

FORMULATION AND EVALUATION OF HERBAL LIPSTICK USING *OPUNTIA DILLENII* AND *CALENDULA OFFICINALIS* AS HERBAL COLORANTS

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ABSTRACT

The present study focuses on the formulation and evaluation of a herbal lipstick using natural colorants derived from *Opuntia dillenii* and *Calendula officinalis*. The primary objective of the study is to assess the compatibility and coloring potential of these two natural pigments when used in combination and to develop different lipstick shades by varying their concentrations. Extracts obtained from *Opuntia dillenii* fruits and *Calendula officinalis* petals were incorporated into a suitable lipstick base containing natural waxes and oils. Multiple formulations were prepared with different ratios of the two colorants and evaluated for color intensity, appearance, spreadability, melting point, breaking point and pH. The optimum combination of the colorants that provided desirable color characteristics along with acceptable physicochemical properties. The findings demonstrated the feasibility of utilizing the combined natural pigments as effective alternatives to synthetic colorants in cosmetic formulations. Four formulations were prepared (F1 – F4) by changing ratio of natural colorants, while holding Lipstick base composition constant. All the excipients were compatible with the oil extracts. Lipstick exhibited desirable character such as color intensity, appearance, spreadability, melting point, breaking point and pH. Both the pigments extract can be used as natural colorants.

KEYWORDS: herbal lipstick, natural colourant, *Opuntia dillenii*, *Calendula officinalis*, betalain, cosmetic formulation.

1. INTRODUCTION

Lipstick is a cosmetic applied to the lips and, under the Drugs and Cosmetics Act of India, falls within the legal definition of a cosmetic, that is, an article applied to the human body to cleanse, beautify or alter appearance.^[1,2] It is a solid dispersion in which pigments are carried in a wax and oil matrix, and shade is usually the first attribute a consumer judges.^[3] In such a stick the wax network provides the rigid framework, the oil and emollient phase occupies the spaces within it, and the pigment particles and additives (antioxidants, flavour, preservatives) are dispersed throughout the matrix.^[4] Because lipsticks are applied repeatedly and a fraction is unavoidably swallowed, the choice of colourant and other ingredients deserves particular care.^[5]

Herbal cosmetics have gained acceptance as natural alternatives to synthetic products, helped by growing awareness of the possible harms of synthetic chemicals.^[6] Lipstick formulations have also changed steadily in shade, texture, gloss, spreadability and consumer acceptability.^[7]

Synthetic dyes and lakes remain the main colourants of commercial lipsticks, and many herbal lipstick studies have examined plant-derived alternatives such as carrot, beetroot and annatto.^[8-10] Rasheed et al. incorporated carrot, beetroot, turmeric, tomato, pomegranate and cocoa into lipsticks and evaluated colour, texture, pH, melting point, breaking point, surface characteristics and stability.^[11] Patil et al. prepared ten formulations with

beetroot, dragon fruit and cocoa pigments and reported acceptable physicochemical properties for the selected formulation^[12], and other plant-based lipsticks have been reported.^[13] Many of these studies use a single pigment source. A two-extract design in which the extract ratio was varied has been described for roselle flower and secang wood^[14], but combinations of other plant colourants remain little explored.

Opuntia dillenii (Ker Gawl.) Haw. (Cactaceae) is a prickly pear that grows in dry and semi-arid tropical and subtropical regions and bears purple-red fruit whose colour is attributed mainly to betalains, water-soluble pigments comprising red-violet betacyanins and yellow betaxanthins.^[16] Betalains form when betalamic acid condenses with cyclo-DOPA or amino acids, giving betacyanins such as betanidin or betaxanthins such as indicaxanthin.^[17] The pigment composition and the colour behaviour of the fruit extracts under different processing conditions have been studied^[18], a total betalain content of about 10 mg/g has been reported for the fruit^[19], and the plant has been reviewed for its composition and pharmacological properties.^[20] Betalains are sensitive to heat, pH, light and oxygen^[21], which is relevant to any product prepared by melting a wax base. Storage of *Opuntia dillenii* extracts near 4 °C was reported to preserve colour and betalain content, whereas strongly acidic conditions caused greater colour change and betalain loss^[22], and the colour stability of betaxanthins derived from the fruit pigment was likewise pH dependent.^[23] Lipsticks containing *Opuntia dillenii* colourant have been reported.^[24]

