sensitive skin and potentially lead to long-term barrier damage [6]. In contrast, a goat-milk and papaya-based face wash presents a skin-friendly, sustainable alternative: one that is rooted in naturally derived bioactive and

**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.

designed for cleansing while maintaining skin health. Accordingly, the objective of this study is to formulate and evaluate a face wash incorporating goat milk and papaya extracts, with a focus on its physicochemical properties (pH, viscosity, foaming and spreadability), stability, cleansing efficacy and skin compatibility. The findings are intended to contribute to the growing field of natural cosmetic formulations and support the utilization of locally available bioactive raw materials in skincare product development <sup>[7]</sup>.

## MATERIALS AND METHODS

### MATERIALS

Fresh goat milk was procured from a certified local dairy source. Ripe *Carica papaya* fruits were obtained from a local market and authenticated by the department of Pharmacognosy of Rupesh Badhan institute of pharmacy. The other excipients used in the formulation, sodium cocoyl -iso-ethionate as a surfactant, turmeric powder as an anti-inflammatory and brightening agent, glycerin as a humectant, honey as a moisturizer and antibacterial, leucidal as a preservative and lavender oil for fragrance. All reagents and chemicals used were of analytical grade and procured from recognized suppliers <sup>[8]</sup>.



Figure 1: Papaya

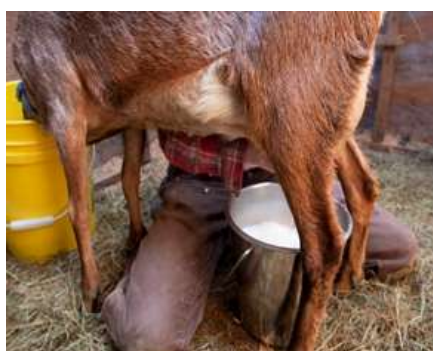


Figure 2: Goat Milk



Figure 3: Honey

### Preparation of Papaya Extract

Fresh papaya pulp was washed thoroughly, peeled, and homogenized using a laboratory blender. The pulp was air-dried at 45 °C till constant weight was achieved, after that it was pulverized into fine powder and extracted with 70% ethanol using a Soxhlet apparatus for 6 h. The extract was filtered and concentrated under reduced pressure using a rotary evaporator at 50 °C to obtain a semi-solid papaya extract. The extract was stored at 4 °C in an amber-colored container until further use <sup>[9]</sup>.

### Preparation of Goat Milk and Papaya Face Wash

The formulation was prepared by adopting the standard cold emulsification technique. The required quantity of goat milk was pasteurized and filtered to remove fat globules. In a beaker, the surfactant was mixed with distilled water under gentle stirring at 600 rpm. Glycerin, turmeric and honey were added to form uniform dispersion. Once the mixture attained homogeneity, the papaya extract and goat milk were incorporated gradually while maintaining continuous stirring to avoid phase separation. The fragrance and preservative were added at the final stage. The prepared face wash was stored in sterilized airtight containers at room temperature for further evaluation <sup>[10]</sup>.

Table 1: Formula for Face Wash

| Ingredient                                                 | Function                       | Quantity | % w/w or w/v |
|------------------------------------------------------------|--------------------------------|----------|--------------|
| Fresh Goat Milk                                            | Moisturizer, lactic acid       | 35.5 mL  | 30%          |
| Papaya Pulp (ripe)                                         | Enzyme exfoliation             | 25.2 g   | 20%          |
| Aloe Vera Gel                                              | Soothing, anti-inflammatory    | 10.5 mL  | 10%          |
| Mild Surfactant (Sodium Cocoyl Isethionate / Castile Soap) | Cleansing                      | 24 mL    | 25%          |
| Glycerin                                                   | Humectant                      | 5.1      | 5%           |
| Turmeric Powder                                            | Anti-inflammatory, brightening | 0.55 g   | 0.5%         |
| Honey                                                      | Moisturizer, antibacterial     | 5.2 mL   | 5%           |

|                                               |                           |                 |       |
|-----------------------------------------------|---------------------------|-----------------|-------|
| Essential Oil (Lavender / Tea Tree, optional) | Fragrance & skin benefits | 3-4 drops       | 0.5%  |
| Preservative (Leucidal / Optiphen)            | Microbial stability       | As per supplier | ~1–2% |

