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FORMULATION AND EVALUATION OF POLYHERBAL LIPSTICK USING NATURAL COLORANTS AND MEDICINAL PLANT EXTRACTS

Rakkimuthu Ramalingam*, Sangeetha Mohanraj, Anandakumar Mohanraj, Sathishkumar Palanisamy, Sowmiya Duraisamy

Dr. Mahalingam Center for Research and Development, PG and Research Department of Botany Nallamuthu Gounder Mahalingam College, Pollachi-642001, Tamil Nadu, India.

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***Corresponding Author**
Rakkimuthu Ramalingam

Dr. Mahalingam Center for Research and Development, PG and Research Department of Botany Nallamuthu Gounder Mahalingam College, Pollachi-642001, Tamil Nadu, India.

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ABSTRACT

The present study successfully demonstrated the formulation and evaluation of a herbal lipstick using ethanol extracts of selected medicinal plants. The lipstick exhibited desirable physical characteristics, including smooth texture, pleasant fragrance, stable color, and excellent water resistance. It maintained a neutral pH and showed no signs of degradation or irritation over a 20-day period. Notably, the formulation displayed strong antioxidant activity (IC_{50} = 27.8 µg/mL), highlighting its potential therapeutic benefits alongside cosmetic use. These findings support the use of natural plant-based ingredients in safe, effective, and multifunctional cosmetic products, offering a promising alternative to synthetic formulations.

KEYWORDS: Herbal Lipstick, Cosmetics, antioxidant, DPPH.

INTRODUCTION

Cosmetics, derived from the Greek term "Kosm tikos," meaning "skilled in decoration" or "having the power to arrange," originate from "kosmein" (to adorn) and "kosmos" (order, harmony).[1] The Association of Southeast Asian Nations (ASEAN) defines cosmetics as substances applied externally for cleaning, perfuming, altering appearance, or maintaining

skin condition.[2] Historically, cosmetics were linked to hunting, religious rituals, and medicine.[3] Today, they include products like toothpaste, shampoo, lotions, perfumes, and lipsticks.[4]

The Indian cosmetic industry, valued at Rs. 15,000 crore, is growing at over 10% annually. This expansion poses challenges for manufacturers to create high-quality, eco-friendly products. Many cosmetics contain preservatives and fragrances, some of which are toxic and banned due to their links to cancer and endocrine disruption. Heavy metals, commonly found in beauty products, pose significant health risks, including organ damage and neurological disorders[2]. Even at low concentrations, metals like lead and cadmium accumulate in the body, causing chronic health issues.[5]

UV filters like benzophenone-1 and benzophenone-3, commonly used in cosmetics, are potential endocrine disruptors. Studies suggest they may cause neuronal delays, congenital malformations, and reduced fertility. The International Agency for Research on Cancer (IARC) classifies benzophenone as possibly carcinogenic (Group 2B), and it has been detected in biological fluids, including maternal milk. Ethylhexyl methoxycinnamate, another UV filter, has been reported to disrupt endocrine regulation.[6]

Lipstick is a widely used cosmetic that enhances beauty while providing protection. Traditionally composed of wax, oils, pigments, and additives, its history dates back to Mesopotamian civilizations. The modern cylindrical metal applicator emerged in 1915[7] lipsticks offer psychological and therapeutic benefits, they can also harbor microbes from the environment. These microbes metabolize lipstick ingredients or transfer from the tongue. Synthetic lipsticks containing phthalates, petrolatum, and lead pose serious health risks, and the damp interior of lipstick tubes fosters bacterial growth.[7]

Frequent lipstick use may contribute to cumulative toxicity. Research by the University of California suggests women apply lipstick 2 to 14 times daily, potentially ingesting up to 87 mg of chemicals per day. Prolonged exposure increases the risk of systemic toxicity.[8] Although metal concentrations in some lipsticks are low, their cumulative effects remain a concern. Lead exposure is linked to neurotoxicity, developmental issues, and reproductive disorders, while chromium can cause ulcers, kidney damage, and other severe conditions.[5]