Calendula officinalis L. (Asteraceae), pot marigold, bears yellow to orange flowers that contain carotenoids,

which give the colour, together with flavonoids and triterpenoids.^[26-30] Triterpenoid esters from the flowers showed topical anti-inflammatory activity in an experimental model^[31,32], and the plant has a long history of use in skin and cosmetic preparations.^[33] In the present work, *Calendula officinalis* was chosen as a yellow to orange colourant to modify the red-purple shade of *Opuntia dillenii*.

A lipstick coloured with *Opuntia dillenii* and *Calendula officinalis* extracts together has not been reported. The aim of this study was therefore to formulate and evaluate herbal lipsticks using extracts of the two plants as colourants. The specific objectives were:

- To extract natural pigments from *Opuntia dillenii* fruits;
- To obtain a coloured aqueous extract from *Calendula officinalis* flowers by maceration;
- To screen the miscibility of the extracts with candidate base ingredients and to prepare four lipsticks in which only the extract ratio was varied;
- To develop different natural shades by varying the ratio of the two extracts; and
- To evaluate the lipsticks for colour, appearance, melting point, breaking point, spreadability and pH.

2. MATERIALS AND METHODS

Materials

The materials and suppliers are listed in Table 1. Equipment comprised a centrifuge (Lab line), an analytical balance (Systronics), a digital pH meter (Infra Digi), a melting point apparatus and a rotary vacuum evaporator.

Table 1: Materials and suppliers.

Material	Supplier
Beeswax	Sisco Research Laboratories
Castor oil	S D Fine-Chem Limited
Cocoa butter	Karnataka Fine Chem, Bangalore
Lanolin	Molychem
Cetyl alcohol	Loba Chemie Pvt. Ltd., Mumbai
Liquid paraffin	S D Fine-Chem Limited
Rose essential oil	S. H. Kelkar and Company
Propyl paraben	Karnataka Fine Chem, Bangalore
Vitamin E (tocopherol)	S D Fine-Chem Limited

Plant material

Opuntia dillenii fruits and *Calendula officinalis* flowers were collected locally in Mysuru, Karnataka, India, and were submitted to the Department of Botany, Sarada Vilas College, Krishnamurthypuram, Mysuru, for species authentication. The fruit was identified as *Opuntia dillenii* (Ker Gawl.) Haw., family Cactaceae, by Dr. M. Devika, Head, Department of Botany (certificate no. SVC/Bot/Auth/09/2026-27, dated 1 July 2026).

Preparation of *Opuntia dillenii* extract

Five to Six peeled fruits (350gm) were homogenised with an equal quantity of water. The mixture was heated at 80 °C for 5 min, rapidly cooled in an ice bath to 8-10 °C and centrifuged at 3200 rpm for 20 min in a hand-operated centrifuge. The supernatant was separated as the extract and stored in amber bottles at 4 °C until use.

Preparation of *Calendula officinalis* extract

About 100 g of flowers was cleaned, shade-dried at room temperature to constant weight and powdered in

a grinder. The powder was macerated in 1 L of distilled water (1:10 w/v) in a closed wide-mouthed glass container for 5 Days at 25-30 °C with intermittent stirring. The mixture was filtered through muslin cloth and then through Whatman No. 1 filter paper. The filtrate was concentrated in a rotary vacuum evaporator at about 50-65 °C under reduced pressure to roughly one-fourth of its volume (about 250 mL from the initial 1 L, depending on extraction losses) and stored in an amber container under refrigeration at 3-4 °C.^[34]

Organoleptic evaluation of the extracts

The colour, state, odour and texture of each extract were recorded by visual inspection, smell and touch.

