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Research Article

Formulation And Evaluation of Loose Powder from Seashells

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ABSTRACT

The growing demand for safe, eco-friendly and sustainable cosmetic products has accelerated interest in natural raw materials as alternatives to traditional synthetic and mineral-based ingredients. This research explores the formulation and evaluation of a natural loose powder incorporating seashell-derived calcium carbonate, a biodegradable and underutilized marine resource. Rich in calcium carbonate, seashells offer inherent qualities such as whiteness, smoothness and mild absorbency, making them ideal for cosmetic applications. The study aims to develop a loose powder formulation aligned with clean beauty principles by replacing conventional fillers like talc and silica, which are increasingly scrutinized for their potential health and environmental risks. The formulation process includes cleaning, grinding and sieving of seashells to achieve the desired particle characteristics, followed by incorporation with natural excipients. The resulting powders were evaluated for physical properties including particle size uniformity, flowability, bulk and tapped density, as well as organoleptic characteristics such as colour, texture and fragrance. Sensory assessments and skin compatibility tests were also conducted to ensure safety and user satisfaction. The findings suggest that seashell powder is a viable, sustainable alternative that provides essential functional benefits while promoting waste valorisation and circular economy practices. This study contributes to the advancement of green formulation strategies in the cosmetics industry and underscores the potential of marine-derived materials in meeting contemporary consumer expectations for high-performing, environmentally responsible products.

INTRODUCTION

In recent years, there has been a growing shift in the cosmetics industry toward natural, safe and sustainable ingredients, driven by increased consumer awareness and environmental concerns. Loose powders are a common cosmetic product used to enhance skin appearance by reducing shine, improving texture and setting makeup. Traditionally, these powders have relied on mineral and synthetic fillers like talc, silica and polymers, which provide desirable functional

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properties but raise concerns regarding toxicity, skin compatibility and ecological impact. As a result, there is a pressing need to identify alternative raw materials that are both effective and environmentally responsible. Marine-derived resources have emerged as promising candidates, with seashells offering unique advantages. Composed mainly of calcium carbonate, seashells possess inherent qualities such as whiteness, smooth texture, absorbency and biodegradability. Their use not only aligns with green chemistry principles but also supports waste valorisation, as they are abundant by-products of the seafood industry. This research explores the formulation of loose powders using seashell-derived calcium carbonate, focusing on key performance parameters such as particle size, flowability, skin feel and safety. The study aims to contribute to the development of high-quality, eco-friendly cosmetic powders that meet modern consumer demands and support sustainable cosmetic innovation.[19]

Materials Characterization

Seashell Powder

Source: Derived from marine mollusks (e.g., snails, clams, oysters) typically collected from coastal areas, sea waste or aquaculture farms and can brought through trusted supplier of seashells.

Chemical Composition of Seashell Powder

Table 1: Chemical compositions of Seashell powder

Component	Concentration
Calcium Carbonate ($CaCO_3$)	90–95%
Magnesium Carbonate ($MgCO_3$)	Trace
Organic Matrix	2–5%
Trace Elements	Present (ppm)

Functional Role in Formulation

1. Acts as a filler and bulk agent.
2. Provides oil absorbency and matte finish.
3. Improves texture, spreadability and skin feel.
4. Contributes to opacity and whiteness in loose powders.

Formulation Table

Table 2: Formulation Table

Sr. No	Ingredients	F1 (90g)	F2 (100g)
1	Seashell Powder	30 g	40 g
2	Talc	30 g	30 g
3	Cornstarch	20 g	20 g
4	Zinc oxide	5 g	5 g
5	Magnesium Stearate	2 g	2 g
6	Fragrance oil	2-3 drops	2-3 drops
7	Methylparaben	0.3 g	0.3 g

Methods of Formulation

A. Preparation of Seashell Powder

- Collect clean, dry seashells.
- Crush them using a mortar and pestle or ball mill.
- Sieve the powder (100 mesh) to obtain fine particles.

B. Weighing of Ingredients

- Accurately weigh all ingredients using a digital balance.

C. Mixing

- In a clean, dry bowl, mix talc, cornstarch, zinc oxide and magnesium stearate using geometric dilution.
- Add the seashell powder and mix thoroughly.

D. Add Fragrance and Preservative

- Dissolve methylparaben in a few drops of alcohol (optional for better dispersion) and sprinkle onto the powder while mixing.
- Add fragrance oil dropwise while continuously stirring to avoid clumping.

E. Secondary Sieving Process

- Pass the blended powder through a fine mesh sieve to ensure consistent particle size, uniform distribution and a smooth final texture.

F. Packaging

- Transfer the final product into an airtight powder container.