Many consumers are now turning to herbal alternatives. Herbal lipsticks, formulated with plant-based ingredients, offer natural moisture and nourishment while minimizing exposure to harmful chemicals. These products contain antioxidants, anti-inflammatory, and antibacterial properties.[9] Unlike synthetic cosmetics, herbal alternatives are often free from toxic preservatives, making them safer for long-term use.[10] Medicated lipsticks provide additional protection against bacterial infections while preventing chapped lips.[11]

This study aims to develop a herbal-based lipstick free from harmful metals and synthetic chemicals. The objective is to formulate a safe and effective alternative with antioxidant and antimicrobial properties. By prioritizing natural ingredients, this formulation seeks to offer a healthier cosmetic option while promoting sustainability and well-being.

MATERIALS AND METHODS

Selection and collection of plant materials

The herbal plants were selected based on the scientific literature that were used in cosmetic formulation based on their phytochemical profile, anti-oxidant and anti-microbial properties, safety and compatibility.

Glandular hairs of *Mallotus philippensis* (Lam.) Müll.Arg. were collected from Valparai, while the pericarp of *Terminalia chebula* Retz. and leaves of *Piper nigrum* L. were obtained from Sethumadai. Additionally, leaves of *Lawsonia inermis* L., *Mangifera indica* L., and *Ocimum tenuiflorum* L. were collected from Anaimalai. Furthermore, rice bran wax, shea butter, coconut oil, sunflower lecithin, rosemary oil, and strawberry essence were procured from commercial sources.

Preparation of Powder and Herbal extract

The freshly collected plant materials were cleaned, shade-dried, and finely powdered. The powdered plant materials were then stored in airtight containers to preserve their bioactive properties.

For extraction, the selected plant powders were separately packed into a Soxhlet apparatus and subjected to ethanol extraction. In contrast, *Mallotus philippensis* and *Lawsonia inermis* were processed using a magnetic stirrer to obtain their respective extracts. The crude concentrated extracts were obtained by evaporating the excess solvent and subsequently stored at 4°C for further analysis.

Preparation of Herbal Lipstick

The selected plant extracts and pigments were incorporated in varying ratios to formulate the herbal lipstick.

Formulation of Herbal Lipstick

The herbal lipstick was developed through the following steps:

Sterilization

All utensils and surfaces coming into contact with the lipstick were thoroughly cleaned and sterilized to prevent contamination.

Melting of Base Ingredients

A water bath or double boiler was used to melt 3 g of rice bran wax and 6 g of shea butter, with continuous stirring to ensure uniform mixing.

Incorporation of Additional Ingredients

Once the base ingredients were fully melted and homogenized, the mixture was removed from heat. 2 ml of coconut oil was added and stirred well for even dispersion.

The following plant extracts were then incorporated: *Terminalia chebula*, *Piper nigrum*, *Lawsonia inermis*, *Mallotus philippensis*, *Ocimum tenuiflorum*, and *Mangifera indica*, ensuring uniform distribution.

Addition of Preservative and Fragrance

2 mL of rosemary oil (as a preservative) and strawberry essence (for fragrance) were added and thoroughly mixed.

Moulding and Solidification

While still warm, the mixture was carefully poured into lipstick moulds, ensuring the absence of air bubbles. The moulds were placed in a refrigerator to facilitate complete solidification.

Final Processing

Once solidified, the lipsticks were carefully removed from the moulds and transferred into lipstick containers for further use and evaluation.

Evaluation of lipstick

To ensure product safety, quality and effectiveness, the formulated herbal lipstick was evaluated on the parameters such as Organoleptic evaluation, melting point, breaking point, P^H determination and solubility test.

Organoleptic evaluation[12]

Organoleptic tests of lipstick preparations include visual observation of the physical appearance of the preparation including texture, aroma and color.

The fragrance retention of the formulated herbal lipstick was evaluated by storing the samples at room temperature for one month. After the storage period, the samples were examined to determine the presence or absence of fragrance, ensuring the stability of the added aromatic components over time.[13]

Breaking point[14]

Herbal lipstick was kept an inch away from socket horizontally. The weight was gradually increased by 10 gm at 30 s interval and determines weight at which lipstick breaks and considered as its breaking point.