Miscibility screening

Compatibility of the extracts with identified base ingredients (beeswax, carnauba wax, castor oil, cocoa butter, shea butter, lanolin, cetyl alcohol and liquid paraffin) was screened by mixing 2 mL of extract with 4 mL of each ingredient. Mixtures were warmed on a water bath at 40-45 °C for 10 min with a glass rod and inspected visually for precipitation, agglomeration or phase separation.

Formulation design and preparation of lipsticks

Four lipsticks (F1 to F4) were prepared with an identical base and different ratios of *Opuntia dillenii* to *Calendula officinalis* extract (Table 2). Beeswax, lanolin and cocoa butter were fused in a beaker over a water bath held at 70-75 °C, with stirring, until a clear and uniform melt was obtained. Castor oil, held at 40-45 °C, was added slowly with stirring. The two extracts were rubbed with a little castor oil into a paste, and this was introduced in portions into the melt at roughly 45-50 °C under constant stirring until evenly distributed. After cooling to about 40°C, vitamin E were added and mixed gently to avoid air entrapment. The mass was poured into moulds lightly lubricated with liquid paraffin, slightly overfilled and tapped to remove air bubbles. The filled moulds were left at room temperature for 30 min and then chilled at 4-8 °C for a further 15-20 min. Sticks were demoulded, briefly flamed or smoothed with a warm spatula for a glossy finish, fitted into containers, and kept away from direct light, heat and moisture at 25 ± 2 °C until they were evaluated.

Table 2: Composition of lipstick formulations F1 to F4 (quantity per batch).

Ingredient	F1	F2	F3	F4
Beeswax (g)	3	3	3	3
Castor oil (mL)	7	7	7	7
Cocoa butter (g)	2	2	2	2
Lanolin (g)	2	2	2	2
Cetyl alcohol (g)	0.5	0.5	0.5	0.5
<i>O. dillenii</i> : <i>C. officinalis</i> extract ratio	4:1	7:3	3:2	1:1
Vitamin E (tocopherol)	q.s.	q.s.	q.s.	q.s.
Rose essential oil	q.s.	q.s.	q.s.	q.s.
Paraben preservative	q.s.	q.s.	q.s.	q.s.
Liquid paraffin	q.s.	q.s.	q.s.	q.s.

q.s., quantity sufficient.

3. EVALUATION OF LIPSTICKS

Appearance, colour, homogeneity and surface defects.

Sticks were examined visually for shade, gloss, uniformity of colour, lumps or coarse particles, and surface defects (crystallisation, cracking, pitting, sweating and oil bleeding). Shade scores were assigned by visual comparison.

Melting point. Each lipstick was melted on a temperature-controlled hot plate and drawn into capillary tubes pre-warmed at 70 °C for 10 min. After solidifying for 10 min, the tubes were placed in the melting point apparatus and the melting range was observed. The test was run in triplicate.

Breaking point. Each stick was fixed horizontally in a holder placed 1 inch from the edge of the support, and weights were added in steps of 5 g every 30 s; the load at which the stick fractured was recorded as its breaking point.

Spreadability. Spreadability was assessed qualitatively by applying the lipstick repeatedly onto a glass slide at room temperature (24 ± 3 °C), noting how evenly the film formed and whether the stick crumbled, changed shape or snapped.

pH. Approximately 1 g of lipstick was suspended in 10 mL of distilled water by gentle mixing and left to equilibrate at room temperature; the pH was then read on a calibrated digital pH meter, with the electrode washed with distilled water.

Ethical considerations. No human volunteers or animals were used, and no ethical approval was required for the work reported.