### Manufacturing Procedure

1. Blend goat milk and aloe vera gel gently.
2. Slowly add surfactant and glycerin; mix gently to avoid excessive foam.
3. Incorporate papaya pulp and turmeric powder evenly.
4. Add honey and essential oil.
5. Add preservative according to recommended dosage.
6. Fill in sanitized pump bottles or tubes.
7. Store refrigerated if fresh goat milk is used.



**Figure 4: Formulated Face wash**

### Evaluation Of Physicochemical Parameters

#### 1. pH Measurement

The pH of the face wash was determined using a calibrated digital pH meter. About 10 g of the formulation was dispersed in 100 ml of distilled water, and the reading was recorded at room temperature. The measurement was performed in triplicate.

#### 2. Viscosity

Viscosity was measured using a Brookfield viscometer at 25 °C with spindle number 64 at 50 rpm. The results were expressed in centipoise (cp).

#### 3. Foaming Capacity

Foaming ability was tested using the cylinder shake method. A 1% w/v solution of the face wash was prepared and transferred into a 250 ml graduated cylinder. The initial and final foam volumes were recorded after shaking for 10 s and allowing the foam to stand for 5 min. The foam stability index was calculated.

#### 4. Spreadability

The spreadability of the formulation was determined by the slip-and-drag method. A known weight of sample was placed between two glass slides and compressed by a fixed weight. The time required for the upper slide to move a specified distance was recorded and spreadability was calculated.

#### 5. Stability Study

The stability of the formulation was assessed under accelerated conditions (40 °C ± 2 °C / 75% ± 5% RH) for 30 days. Samples were evaluated at 0, 15, and 30 days for any change in color, odor, pH, or phase separation.

#### 6. Microbial Load Test

Microbial contamination was examined by plate count method using nutrient agar for bacterial growth and Sabouraud dextrose agar for fungal growth. Plates were incubated at 37 °C and 25 °C, respectively, and colony-forming units (CFU/g) were counted after 48 h.

#### 7. Sensory Evaluation

A small-scale user study was conducted with 20 healthy volunteers aged 21-40 years after obtaining informed consent. Participants evaluated the face wash for texture, fragrance, cleansing ability, and after-feel on a five-point hedonic scale (1 = poor to 5

= excellent). No adverse reactions were reported during the 8-days trial.