Melting point[15]

The lipstick melting point was determined by heating the lipstick over the water bath in the container and a thermometer is placed in it to determine the temperature at which the lipstick melts.

Solubility test[11]

Dissolve the lipstick in different solvents and observe the solubility in each solvent.

Water resistance of the applied area[16]

The prepared herbal lipstick was evaluated for water resistance by applying a thin, uniform coat onto a tissue paper. Subsequently, 5–6 drops of water were carefully added using a pipette. The lipstick's ability to prevent water penetration through the tissue paper was considered an indication of its water-resistant property.

Skin sensitivity test[17]

The skin irritation test was conducted by applying the formulated herbal lipstick as a patch on the skin and allowing it to remain for 20 minutes. The skin reaction was then observed and recorded using the following criteria:

N- No reaction

R- Redness of the skin

I-Irritancy or itching

P^H Determination[18]

The pH determination of the formulated herbal lipstick was carried out by weighing 1 gram of the sample and melting it using a water bath. Once fully melted, a pH strip was immersed in the liquid lipstick, and the pH value was recorded. This analysis ensured that the lipstick's pH was within a skin-compatible range, ensuring safety and comfort during application.

Homogenous test[18]

The homogeneity of each formulated herbal lipstick was assessed by applying a small amount of the product onto a transparent glass surface. The formulation was then examined for Uniformity in texture and consistency and Absence of visible coarse grains or particle aggregation. A well-formulated lipstick should exhibit a smooth, homogeneous appearance without any phase separation or granularity.

Antioxidant activity[19]

The formulated herbal-infused lipstick was subjected to antioxidant activity assessment to evaluate its potential in free radical scavenging. The extract was prepared by dissolving the lipstick formulation in 95% ethanol to obtain a stock concentration of 10 mg/mL. From this stock solution, working concentrations of 250, 500, 750, and 1000 µg/mL were prepared for the antioxidant study. Ascorbic acid was used as the standard antioxidant, with concentrations of 10, 20, 30, 40, and 50 µg/mL.

The antioxidant potential of the lipstick extract was evaluated using an *in vitro* DPPH (2,2-Diphenyl-1-Picrylhydrazyl) radical scavenging assay. This assay measured the extract's ability to neutralize free radicals by monitoring the reduction in absorbance at a specific wavelength. The percentage inhibition of free radicals was calculated for each concentration tested. Additionally, the IC_{50} value, representing the concentration required to scavenge 50%

of the DPPH radicals, was determined to facilitate comparative analysis of antioxidant activity.

RESULTS AND DISCUSSION

The selected plants were extracted with ethanol using Soxhlet apparatus and Magnetic stirrer. After the extraction, all the extracts were used in particular quantity to formulate the Herbal lipstick (Table 1).

Organoleptic studies

The formulated lipstick (Figure 1) was evaluated for its physical attributes. It appeared brown in colour and exhibited a sweet, pleasant odour. The formulation was in a semi-solid state, and its texture was found to be smooth**.**

Figure 1: Formulated Herbal lipstick.

Table 1: Selected plant materials for the formulation of Herbal lipstick.

S.No	Ingredients	Quantity
1	*Lawsonia inermis* L.	0.5gm
2	*Terminalia chebula* Retz.	1 gm
3	*Mallotus philippensis* (Lam.)Mull.Arg	1 gm
4	*Mangifera indica* L.	0.5 gm
5	*Ocimum tenuiflorum* L.	0.5 gm
6	*Piper nigrum* L.	0.5 gm
7	*Beta vulgaris*	3 gm
8	*Basella rubra*	3 gm
9	Rice bran wax	3 gm
10	Shea butter	6 ml
11	Sunflower lecithin	1.5 gm
12	Coconut oil	2 ml
13	Strawberry essence	1 ml
14	Rosemary oil	2 ml

Organoleptic evaluation was carried out at regular intervals over a 20-day period to assess the physical stability and sensory characteristics of the formulated lipstick. The colour, odour, and texture remained unchanged throughout the study period. The texture remained smooth, and no phase separation or signs of degradation were observed during the 20 days of observation (Table 2).