Evaluation & Results

❖ Appearance

Table 3: Appearance

Parameter	F1	F2	Interpretation
Colour	White	White	Uniform white appearance
Texture	Smooth with slight grit	Smooth with slight grit	smooth texture with minor grittiness
Fragrance	Floral scent	Floral scent	Pleasant floral scent

Formulations F1 and F2 exhibited a uniform white colour, smooth texture with slight grittiness (likely due to seashell powder) and a mild floral scent. These consistent organoleptic properties indicate good blending, acceptable application quality and reproducibility of the formulation process.

❖ Flow Properties

a) Angles of repose

Table 4: Height(h) and Radius(r) of Formulation F1 & F2 respectively

Batch	Height (h)	Radius (r)
F1	3.8 cm	4.5 cm
F2	4.0 cm	5.0 cm

Calculations:

The angle of repose was calculated using the formula: $\boldsymbol{\theta} = \tan^{-1}\left(\frac{h}{r}\right)$

For Formulation F1,

$$\boldsymbol{\theta} = \tan^{-1}\left(\frac{3.8}{4.5}\right)$$

$= \tan^{-1}(0.844)$

$= 40.2^{\circ}$

For Formulation F2,

$\theta = \tan^{-1}\left(\frac{4.0}{5.0}\right)$

$= \tan^{-1}(0.8)$

$= 38.7^{\circ}$

Table 5: Angle of repose

Parameter	F1	F2	Interpretation
Angle of repose	40.2°	38.7°	Indicates fair to good flow property

The angles of repose for both formulations (F1 = 40.2°, F2 = 38.7°) fall within the range indicating fair to good flow properties. This suggests that the powder blends are suitable for handling and processing in formulation steps like filling and packaging.

b) Bulk Density

The bulk density was calculated using the formula:

$$\text{Bulk Density (g/mL)} = \frac{\text{Mass of Powder (g)}}{\text{Bulk Volume (mL)}}$$

For Formulation F1,

20 g of powder occupied a volume of 28.02 mL.

$$\textbf{Bulk Density} = \frac{20}{28.02} = \mathbf{0.714\ g/mL}$$

For Formulation F1,

20 g of powder occupied a volume of 27.59 mL.

$$\textbf{Bulk Density} = \frac{20}{27.59} = \mathbf{0.725\ g/mL}$$

Table 6: Bulk density

Parameter	F1	F2	Interpretation
Bulk Density	0.714g/mL	0.725g/mL	Indicates moderate packing

The bulk densities of F1 and F2 were 0.714 g/mL and 0.725 g/mL, respectively, indicating moderate particle packing suitable for pharmaceutical or cosmetic formulations.

c) Tapped Density

The Tapped Density was calculated using the formula:

$$\text{Tapped Density (g/mL)} = \frac{\text{Mass of Powder (g)}}{\text{Tapped Volume (mL)}}$$

For Formulation F1,

The final tapped volume was 22.50 mL

$$\text{Tapped Density} = \frac{20}{22.50} = \mathbf{0.889\ g/mL}$$

For Formulation F2,

The final tapped volume was 22.10 mL

$$\text{Tapped Density} = \frac{20}{22.10} = \mathbf{0.905\ g/mL}$$

Table 7: Tapped Density

Parameter	F1	F2	Interpretation
Tapped Density	0.889g/mL	0.905g/mL	Reflects good particle rearrangement and packing upon tapping.

The tapped densities of F1 and F2 were 0.889 g/mL and 0.905 g/mL, respectively, indicating efficient particle rearrangement and good packing behaviour upon tapping.

d) Carr's Index

The Carr's Index was calculated using the formula:

$$\text{Carr's Index (\%)} = \left(\frac{\text{Tapped Density} - \text{Bulk Density}}{\text{Tapped Density}}\right) \times 100$$

For Formulation F1,

Bulk Density = 0.714 g/mL & Tapped Density = 0.889 g/mL

$$\text{Carr's Index (\%)} = \left(\frac{0.889-0.714}{0.889}\right) \times 100$$

$$= \left(\frac{0.175}{0.889}\right) \times 100$$

$$= \mathbf{19.7\%}$$

For Formulation F2,

Bulk Density = 0.725 g/mL & Tapped Density = 0.905 g/mL

$$\text{Carr's Index (\%)} = \left(\frac{0.905-0.725}{0.905}\right) \times 100$$

$$= \left(\frac{0.180}{0.905}\right) \times 100$$

$$= \mathbf{19.89\%}$$

Table 8: Carr's Index

Parameter	F1	F2	Interpretation
Carr's Index	19.7%	19.89%	Fair to good flowability

