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ANTIOXIDANT-ENRICHED HERBAL LIPSTICK DEVELOPED FROM BLACK CARROT AND RED CABBAGE EXTRACTS: COMPARATIVE EVALUATION WITH MARKETED FORMULATION

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ABSTRACT

The present project focuses on the formulation of a natural lipstick using plant-based colorants derived from Red Cabbage (*Brassica oleracea var. capitata f. rubra*) and Black Carrot (*Daucus carota ssp. Sativus var. atrorubens*). The primary objective of this study is to develop a safe, eco-friendly, and cost-effective alternative to synthetic lip colorants by utilizing anthocyanin-rich extracts. Pigments were extracted using 70% lab-grade ethanol to ensure efficient solubility and color intensity. Seeds were removed prior to grinding to enhance purity and yield of the color extract. Both extracts were tested separately and in combination to evaluate their compatibility, stability, and aesthetic appeal in the final formulation. The lipstick was prepared using standard ingredients such as beeswax, cocoa butter castor oil etc to ensure proper consistency, spreadability, and moisturizing properties. Preliminary evaluation showed good texture, acceptable pH, and pleasing color with satisfactory adherence to lips. This study demonstrates the potential of natural colorants in cosmetic applications, supporting the growing demand for herbal and chemical-free personal care products. And comparing it with marketed formulation.

KEYWORDS: Plant based colorants, eco-friendly, aesthetic appeal, cosmetic applications, and chemical-free personal care.

INTRODUCTION

In recent years, the growing awareness of the harmful effects of synthetic chemicals in cosmetics has led to an increased demand for natural, herbal-based alternatives. Among these, herbal lipsticks have gained significant popularity due to their safer profiles and added health benefits. Unlike conventional lipsticks that often contain heavy metals and artificial colorants, herbal lipsticks are formulated using plant-based pigments and bioactive compounds, making them not only safer for daily use but also beneficial for lip care.

This study focuses on the development of an antioxidant-enriched herbal lipstick using natural extracts derived from Black Carrot (*Daucus carota ssp. Sativus var. atrorubens*) and Red Cabbage (*Brassica oleracea var. capitata f. rubra*). Both these vegetables are rich in anthocyanins, potent natural pigments known for their vibrant coloration and strong antioxidant properties. These phytochemicals help neutralize free radicals, providing protective and anti-aging benefits to the delicate skin of the lips.

The aim of this formulation is to create a lipstick that not only imparts a desirable hue but also nourishes and protects the lips from environmental stressors. The incorporation of Black Carrot and Red Cabbage extracts serves a dual purpose delivering rich, natural color and enhancing the therapeutic value of the cosmetic product.

The present study focuses on the formulation and evaluation of herbal lipsticks using natural colorants such as red cabbage and black carrot extracts, aiming to provide a safer, skin-friendly alternative to conventional

commercial lipsticks. Various formulations (F1–F5) were developed by altering the proportions of key ingredients like olive oil, castor oil, and cocoa butter. These were compared with a marketed formulation, in terms of physicochemical parameters, solubility, and antioxidant activity. The comparison highlights the potential of herbal formulations to match or even to the standard products in terms of safety, functionality, and overall performance.

Fig. 1: Test Formulations.

Fig. 2: Marketed Formulation.

OBJECTIVES

1. To formulate herbal lipsticks using natural colorants such as red cabbage and black carrot extracts.
2. To evaluate the physicochemical properties of the formulated lipsticks, including melting point, pH, softening point, breaking point, and thixotropic character.
3. To compare the solubility behaviour of the formulated lipsticks with that of a standard marketed lipstick.
4. To analyze the antioxidant activity of the formulations using DPPH assay.
5. To assess and compare the lead content in the test and marketed lipsticks to ensure safety.
6. To determine the overall performance and stability of the herbal lipsticks in comparison with the marketed lipstick.