Table 2: Organoleptic studies of the formulated Herbal lipstick.

Day interval	Colour	Odour	Texture	Degradability
0	Brown	Fragrant	Smooth	-
5	Brown	Fragrant	Smooth	-
10	Brown	Fragrant	Smooth	-
15	Brown	Fragrant	Smooth	-
20	Brown	Fragrant	Smooth	-

Studies on solubility, melting point, pH and water resistance

The solubility test revealed that the formulated lipstick was soluble in organic solvents such as ethanol. The melting point was recorded at 80°C, indicating that the formulation was thermally stable under moderate temperatures. The pH of the lipstick was found to be 7.0, which was neutral and therefore suitable for topical application. Water resistance was assessed by applying a thin layer of the formulation onto a tissue paper. The water droplets remained on the surface without being absorbed by the tissue, indicating that the lipstick was highly water-resistant.

Skin sensitivity

The sensitivity test was conducted by applying the formulated lipstick as a patch on the inner forearm of 10 volunteers for a duration of 20 minutes. The observed reactions were recorded as follows: no reaction was observed in all 10 volunteers; there were no cases of skin redness or irritation. These results indicated that the formulation was non-irritant and safe for topical application.

P^H Determination and homogeneity

The pH and homogeneity of the prepared formulation were monitored over a 20-day period. The pH remained constant at 7.0 throughout the study, indicating that there was no significant change in the acidity or alkalinity of the formulation over time. Homogeneity was rated as "Excellent" from Day 0 to Day 10, suggesting that the formulation was well mixed and uniform in texture during the initial phase. From Day 15 onward, the homogeneity was rated as "Good," indicating a slight reduction in uniformity (Table 3).

Table 3: P^H and homogeneity of the formulated Herbal lipstick.

Time interval (Day)	P^H	Homogeneity
0	7.0	Excellent
5	7.0	Excellent
10	7.0	Excellent
15	7.0	Good
20	7.0	Good

DPPH Radical Scavenging Activity

The antioxidant activity of the formulated herbal lipstick was assessed using the DPPH radical scavenging assay at concentrations ranging from 250 to 1000 µg/mL. The percentage of inhibition increased in a concentration-dependent manner. At 250 µg/mL, the formulation exhibited 59.18 ± 0.4% inhibition, which increased to 98.05 ± 0.8% at 1000 µg/mL. The IC_{50} value of the formulation was found to be 27.8 ± 1.2 µg/mL, indicating strong free radical scavenging potential. Ascorbic acid was used as the standard for comparison. It showed 32.3 ± 1.5% inhibitions at 10 µg/mL, which increased to 93.3 ± 1.5% at 50 µg/mL, with an IC_{50} value of 20.93 ± 0.7 µg/mL. Although the IC_{50} of the standard was slightly lower, the formulated lipstick demonstrated comparable antioxidant activity, suggesting the presence of effective antioxidant constituents in the formulation (Table 4).

Table 4: Percentage of inhibition of DPPH radical scavenging activity of formulated lipstick.

S. No	Concentration (µg/mL)	% of inhibition	IC_{50} (µg/mL)
1	**250**	59.18±0.4	27.8 ±1.2
2	**500**	76.92±0.4	
3	**750**	87.19±0.6	
4	**1000**	98.05±0.8	
S. No	**Standard Ascorbic acid**		20.93±0.7
1	**10**	32.3 ±1.5	
2	**20**	56.3±1.5	
3	**30**	60.0±1.0	
4	**40**	63.3±1.5	
5	**50**	93.3±1.5	