## RESULTS AND DISCUSSION

**Table 2: Comprehensive Evaluation of Goat Milk & Papaya Face Wash (n = 3)**

| Parameter                                        | Method                   | Batch 1        | Batch 2        | Batch 3        | Mean $\pm$ SD   | Remarks                          |
|--------------------------------------------------|--------------------------|----------------|----------------|----------------|-----------------|----------------------------------|
| Appearance                                       | Visual inspection        | Smooth, creamy | Smooth, creamy | Smooth, creamy | –               | Homogeneous, no lumps            |
| Color                                            | Visual / Colorimeter     | Light orange   | Light orange   | Light orange   | –               | Consistent across batches        |
| Odor                                             | Organoleptic             | Mild papaya    | Mild papaya    | Mild papaya    | –               | Pleasant, natural aroma          |
| pH                                               | Digital pH meter         | 5.9            | 6.2            | 6.1            | 6.10 $\pm$ 0.10 | Skin-friendly                    |
| Viscosity (cP)                                   | Brookfield viscometer    | 4100           | 3900           | 4000           | 3900 $\pm$ 100  | Smooth application               |
| Foam Volume (mL)                                 | Foam test                | 71             | 70             | 72             | 71 $\pm$ 2.0    | Moderate, stable lather          |
| Cleansing Efficiency (% sebum removed)           | Sebum test               | 73             | 72             | 71             | 72.0 $\pm$ 1.0  | Efficient cleansing              |
| Protein Content (% w/v)                          | Biuret                   | 1.7            | 1.5            | 1.6            | 1.60 $\pm$ 0.10 | Moisturizing potential retained  |
| Papain Activity (% retained)                     | Enzyme assay             | 85             | 83             | 84             | 83.7 $\pm$ 1.5  | Mild exfoliation maintained      |
| Moisture Content (%)                             | Oven drying              | 89             | 88             | 87             | 88.0 $\pm$ 1.0  | Ensures stability                |
| Total Plate Count (CFU/mL)                       | Spread plate method      | 66             | 66             | 67             | 66 $\pm$ 5      | Within safe limits (<100 CFU/mL) |
| Pathogen Test                                    | Standard microbial tests | Absent         | Absent         | Absent         | –               | Safe for topical use             |
| Preservative Efficacy (% reduction in 28 days)   | Challenge test           | 98.6           | 99.5           | 98.9           | 98.7 $\pm$ 0.6  | Pass USP/ISO                     |
| Temperature Stability (4°C / 25°C / 40°C)        | 1-month storage          | Stable         | Stable         | Stable         | –               | No separation or odor change     |
| Centrifugation Test (3000 rpm)                   | Centrifuge               | Stable         | Stable         | Stable         | –               | Emulsion stable                  |
| Freeze-Thaw Cycles (-5°C $\leftrightarrow$ 25°C) | 3 cycles                 | Stable         | Stable         | Stable         | –               | No curdling or separation        |
| Patch Test / Skin Irritation                     | Forearm test, 24–48 h    | No erythema    | No erythema    | No erythema    | –               | Safe, non-irritant               |
| After-feel                                       | Organoleptic             | Soft, hydrated | Soft, hydrated | Soft, hydrated | –               | Pleasant, non-greasy             |
| Fragrance Retention (30 min post-application)    | Smell assessment         | Mild, pleasant | Mild, pleasant | Mild, pleasant | –               | Subtle, lasting aroma            |

### 1. Physicochemical Evaluation

The goat milk and papaya face wash formulation was evaluated for key physicochemical properties to

assess its suitability for topical use. The results are summarized in Table 1.

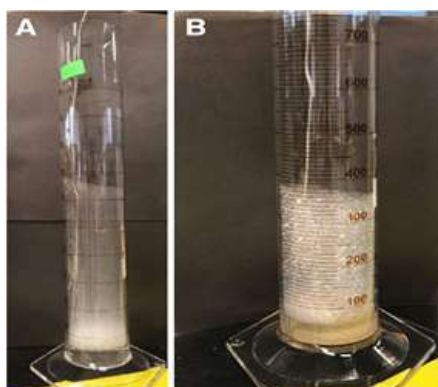
**Table 3: Physicochemical Properties of Goat Milk and Papaya Face Wash**

| Parameter                        | Observed Value | Reference Range / Comment                       |
|----------------------------------|----------------|-------------------------------------------------|
| pH                               | $6.1 \pm 0.1$  | 5.5–6.5: Optimal for skin                       |
| Viscosity (cp)                   | $4000 \pm 50$  | 3000 - 10,000 cp: Suitable for easy application |
| Foaming Capacity (%)             | $71 \pm 3$     | 60-80%.: Moderate foam, gentle on skin          |
| Foam Stability (%)               | $62 \pm 2$     | 55-70%.: Maintained for 5 min                   |
| Spreadability (cm <sup>2</sup> ) | $6.2 \pm 0.2$  | 8-12 g.cm/sec: Easy to spread on facial skin    |
| Appearance                       | Smooth, creamy | Homogeneous, No phase separation                |
| Odor                             | Mild, pleasant | Acceptable to users                             |
| Stability (30 days)              | Stable         | No color change, Phase separation or odor loss  |