EXTRACTION

Black carrot extraction

a. **Preparation**: Fresh black carrots were washed, peeled and chopped.
b. **Grinding**: Carrots were ground using a blender with 70% ethanol to make a smooth pulp with 1:5 ratio (Extract: Ethanol).
c. **Extraction**: The pulp was soaked in 70% ethanol for 24 hours at room temperature or refrigerated for better pigment preservation.
d. **Filtration**: The mixture was filtered using muslin cloth or filter paper to collect the colored extract.
e. **Storage**: The final extract was stored in amber colored bottle at 4°C to maintain color stability.

Red cabbage extraction

a. **Preparation**: Fresh red cabbage leaves were washed, chopped into small pieces for better surface area.
b. **Grinding**: The pieces were blended using 70% ethanol to form a smooth pulp with 1:5 ratio (Extract: Ethanol).
c. **Extraction**: The pulp was soaked in 70% ethanol for 24 hours at room temperature or refrigerated to protect pigments.
d. **Filtration**: The mixture was filtered using muslin cloth or filter paper to obtain the colored extract.

e. **Storage**: The extract was stored in amber colored bottle at 4°C to preserve pigment quality.

METHODOLOGY

1. Melting Waxes and Butter

In a china dish placed on a water bath at 70°C, the following ingredients were added in their melting order:

a) Candelilla wax,
b) White beeswax,
c) Cetearyl alcohol,
d) Cocoa butter.

These were allowed to melt completely with continuous stirring.

2. Oil and Extract Phase

In a separate china dish, olive oil and castor oil were mixed thoroughly.

To this mixture, the black carrot extract (prepared in 70% ethanol) was added and stirred until uniformly blended.

3. Combining Phases

The oil–extract mixture was then slowly added to the melted wax–butter phase with continuous stirring, maintaining the temperature around 60–70°C.

4. Pouring and Molding

The final molten mixture was poured into lipstick molds and allowed to cool and solidify at room temperature or under refrigeration.

5. Finishing

Once solid, the lipsticks were removed from molds and stored in suitable containers for further evaluation.

FORMULAS

Ingredients	F1	F2	F3	F4	F5
White beeswax	1.5 g	1.5 g	1.5 g	1.5 g	1.5 g
Candelilla Wax	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g
Cetearyl Alcohol	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g
Cocoa Butter	1.25 g	1.25 g	1.25 g	1.25 g	1.25 g
Castor Oil	1.5 mL	2.0 mL	-	2.5 mL	4.0 mL
Olive Oil	2.5 mL	2.0 mL	4.0 mL	1.5 mL	-
Black Carrot Extract	1.0 mL	1.0 mL	1.0 mL	1.0 mL	1.0 mL
Red Cabbage Extract	0.5 mL	0.5 mL	0.5 mL	0.5 mL	0.5 mL
Mica powder	0.3 gm	0.3 gm	0.3 gm	0.3 gm	0.3 gm
Vitamin E	0.3 mL	0.3 mL	0.3 mL	0.3 mL	0.3 mL
Lavender Oil	0.2 mL	0.2 mL	0.2 mL	0.2 mL	0.2 mL

GENERAL EVALUATION

PRE-EVALUATION

I. Solubility test

The test sample was weighed accurately (approximately 1 g) using an analytical balance. A series of solvents (e.g., distilled water, ethanol, glycerine, castor oil, and acetone) were selected for the solubility test. About 10 mL of each solvent was measured and poured into separate clean, dry test tubes. The weighed sample was added to each test tube containing the solvent. The contents of each test tube were stirred using a glass rod to facilitate dissolution. The test tubes were observed for any changes, such as clarity of solution or residue remaining undissolved. The degree of solubility was recorded as soluble, sparingly soluble, slightly soluble, or insoluble based on the visual observation. The test tubes were allowed to stand for 5–10 minutes to ensure complete dissolution or precipitation. The results were tabulated for comparison and analysis.

II. Phytoconstituents confirmation after extraction (In both extracts)

1. Test for Anthocyanins (Main pigment in both)

Chemical Test: pH Sensitivity Test

Procedure

- Take a small amount of extract in a test tube.
- Add few drops of dilute HCl → color shifts to red.
- Add few drops of NaOH → color shifts to blue-green or green.

