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Review Article

Herbal Ph-Responsive Lipstick : Formulation, Evaluation, and Applications

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ABSTRACT

In recent years, the growing preference of consumers for herbal and natural cosmetic products has driven significant research into plant-based formulations. Herbal pH-responsive lipsticks represent a novel class of cosmetics that combines therapeutic and safety benefits. These lipsticks exhibit a color-changing property depending on the pH of the lips, thereby producing a personalized shade for each user. The color transformation is primarily due to natural pH-sensitive pigments such as anthocyanins derived from herbal sources. This review provides a detailed discussion on herbal pH-responsive lipsticks, covering their historical background, mechanism of action, herbal ingredients, formulation aspects, evaluation parameters, storage, advantages, limitations, and future prospects.

INTRODUCTION

Cosmetics have been an important part of human civilization since ancient times. Natural pigments, oils, and waxes were traditionally used by early civilizations such as the Egyptians and Indians for beautification purposes. With the rise of industrialization, synthetic dyes and chemical additives gradually replaced herbal ingredients due to their low cost and high stability. However, prolonged use of synthetic cosmetics has been associated with adverse effects such as skin irritation, allergic reactions, and potential toxicity.

In recent years, there has been a renewed interest in herbal cosmetics owing to increased consumer awareness regarding safety, environmental sustainability, and long-term health effects. Herbal pH-responsive lipsticks have emerged as an innovative product in this domain. These lipsticks are designed to change color upon application based on the pH of the lips, thereby offering a customized shade along with lip care benefits. The incorporation of herbal ingredients further enhances their acceptability and safety profile.

Historical Background and Need for Herbal pH-Responsive Lipsticks

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Traditionally, lipsticks were formulated using natural colorants such as carmine, henna, and plant extracts. Over time, synthetic dyes replaced these natural substances due to better color intensity and shelf life. However, concerns regarding the toxicity of synthetic dyes, including heavy metal contamination, have led to strict regulatory scrutiny.

The need for herbal pH-responsive lipsticks arises from:

- Increasing cases of hypersensitivity reactions caused by synthetic colorants
- Growing demand for personalized and multifunctional cosmetic products
- Preference for eco-friendly, biodegradable, and cruelty-free cosmetics
- Rising awareness of traditional herbal knowledge integrated with modern cosmetic science

Concept of pH-Responsive Lipstick

A pH-responsive lipstick is a cosmetic preparation that exhibits a visible change in color when applied to the lips. The color change depends on the interaction between pH-sensitive pigments and the natural pH of the lips, which generally ranges from slightly acidic to neutral.

Human lips possess a slightly acidic to near-neutral pH, generally ranging between pH 4.5 and 6.5. This pH is not constant and varies among individuals depending on factors such as hydration, diet, skin physiology, cosmetic use, and environmental exposure. The fundamental idea behind pH-responsive lipstick is to utilize pigments that are chemically sensitive to such pH variations.

In herbal pH-responsive lipsticks, plant-based pigments such as anthocyanins are employed instead of synthetic dyes. These natural pigments have an inherent ability to act as biological pH indicators. When exposed to different pH environments, their molecular structure changes, resulting in visible alterations in color. This property is traditionally observed in herbal indicators like red cabbage and hibiscus extracts, which have long been used in natural pH testing.

Mechanism of Color Change

The mechanism of color change in herbal pH-responsive lipsticks is based on the chemical behaviour of natural pigments such as anthocyanins derived from the red cabbage and hibiscus extract.

Anthocyanins are water-soluble flavonoid compounds commonly found in flowers, fruits, and vegetables. Their molecular structure changes with pH, leading to different colors:

- At acidic pH: red or pink coloration
- At near-neutral pH: purple coloration
- At alkaline pH: bluish or greenish coloration

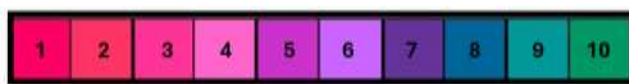


FIG : 1 [Ph Chart]

When the lipstick is applied to the lips, moisture and lip pH trigger the structural transformation of the pigment molecules. This results in the development of a characteristic shade that appears natural and long-lasting. The colour varies from one person to another according to their lip's pH. The waxy base of the lipstick aids in uniform application and retention of color.

Herbal Ingredients Used in pH-Responsive Lipsticks

1. Beeswax

Beeswax is a natural wax obtained from honeycombs and is widely used in traditional lipstick formulations. It acts as a structuring and stiffening agent, providing shape, firmness, and mechanical strength to the lipstick. Beeswax forms a protective film on the lips, which improves moisture retention. It ensures smooth application and better color on lips.