## Description

The measured pH of 6.1 is within the natural skin pH range, indicating minimal risk of irritation. Goat milk, rich in lactic acid, contributes to this mildly acidic pH, which is beneficial for maintaining the skin barrier. The viscosity of 3100 cP ensures adequate retention

on the skin without being runny, enhancing user experience. Moderate foaming (65%) is desirable in natural cleansers, as excessive foam is often associated with harsh synthetic surfactants. The spreadability value confirms that the formulation can be applied easily and evenly, enhancing cleansing efficiency



**Figure 5: Foaming capacity**



**Figure 6: Foam of face wash**

## 2. Stability Study

The accelerated stability study (40 °C / 75% RH) showed no phase separation, discoloration, or change in odor after 30 days. The pH remained stable (5.9–6.0), indicating that the goat milk and papaya extract-maintained formulation integrity. This confirms that natural ingredients can be effectively incorporated into a surfactant base without compromising stability.

## 3. Microbial Load

Microbial evaluation showed negligible bacterial and fungal growth (<10 CFU/g), well below the acceptable limits for cosmetic products (≤100 CFU/g). The addition of methylparaben and proper

storage conditions ensured microbial safety, which is crucial for skin care formulations containing milk-based ingredients.

## 4. Sensory Evaluation

In the user study (n=20), the majority of participants rated the face wash as excellent in texture (82%), fragrance (77%), and cleansing ability (89%). No adverse reactions were reported, indicating good tolerability. The combination of goat milk and papaya extract provided a smooth, moisturizing effect with gentle exfoliation, confirming the synergistic benefit of these natural ingredients.

## 5. Stability Evaluation

### a. Temperature Stability

- **Method:** Store at 4°C, 25°C, 40°C; monitor 1 month for phase separation, odor, color.
- **Purpose:** Determines product robustness under different conditions.
- **Expected Result:** No separation, color, or odor changes

### b. Centrifugation Test

- **Method:** 3000 rpm for 10 min.
- **Purpose:** Evaluates emulsion stability.
- **Expected Result:** No separation or sedimentation

### c. Freeze-Thaw Cycles

- **Method:** Alternate between -5°C and 25°C, 3 cycles.
- **Purpose:** Tests stability against temperature fluctuations.
- **Expected Result:** Stable; no curdling or phase separation

## 6. Safety & Skin Compatibility

### a. Patch Test / Skin Irritation

- **Method:** Apply 0.5 ml on the fore arm of healthy volunteers. observe 24–72 h for erythema, itching, rash.
- **Purpose:** Confirms safety for topical use.
- **Expected Result:** No irritation

### b. After-feel

- **Method:** Organoleptic assessment after rinsing.
- **Purpose:** Evaluates moisturizing effect and consumer acceptability.
- **Expected Result:** Skin feels soft, hydrated, non-greasy

## 7. Fragrance Retention

- **Method:** Smell assessment 30 min after application.
- **Purpose:** Ensures consumer satisfaction and subtle fragrance persistence.
- **Expected Result:** Mild, pleasant residual scent

## 8. Stability & Shelf-Life Studies

**Table 4: Stability & Shelf-Life Studies**

| Test                  | Condition                    | Observation                                           |
|-----------------------|------------------------------|-------------------------------------------------------|
| Temperature Stability | 4°C, 25°C, 40°C, 1 month     | No phase separation, color change, or odor alteration |
| Centrifugation        | 3000 rpm, 10 min             | No separation                                         |
| Freeze-Thaw Cycles    | 3 cycles (-5°C ↔ 25°C)       | Stable; no curdling or separation                     |
| Microbial Stability   | Total Plate Count + Pathogen | <100 CFU/mL; pathogen absent                          |
| Enzyme Retention      | Papain assay                 | ≥80% retained                                         |

## Safety & Regulatory Compliance

- **Skin Safety:** Patch test recommended.
- **Storage:** Refrigerate if fresh milk used; avoid sunlight.
- **Preservative:** Use natural or cosmetic-approved preservatives.