2. Test for Flavonoids

Chemical Test: Shinoda Test

Procedure

- Add extract + magnesium turnings.
- Add few drops of concentrated HCl.

3. Test for Phenolic Acid

Chemical Test: Ferric Chloride Test

Procedure

Add 1-2 drops of 1% ferric chloride ($FeCl_3$) to the extract.

POST-EVALUATION

1. Melting point

The melting point of the formulated lipstick was determined to evaluate its thermal stability and storage conditions. A small portion of each lipstick formulation (approximately 2–3 mm in height) was carefully packed into a clean, dry capillary tube by gently tapping the sealed end on a hard surface to ensure uniform filling. The capillary tube was then attached to a thermometer

and immersed in an oil bath (such as liquid paraffin or silicone oil) mounted on a controlled heating apparatus. The setup was slowly heated, especially as the temperature approached the expected melting range, typically increasing at a controlled rate of 1°C per minute to ensure precision. The temperature at which the lipstick started softening and then completely liquefied was noted as the melting point**.** This procedure was repeated at least three times for each formulation to ensure reproducibility, and the average melting point was calculated and recorded.

2. pH parameter

The pH meter was calibrated using standard buffer solutions (typically pH 4.0, 7.0, and 9.2) before testing. The sample was prepared by accurately weighing a specified amount and dispersing or dissolving it in distilled water, as per the product requirements. The solution was allowed to stand for a few minutes to reach room temperature (25 ± 2°C). The electrode of the pH meter was rinsed with distilled water and gently blotted dry with tissue paper before immersion. The electrode was immersed into the prepared sample solution, ensuring that it was fully submerged and not touching the container walls. The pH value was allowed to stabilize, and the final reading was recorded. The electrode was rinsed with distilled water after each use to prevent cross-contamination. The pH value obtained was compared with the acceptable range for the formulation to evaluate the product's stability and compatibility. All observations and results were documented in the analysis report.

3. Softening Point Test

The softening point test determines the resistance of lipstick to deformation under heat, simulating conditions it may encounter during handling or storage (e.g., in a handbag). The Ring and Ball method was used for this purpose. Lipstick samples were inserted into standardized rings and refrigerated at 6 °C for 10 minutes to ensure uniform hardness. The ring and ball assembly was then placed in a water bath, and the temperature was raised at a controlled rate of 1 °C per minute starting from 45 °C. The softening point was defined as the temperature at which the ball passed through the lipstick sample. The expected range for an optimally stable formulation was between 68 °C and 74 °C higher values indicating better thermal resistance.

4. Breaking point

The breaking point test is an important mechanical evaluation used to assess the structural integrity and firmness of lipstick formulations. In this test, a lipstick bullet is placed horizontally on a fixed support with exactly one inch of the stick extending beyond the edge. Gradually increasing weights are then applied to the overhanging portion of the lipstick in 10-gram increments at intervals of 30 seconds. This stepwise addition of weight continues until the lipstick breaks or snaps due to the applied stress. The total weight at which the lipstick breaks is noted as its breaking point. This procedure is typically repeated three times for each formulation to ensure accuracy and consistency, and the average value is recorded. A higher breaking point indicates a stronger and more durable lipstick that can withstand pressure during use, while a lower breaking point suggests a softer or more brittle product. This test is particularly useful for evaluating experimental or herbal formulations to ensure they meet mechanical strength standards required for consumer use.

5. Thixotropy Characterization

Thixotropy evaluates the structural integrity and viscosity recovery behavior of the lipstick base under stress, which is important for texture and consumer application. A penetrometer was used to assess thixotropic properties. A standard needle was allowed to penetrate the lipstick under a 50-gram load for 5 seconds at 25 °C. The depth of penetration was recorded as an indication of the formulation's structural breakdown and recovery. Lipsticks exhibiting penetration values in the range of 9.0 to 10.5 mm were considered to have good thixotropic characteristics, ensuring smooth application and consistency.