The present study successfully formulated and evaluated a herbal lipstick using ethanol-extracted plant ingredients such as *Lawsonia inermis, Terminalia chebula, Mallotus philippensis, Mangifera indica, Ocimum tenuiflorum, Piper nigrum, Beta vulgaris*, and *Basella rubra*, combined with natural bases like rice bran wax, shea butter, sunflower lecithin, and essential oils. The extract-rich formulation demonstrated excellent organoleptic properties—retaining its brown colour, pleasant fragrance, and smooth texture over a 20-day

period—suggesting high physical stability, comparable to the rose-based herbal lip balm studied by *Vikram et al*.[20] The melting point of 80°C indicated strong thermal stability, exceeding the 63–65°C range reported for lip balms, likely due to the higher wax content. The formulation's pH remained stable at 7.0, confirming its neutrality and skin compatibility, while water resistance testing showed non-absorption of water droplets, suggesting good hydrophobicity and long-lasting wear. Homogeneity was rated excellent until Day 10 and good from Day 15, with no phase separation. Skin sensitivity tests confirmed its safety, with no reactions observed in all 10 volunteers. Most notably, the formulation exhibited strong antioxidant potential in the DPPH assay, with a maximum inhibition of 98.05% at 1000 µg/mL and an IC_{50} of 27.8 µg/mL, close to that of ascorbic acid (IC_{50} = 20.93 µg/mL), demonstrating the presence of effective antioxidant phytocompounds such as tannins, flavonoids, and anthocyanins from the plant extracts. Compared to the lip balm in the vikram *et al*.[20] study, the current herbal lipstick formulation offers added benefits of pigmentation, antioxidative protection, and improved physicochemical stability, supporting the application of medicinal plant extracts in safe, effective, and multifunctional herbal cosmetics.

Based on the study by Nuha Rasheed *et al*.,[21] which formulated herbal lipsticks using natural colorants like beetroot, carrot, turmeric, and pomegranate, and evaluated parameters such as melting point, pH, breaking point, and perfume stability, our herbal lipstick formulation demonstrates comparable or enhanced properties. Our product exhibited a stable pH of 7.0, aligning with the pH range of 6.2 to 6.8 reported in their formulations, ensuring skin compatibility. The melting point of our lipstick was 80°C, indicating robust thermal stability, which is within the range of 62°C to 85°C observed in their study. Both studies reported no skin irritation and smooth aging stability, highlighting the safety and durability of herbal ingredients. While their formulations utilized ingredients like beeswax and carnauba wax, our use of rice bran wax and shea butter contributed to the product's smooth texture and application ease. These findings suggest that our herbal lipstick not only matches but may surpass existing formulations in terms of stability, safety, and added therapeutic benefits.

Our findings are in line with Gajare *et al*.[22] studies on beetroot-based herbal lipsticks and support the use of natural ingredients like *Terminalia chebula*, *Lawsonia inermis*, and *Ocimum tenuiflorum* for their beneficial properties. Overall, the lipstick combines functional, aesthetic, and therapeutic qualities, making it a promising alternative to synthetic lip products.

The present study is in agreement with the findings of Sudha *et al.*,[23] who formulated a herbal lipstick using *Beta vulgaris* extract and reported good stability, pleasant color, and no skin irritation. Compared to their single-plant approach, our formulation used a combination of medicinal plants, which contributed to enhanced antioxidant activity (IC_{50} = 27.8 ± 1.2 µg/mL) and better functional properties. Both studies confirmed a neutral pH, smooth texture, and good water resistance. However, our multi-ingredient formulation offered broader therapeutic and cosmetic benefits. This supports the effectiveness and safety of herbal lipsticks made with natural ingredients.

The present study aligns with Sanap *et al.*[24] who formulated herbal edible lipsticks using natural colorants like beetroot and red sandalwood, achieving good texture, pH, and stability. Both studies confirmed the safety and effectiveness of plant-based ingredients. However, our formulation, enriched with multiple medicinal extracts, showed higher antioxidant activity suggesting enhanced therapeutic benefits. This supports the multifunctional role of natural pigments in cosmetics.

Conflicts of interest

The authors declare that there are no conflicts of interest with respect to the authorship and / or publication of this article.

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