2. Cocoa Butter

Cocoa butter is a natural fat extracted from cocoa beans. It functions primarily as an emollient in herbal pH-responsive lipsticks. Cocoa butter melts near body temperature, which helps the lipstick spread easily on application. It nourishes and softens the lips, prevents dryness, and contributes to a creamy mouthfeel.

3. Coconut Oil

Coconut oil is a herbal oil rich in fatty acids. It serves as a natural moisturizer and antimicrobial agent. Coconut oil improves lip hydration, prevents cracking, and enhances softness. The antimicrobial property of coconut oil also supports microbial stability in herbal formulations.

4. Olive Oil

Olive oil is a well-known herbal emollient. In pH-responsive lipsticks, olive oil improves lip nourishment, elasticity, and smoothness. It assists in solubilizing herbal pigments and ensures even color distribution. Olive oil also enhances the conditioning effect of the formulation, making it suitable for sensitive lips.

5. Vitamin E (Tocopherol)

Vitamin E acts as an antioxidant and lip-conditioning agent. It prevents oxidation of oils and natural pigments, thereby improving formulation stability and shelf life. Vitamin E also protects lips from oxidative damage, promotes healing of chapped lips, and enhances overall lip health.

6. Red Cabbage Extract

Red cabbage extract is rich in anthocyanins, which are natural pH-sensitive pigments. These compounds act as natural pH indicators and are responsible for the color-changing property of the lipstick. At acidic pH, anthocyanins exhibit pink to red shades, while at neutral to slightly alkaline pH they appear purple or bluish. When applied to the lips, the extract reacts with lip pH and moisture, resulting in a personalized color development according to their lip's pH.

7. Hibiscus Powder

Hibiscus powder contains anthocyanins and organic acids that contribute to red and pink coloration. It enhances the intensity and warmth of the shade produced by the lipstick.

8. Beetroot Powder

Beetroot powder is a natural colorant rich in betacyanins. These pigments impart reddish-pink tones and contribute to the overall color depth. Beetroot pigments also exhibit mild pH sensitivity and antioxidant activity.

Mechanism of Action of Herbal pH-Responsive Lipstick

The mechanism of action of herbal pH-responsive lipstick is based on the interaction between pH-sensitive herbal pigments and the natural pH of the lips. Human lips typically exhibit a slightly acidic to near-neutral pH, which varies among



individuals due to factors such as hydration level, diet, and skin physiology.

When the lipstick is applied, the wax–oil base melts slightly due to body temperature, allowing the herbal pigments to come in contact with lip moisture. Anthocyanins present in red cabbage extract and hibiscus powder undergo structural transformation in response to pH variation. At lower pH values, the pigments appear pink or red, whereas at higher pH values they shift toward purple or bluish shades.

Beetroot pigments contribute to the reddish color and enhance color intensity. The combined effect of these pigments results in a unique shade that adapts to individual lip pH. Beeswax and cocoa butter help retain the pigments on the lips, while oils such as coconut oil, olive oil, and liquid paraffin improve spreadability and color uniformity. Vitamin E stabilizes the formulation and protects both the pigments and lip tissue from oxidative damage.

Thus, the overall color change and performance of herbal pH-responsive lipstick are governed by the synergistic action of herbal pigments, emollients, and structural agents.

Formulation Aspects

The formulation of herbal pH-responsive lipstick is a critical step that determines its stability, performance, and consumer acceptability. Since herbal pigments are sensitive to heat, light, and pH variations, careful selection and processing of ingredients is essential.

1. Selection of Base

A balanced combination of waxes, butters, and oils is required to achieve suitable hardness, melting point, and spreadability.

- Beeswax provides structural rigidity and mechanical strength.
- Cocoa butter softens the formulation and improves sensory feel.
- Liquid paraffin, coconut oil, and olive oil act as emollients and improve pigment dispersion.

The ratio of wax to oil must be optimized to prevent excessive hardness or melting at room temperature.

2. Incorporation of Herbal Pigments

Herbal pigments such as red cabbage extract, hibiscus powder, and beetroot powder should be finely powdered or pre-extracted to avoid grittiness. Pigments are incorporated at controlled temperatures to prevent degradation. Uniform mixing is essential to ensure consistent color development.