4. RESULTS AND DISCUSSION

Characteristics of the extracts

The *Opuntia dillenii* extract was a reddish-purple, slightly viscous liquid with a pleasant fruity odour, and

the *Calendula officinalis* extract was a smooth, yellowish-orange liquid with a faint aromatic odour (Table 3; Fig. 1). The reddish-purple colour is consistent with the betalains reported for this fruit, but pigment content was not measured here, so this attribution is presumptive. Likewise, carotenoids are the best-known

yellow-orange pigments of *Calendula* flowers, but they are lipophilic, and an aqueous extract would be expected to carry mainly polar constituents. The colour of the present extract may therefore not be assigned to carotenoids without analysis. Extract yield, pH and pigment content were not determined.

Table 3: Organoleptic characteristics of the extracts.

Parameter	<i>Opuntia dillenii</i> extract	<i>Calendula officinalis</i> extract
Colour	Reddish-purple	Yellowish-orange
State	Viscous liquid	Liquid
Odour	Pleasant fruity	Faintly aromatic
Texture	Slightly viscous	Smooth



Fig. 1: Appearance of the extracts: (a) *Opuntia dillenii* extract; (b) *Calendula officinalis* extract.

Miscibility of the extracts with base ingredients

Six of the eight ingredients mixed with the extracts without visible precipitation or phase separation, whereas carnauba wax and shea butter formed agglomerates (Table 4; Fig. 2). The six compatible ingredients were therefore used in the base, and the two incompatible ones were excluded. Because the extracts are aqueous and the ingredients are fatty or waxy, a visual absence of separation indicates dispersibility under the test conditions rather than true molecular miscibility. The warming temperature (40-45 °C) was below the melting range of beeswax and carnauba wax, so outcomes for the solid waxes should be interpreted cautiously. The reason for the agglomeration of carnauba wax and shea butter was not investigated.

Table 4: Miscibility of the extracts with base ingredients.

Sr. No.	Ingredient	Result	Observation
1	Beeswax	Compatible	Uniform mixture, no visible separation
2	Carnauba wax	Not compatible	Agglomerates
3	Castor oil	Miscible	Clear, homogeneous mixture
4	Cocoa butter	Compatible	Uniform mixture, no phase separation
5	Shea butter	Not compatible	Agglomerates
6	Lanolin	Compatible	Homogeneous mixture
7	Cetyl alcohol	Compatible after heating	Uniform mixture without lumps or separation
8	Liquid paraffin	Miscible	Homogeneous mixture

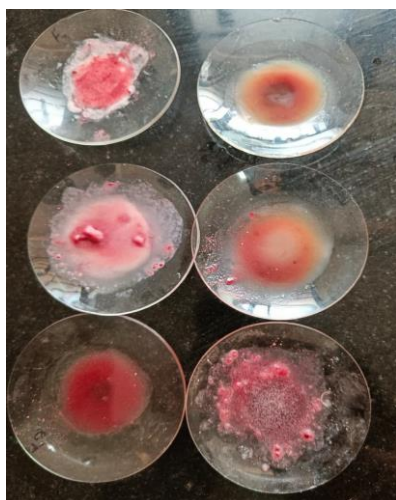


Fig. 2: Miscibility screening of the extracts with the candidate base ingredients.

Shade and appearance

Changing the extract ratio produced four visually distinguishable shades (Table 5; Figs. 3 and 4). F1 (4:1) was described as deep berry, F2 (7:3) as berry wine, F3 (3:2) as berry red and F4 (1:1) as rose berry, the lightest of the four. All sticks were homogeneous, smooth and free from lumps, coarse particles, cracks and visible surface defects. These descriptions suggest that a higher proportion of *Opuntia dillenii* extract gave deeper shades, but the names are subjective and no instrumental colour measurement was made, so differences in colour intensity are not quantified. Because the base was identical in all batches, the shade differences can reasonably be linked to the extract ratio, although the total quantity of extract added per batch is not stated in Table 2. Betalain colour may change on heating or storage, and shade stability was not assessed.

Table 5: Colour, appearance and homogeneity of the lipsticks.