Carr's Index values of 19.7% (F1) and 19.89% (F2) were calculated, indicating fair to good flowability. These values fall within the 15–20% range, suggesting both formulations possess acceptable flow properties for cosmetic processing.

e) Hausner's ratio

The Hausner's ratio was calculated using the formula:

$$\text{Hausner's ratio} = \frac{\text{Tapped Density}}{\text{Bulk Density}}$$

For Formulation F1,

Tapped Density = 0.889 g/mL & Bulk Density = 0.714 g/mL.

$$\text{Hausner's ratio} = \frac{0.889}{0.714} = \mathbf{1.24}$$

For Formulation F2,

Tapped Density = 0.905 g/mL & Bulk Density = 0.725 g/mL.

$$\textbf{Hausner's ratio} = \frac{\mathbf{0.905}}{\mathbf{0.725}} = \mathbf{1.25}$$

Table 9: Hausner's ratio

Parameter	F1	F2	Interpretation
Hausner's ratio	1.24	1.25	Indicates good flow

❖ Moisture Content

The Moisture content was calculated using the formula:

$$\text{Moisture Content (\%)} = \left(\frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}}\right) \times 100$$

For Formulation F1,

Initial Weight = 5.00 g & Final (Dry) Weight = 4.912 g.

$$\text{Moisture Content (\%)} = \left(\frac{5.00-4.912}{5.00}\right) \times 100$$

$$= \left(\frac{0.088}{5.00}\right) \times 100$$

$$\mathbf{= 1.76\%}$$

For Formulation F2,

Initial Weight = 5.00 g & Final (Dry) Weight = 4.895 g

$$\text{Moisture Content (\%)} = \left(\frac{5.00-4.895}{5.00}\right) \times 100$$

$$= \left(\frac{0.105}{5.00}\right) \times 100$$

$$\mathbf{= 2.10\%}$$

Table 10: Moisture Content

Parameter	F1	F2	Interpretation
Moisture Content	1.76%	2.10%	Formulations are suitably dry.

Moisture content was found to be 1.76% for F1 and 2.10% for F2, indicating that both formulations are suitably dry and within acceptable limits for stable storage and flow.

The pH of a formulation is crucial for ensuring skin compatibility and product stability. It was measured using a calibrated digital pH meter by dispersing the powder in distilled water.

❖ pH

Table 11: pH

Parameter	F1	F2	Interpretation
pH	6.2	6.4	Skin compatible.

The pH values of F1 (6.2) and F2 (6.4) fall within the skin-friendly range, confirming that both formulations are suitable for topical application.

❖ Skin irritation test

The skin irritation test was conducted to assess the dermatological safety of the formulations. A small quantity of each sample was applied to a defined area of the skin and observed for 24-48 hours for any signs of redness, itching or inflammation.

Table 12: Skin Irritation Test

Parameter	F1	F2	Interpretation
Skin irritation test	No signs of irritation	No signs of irritation	Non-irritant and safe for topical use.

Both F1 and F2 show no signs of irritation, indicating they are non-irritant and safe for topical use.

CONCLUSION

The flow properties, moisture content, pH and skin irritation potential of formulations F1 and F2 were evaluated. The angle of repose for F1 and F2 was 40.2° and 38.7°, respectively, indicating fair to good flow properties. The bulk density for F1 and

F2 was 0.714 g/mL and 0.725 g/mL, reflecting moderate packing, while the tapped density was 0.889 g/mL for F1 and 0.905 g/mL for F2, suggesting good particle rearrangement and packing upon tapping. The Carr's index was 19.7% for F1 and 19.89% for F2, both indicating fair to good flowability. The Hausner's ratio was 1.24 for F1 and 1.25 for F2, which reflects good flow characteristics. Additionally, the moisture content of both formulations was within acceptable ranges, ensuring stability during storage and preventing degradation. The pH of both formulations was within a neutral to slightly acidic range, confirming their compatibility with the skin and minimizing irritation risk. The skin irritation test showed no signs of irritation (e.g., redness, swelling or itching) for either formulation, confirming both F1 and F2 as non-irritant and safe for topical use. In conclusion, both formulations exhibit good flowability, moderate packing and adequate compressibility. The moisture content, pH and skin irritation test results further support their stability, skin compatibility and safety for topical use. F1 and F2 are both suitable for handling, processing and large-scale production. These evaluation outcomes collectively validate the functional potential of both formulations for use as loose powders in cosmetic applications. The consistent results between F1 and F2 indicate reproducibility and formulation reliability, which are essential for product development and scale-up. Furthermore, the incorporation of natural ingredients contributes to the eco-friendliness and market appeal of the final product, aligning with current trends in sustainable and skin-friendly formulations.

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