3. Antioxidants and Stabilizers

Vitamin E is added to prevent oxidative degradation of oils and pigments. It also improves shelf life and enhances lip-conditioning properties.

Manufacturing Procedure

The general steps involved in formulation include:

1. Melting of beeswax and cocoa butter using a water bath with constant stirring.
2. Addition of liquid oils with continuous stirring.
3. Incorporation of herbal pigments under controlled temperature
4. Addition of vitamin E and flavouring agents



5. Pouring the molten mass into moulds and allowing it to cool and solidify

Proper temperature control and continuous stirring are necessary to obtain a smooth and homogeneous lipstick mass.

Evaluation Parameters

Evaluation of herbal pH-responsive lipstick is essential to ensure quality, safety, and performance. The following parameters are commonly assessed in academic and industrial settings:

1.Organoleptic Properties

The lipstick is evaluated for color, odour, texture, and appearance. A uniform color and pleasant odour indicate good formulation quality.

Method:

Visually inspect under normal light and check for air bubbles, cracks and uneven color.

2.Melting Point

Melting point determination helps to assess thermal stability. The lipstick should remain solid at room temperature but melt slightly at body temperature.

Method:

A small quantity of sample is filled into capillary tube and subjected to gradual heating in a melting point apparatus. The temperature at which the lipstick starts softening or melting is noted.

3.pH Determination

The pH of the lipstick is measured to ensure compatibility with lip skin and to confirm pH-responsive behaviour.

Method:

A small amount of lipstick is dissolved in distilled water, and the pH was measured using a pH meter.

4.Spreadability

Spreadability indicates ease of application and smoothness on lips. Good spreadability ensures uniform color deposition.

Method:

Lipstick is applied on glass surface and observed for its ability to spread smoothly and uniformly.

5.Breaking Point

Breaking point determines mechanical strength by measuring the force required to break the lipstick. Adequate strength is necessary for handling and application.

Method:

Lipstick is held horizontally and increasing weight is applied on it, the weight at which it breaks is noted.

6.Stability Studies

Stability testing is performed by storing the lipstick at different temperatures and observing changes in color, texture, odour, and appearance.

Method:

Lipstick is stored at different temperature and observed for any colour, odor, texture and appearance change.

7.Skin Irritation Test

The formulation is evaluated for any signs of irritation or redness to ensure safety for topical application.



Method:

Patch Testing : Lipstick is applied on a small area of skin and observed for any redness, itching or irritation.

Advantages of Herbal pH-Responsive Lipsticks

- Personalized color development based on individual lip pH
- Use of herbal and naturally derived ingredients
- Reduced risk of toxicity and allergic reactions
- Moisturizing and nourishing effect on lips
- Antioxidant protection against environmental damage
- Environmentally friendly, biodegradable, and cruelty-free

Limitations

- Lower stability of natural pigments compared to synthetic dyes
- Sensitivity of herbal pigments to heat, light, and oxygen
- Limited range of intense shades
- Possibility of batch-to-batch color variation
- Shorter shelf life due to absence of strong synthetic preservatives

Storage Conditions

Herbal pH-responsive lipsticks should be stored in a cool, dry place away from direct sunlight and excessive heat. Exposure to high temperature may cause softening or melting, while light exposure can degrade natural pigments. Airtight and opaque

packaging is recommended to protect the formulation from oxidation and moisture.

Applications

Herbal pH-responsive lipsticks are suitable for daily cosmetic use and are particularly beneficial for individuals with sensitive lips. Useful for the one who wants their personalized lip shade according to pH. They are widely accepted in the natural and organic cosmetic market due to their innovative color-changing property and herbal composition.

Future Prospects

Future developments in herbal pH-responsive lipsticks focus on improving stability, performance, and consumer appeal. Techniques such as microencapsulation of natural pigments may enhance color stability and protect pigments from environmental factors. The use of advanced herbal preservatives and innovative packaging systems can further extend shelf life.

Research into novel plant sources of pH-sensitive pigments and synergistic combinations of herbal extracts may expand the shade range. With increasing global demand for clean, green, and sustainable beauty products, herbal pH-responsive lipsticks are expected to play a significant role in the future cosmetic market.

CONCLUSION

Herbal pH-responsive lipsticks are a great mix of traditional herbal knowledge and modern cosmetic technology. They not only enhance beauty by giving a personalized color but also help in keeping lips safe and healthy. Although there are some issues like stability and shorter shelf life, ongoing research can solve these problems. Overall, these lipsticks have a bright future in the cosmetic industry.



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