Code	Shade	Appearance	Homogeneity	Surface
F1	Deep berry	Smooth, glossy, uniform	Homogeneous	Smooth, free from cracks and air bubbles
F2	Berry wine	Smooth, glossy, uniform	Homogeneous	Smooth, free from surface defects
F3	Berry red	Smooth, uniform	Homogeneous	Smooth, even, free from cracks
F4	Rose berry	Smooth, slightly lighter	Homogeneous	Smooth, even, free from visible defects

**Fig. 3: Lipstick formulations F1 to F4 in the moulds before demoulding (top to bottom: F1, F2, F3 and F4).****Fig. 4: Finished herbal lipstick in its container: (a)F1, (b)F2.****Melting point**

The physicochemical results are summarised in Table 6. Melting ranges were 54-59 °C (F1), 50-56 °C (F2), 52-58 °C (F3) and 55-60 °C (F4). A lipstick should remain intact at the temperatures met in storage and handling but soften on the lips. These ranges fall below the 60-66 °C reference range commonly applied to lipsticks, so a risk of deformation in warm climates cannot be excluded.(Fig. 5)

Breaking point

Breaking points were breaking points were 30, 35, 25 and 30 g for F1 to F4. The differences are small and no replicate values or standard deviation were recorded. Since the wax, butter and oil content was the same in all

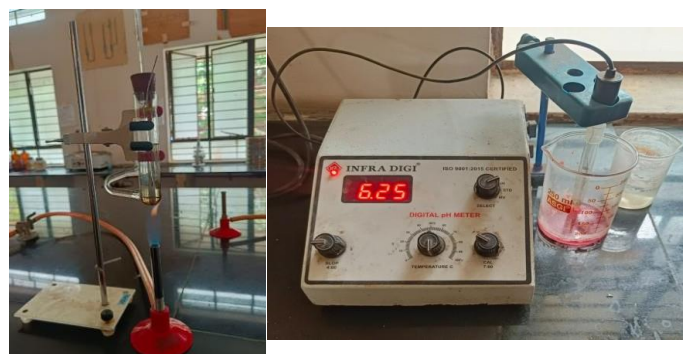
batches, differences in hardness might arise from the extract fraction added, but this was not tested.

pH

The pH of F1 to F4 was 6.82, 6.57, 6.33 and 6.25, respectively (mean values; Table 6). The pH fell steadily as the proportion of *Opuntia dillenii* extract decreased from 80% to 50% of the extract mixture. This may reflect a difference in acidity between the two extracts, but the pH of the individual extracts was not measured. A pH close to neutral is generally desirable for a product that contacts the lips, but pH measured in a water dispersion of a wax-oil stick is an indirect measure and does not establish safety or absence of irritation, neither of which was tested.(Fig. 5).

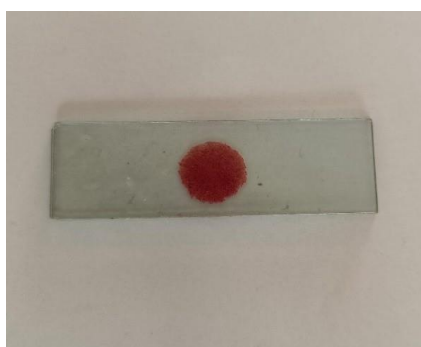
Table 6: Physicochemical evaluation of the lipsticks.