6. Spreadability Test

Spreadability reflects the lipstick's ability to form a smooth, uniform layer on a surface, contributing to aesthetic appeal and user comfort. The lipstick was applied in a single stroke for at least 3 cm on either a glass slide or a paper surface.

The visual assessment was done based on the consistency, surface smoothness, and structural integrity of the lipstick during application. Results were categorized as follows:

- **Excellent (E):** No fragmentation; smooth, uniform surface application without lipstick deformation.
- **Intermediate (I):** Minor fragmentation; uniform application with slight deformation.
- **Unsatisfactory (U):** Noticeable fragmentation; uneven application with significant deformation.

This evaluation helps determine the formulation's performance under practical usage conditions.

PHYSIOCHEMICAL TEST

1. Antioxidant activity Determination

DPPH assay

The percentage of antioxidant activity of each substance was assessed by DPPH free radical assay. The measurement of the DPPH radical scavenging activity was performed. The samples were reacted with the stable DPPH radical in methanol solution. The reaction mixture consisted of adding 0.5 mL of sample, 1 mL of methanol and 1 mL of DPPH radical solution 0.5 mL in methanol. When DPPH reacts with an antioxidant compound, which can donate hydrogen, it is reduced. The changes in color (from deep violet to light yellow) were read [Absorbance (Abs)] at 517 nm after 100 min of reaction using a UV-VIS spectrophotometer. The control solution

was prepared by mixing methanol (1.0 mL) and DPPH radical solution (1.0 mL) and 1 mL of methanol serves as blank. The scavenging activity percentage was determined according to

% of inhibition = Control O.D – Sample O.D/Control O.D X 100

2. Lead test determination

Standard solutions with varying concentrations of 1.0 ppm, 2.5 ppm, 5.0 ppm, 7.5 ppm, and 10.0 ppm were prepared and adjusted to the optimal pH using 0.1 M NaOH. A 5 mL aliquot of each standard solution was taken, followed by the addition of 1 mL of 0.001 M ARS (Alizarin Red S) solution and 1 mL of pH 7 buffer. The mixtures were allowed to react for 10 to 20 minutes before measuring their absorbance at a wavelength of 509 nm.

RESULTS

Pre-evaluation

Solvent	Ethanol	Glycerine	Acetone	Distilled water
Solubility (Test sample)	Completely soluble	Partially soluble	Completely soluble	Partially soluble
Solubility (Marketed Sample)	Completely soluble	Insoluble	Completely soluble	Insoluble

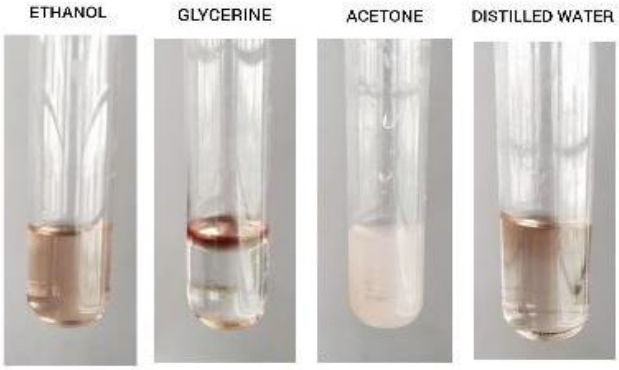

Fig. 3: Solubility test.

S. No	Phytoconstituent test (For test sample)	Observation	Inference
1.	Anthocyanin (pH sensitivity test)	Color changes (red or bluish green)	Presence of anthocyanin
2.	Flavonoid (Shinoda test)	Red color	Presence of flavonoids
3.	Phenolic acid (Ferric chloride test)	Green color	Presence of phenols

Post-evaluation

S. No	Tests	F1	F2	F3	F4	F5	Marketed sample
1.	Melting point	57 °C	58 °C	60 °C	59 °C	58 °C	60 °C
2.	pH parameter	5.61	5.73	5.66	5.77	5.64	5.80
3.	Softening point	71°C	73°C	72°C	73°C	71°C	73°C
4.	Breaking Point	31 gm	32 gm	31gm	32gm	33gm	35 gm
5.	Thixotropic character	9.8 mm	10.1 mm	9.9 mm	9.8 mm	10.2 mm	9.5 mm
6.	Spreadability	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

Fig.4. Melting point.