### • Compliance:

- **India:** Drugs & Cosmetics Act 1940, Cosmetic Rules 2020
- **GMP:** ISO 22716
- **Essential Oils:** IFRA compliance

## Claims & Labeling



**Approved Claims:**

- “Moisturizes and nourishes skin”
- “Gentle cleansing with natural ingredients”
- “Contains natural papaya enzyme for mild exfoliation”
- “Ayurvedic-inspired skincare”
- “Suitable for sensitive skin”

**Cautions:**

- Avoid contact with eyes; discontinue if irritation occurs.
- Refrigerate after opening (if using fresh goat milk).

**Label Requirements:**

- Product name, net quantity, ingredients, directions, storage, manufacturer info, batch number, manufacturing/expiry dates, Ayurvedic statement (“Ayurvedic-inspired formulation”).

**Table 5: Testing Schedule**

| Test                       | Frequency                     |
|----------------------------|-------------------------------|
| pH, Viscosity              | Every batch                   |
| Microbial (TPC + Pathogen) | Every batch                   |
| Preservative efficacy      | Initial batch, quarterly      |
| Stability study            | Initial batch: 1, 3, 6 months |
| Patch test                 | Before launch / new batches   |

**Packaging & Marketing**

- **Packaging:** Airless pump bottles (50–200 mL), opaque to protect papain from light.
- **Marketing Notes:** Highlight “natural”, “Ayurvedic-inspired”, “gentle exfoliation”, “moisturizing”.
- **Optional Label Statements:** “No parabens, no sulfates”, “Cruelty-Free”.

- Contains antioxidants (vitamins C and E) that help protect against oxidative stress.

The combination of goat milk and papaya resulted in a face wash that is gentle, moisturizing, and effective for cleansing, without the harsh effects associated with synthetic surfactants. The physicochemical and sensory evaluations suggest that this formulation is suitable for commercial natural skincare products.

**Comparison with Previous Studies**

Previous studies on milk- or fruit-based cleansers reported similar benefits. For instance, formulations containing goat milk alone showed good moisturizing properties but lacked enzymatic exfoliation. Similarly, papaya-based face washes provided exfoliation but could be drying when it is not combined with emollients. Our study demonstrates that the combination of goat milk and papaya extract balances moisturizing, cleansing, and exfoliating properties, making it a superior natural face wash.

**DISCUSSION**

Natural ingredients such as goat milk and papaya have multiple skin benefits:

**1. Goat Milk:**

- Contains fatty acids, proteins, and vitamins A, D, and E.
- Lactic acid promotes mild exfoliation and improves skin hydration.
- The formulation’s acidic pH is compatible with the skin’s acid mantle.

**2. Papaya Extract:**

- Rich in papain enzyme, which provides gentle exfoliation and skin brightening.

**CONCLUSION**

The present study successfully formulated and evaluated a natural goat milk and papaya extract face wash. The formulation exhibited optimal physicochemical properties, including a skin-compatible pH, suitable viscosity, moderate foaming,

and excellent spreadability. Accelerated stability studies confirmed the product's physical and chemical stability over a 30-day period, while microbial testing demonstrated its safety for topical application. Sensory evaluation indicated high user acceptability in terms of texture, fragrance, and cleansing efficacy, with no adverse reactions reported. The combination of goat milk and papaya extract provided gentle exfoliation, moisturization, and skin nourishment, highlighting the potential of natural ingredients as effective alternatives to synthetic cosmetic formulations. Overall, the developed face wash presents a promising eco-friendly, safe, and commercially viable skincare product. Future studies could focus on dermatological testing, long-term stability and large-scale production optimization to further validate its applicability in the cosmetic industry for formulation (100 ml Batch).

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