Parameter	F1	F2	F3	F4
Melting range (°C)	54-59	50-56	52-58	55-60
Breaking point (g)	30	35	25	30
pH (mean $\pm$ SD)	6.82 $\pm$ 0.1	6.57 $\pm$ 0.3	6.33 $\pm$ 0.1	6.25 $\pm$ 0.2
Spreadability	Good	Good	Good	Good
Surface defects	None observed	None observed	None observed	None observed

**Fig. 5: Test set-up: (a) melting point determination; (b) digital pH meter during measurement of a lipstick dispersion.****Spreadability and surface characteristics**

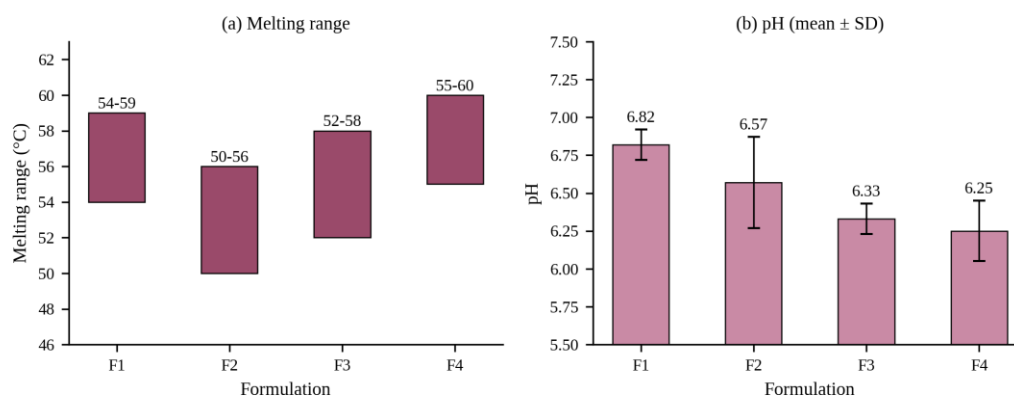
All four lipsticks laid down a uniform film on a glass slide without fragmenting or deforming during the test,

and none showed crystallisation, cracking, pitting, sweating or oil bleeding on visual inspection (Fig. 6).

**Fig. 6: Lipstick film on a glass slide during the spreadability test of F2.****Comparative evaluation of the formulations**

The melting ranges and pH values of F1 to F4 are compared in Fig. 7. The formulations differed only in extract ratio, and the variation in these parameters was small: melting ranges overlapped between 55 °C and 56

°C for all four, and pH varied by 0.57 units. No formulation was clearly superior on every measured parameter, so no single formulation is proposed as optimal; this would require colour measurement, stability data and consumer acceptability testing.

**Fig. 7: Comparison of F1 to F4: (a) melting range; (b) pH (mean $\pm$ SD, as in Table 6).**

Comparison with earlier reports and colour-stability considerations

The parameters evaluated here (melting point, breaking point, pH and surface characteristics) are those commonly used for herbal lipsticks, and earlier studies of natural-pigment lipsticks reported acceptable physicochemical properties for their selected formulations. *Opuntia dillenii* fruit extract has been used as the principal colourant of a cosmeceutical lipstick; the present work differs in pairing it with *Calendula officinalis* and varying the ratio of the two extracts.

Colour stability is the main open question for betalain-coloured lipsticks. Extracts of *Opuntia dillenii* were reported to keep their colour and betalain content best when stored near 4 °C, with greater losses under strongly acidic conditions, and some betaxanthins derived from the fruit pigment were more stable at pH 6. The extracts here were stored at 4 °C and the sticks had pH values of 6.25-6.82, which is close to the pH 6 value reported to favour some betaxanthins. However, the sticks were prepared by incorporating the extract into a melt at 65-70 °C, betalains are heat sensitive, and neither colour retention nor betalain content was measured, so no conclusion about the stability of the finished colour can be drawn.

5. CONCLUSION

Aqueous extracts of *Opuntia dillenii* fruit and *Calendula officinalis* flowers could be incorporated into a wax-oil lipstick base, and varying their ratio from 4:1 to 1:1 produced four distinguishable berry-type shades with smooth, homogeneous sticks, breaking points of 25-35 g and pH values of 6.25-6.82. These observations support the feasibility of combining the two extracts as natural colourants, but not their stability, safety or performance relative to commercial lipsticks. Colourimetric analysis, accelerated and long-term stability studies, microbial testing and safety evaluation are needed before any claim of suitability for use.

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