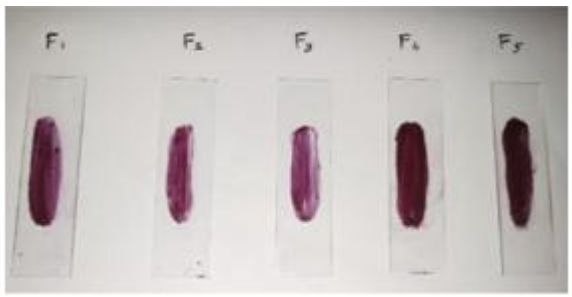

Fig.5. Spreadability.

Concentration (µg/ml)	% of Inhibition (Test Samples)					% of Inhibition (Marketed or Branded sample)
	F1	F2	F3	F4	F5	
20 µg/mL	18.7%	18.3%	19.1%	18.5%	17.2%	7.5%
40 µg/mL	35.6%	34.8%	36.2%	35.2%	33.5%	19.8%
60 µg/mL	53.2%	52.1%	54.0%	52.8%	50.1%	31.1%
80 µg/mL	62.4%	61.1%	63.1%	62.0%	59.0%	39.6%
100 µg/mL	71.5%	70.3%	72.1%	70.8%	68.0%	46.3%

Physiochemical test results

A) Antioxidant activity

DPPH (2,2-diphenyl-1-picrylhydrazyl) assay

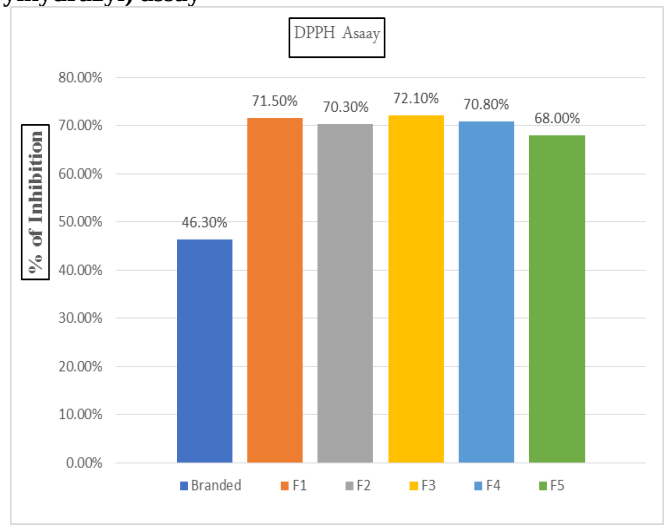

Fig. 6: DPPH Assay chart.

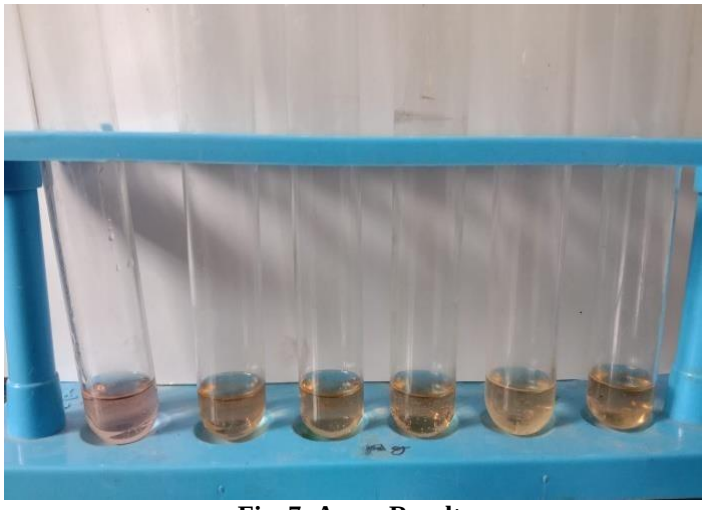

Fig. 7: Assay Result.

B) Lead determination

Lead Concentration (ppm)	% of Lead Present					
	F1	F2	F3	F4	F5	Marketed sample
10	7.15%	7.51%	6.79%	7.27%	6.44%	9.50%
20	17.41%	18.28%	16.54%	17.15%	15.67%	22.50%
30	22.54%	23.67%	21.41%	22.79%	20.29%	31.20%
40	28.21%	29.62%	26.80%	28.03%	25.39%	39.80%
50	34.87%	36.61%	33.13%	35.36%	31.38%	49.60%
60	42.65%	44.78%	40.52%	42.91%	38.39%	60.20%
70	50.91%	53.46%	48.36%	45.99%	45.82%	71.50%

80	59.54%	62.52%	56.59%	52.50%	53.59%	79.90%
90	67.12%	70.48%	63.76%	61.83%	60.41%	86.40%
100	73.84%	77.53%	66.46%	68.22%	66.56%	92.80%

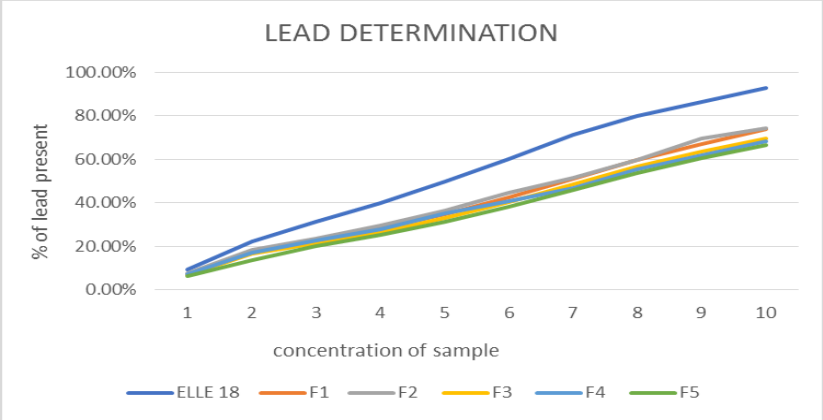

Fig. 8: Lead Determination.

Regression coefficient of determination (R^2)

F1	F2	F3	F4	F5	Marketed product
0.9963	0.9964	0.9963	0.9974	0.9971	0.9948

Normal range of R^2 = 0.8-1.2 (It indicates safe or appropriate level of lead content present in lipstick)
R^2= Regression coefficient of determination.

CONCLUSION

The present study successfully developed five herbal lipstick formulations (F1–F5) using black carrot and red cabbage extracts as natural colorants. These formulations were evaluated against a marketed lipstick to assess their physicochemical, functional, and safety parameters. The results demonstrated that all five formulations exhibited comparable performance to the marketed product.

The melting point, softening point, breaking point and pH values of the formulations were consistent with those of the commercial standard, indicating good structural stability and user safety. Solubility studies confirmed that both the herbal and marketed lipsticks were completely soluble in ethanol and acetone, indicating similar pigment dispersion and compatibility with the base materials.

Furthermore, all formulations displayed favourable thixotropic behavior, ensuring smooth application, easy spreadability, and quick re-solidification after use an essential attribute for consumer satisfaction. Antioxidant studies using the DPPH assay showed that the herbal lipsticks provided effective free radical scavenging activity, owing to the rich anthocyanin content in black carrot and red cabbage. This not only enhances the product's cosmetic appeal but also contributes to lip health.

Importantly, the lead content in all formulations was within permissible safety limits, highlighting the non-toxic nature of the ingredients used. This confirms the formulations' compliance with safety standards and their potential for regular use.

Overall, the study concludes that the formulated herbal lipsticks are a safe, effective, and eco-friendly products (F1-F5), which complies with marketed sample. Thus, these lipsticks present a promising option for consumers seeking herbal and antioxidant-enriched cosmetic products.

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