

Formulation and evaluation of lip tint using beetroot (*Beta vulgaris*), carrot (*Daucus carota*), and dragon fruit (*Hylocereus costaricensis*) as natural colorants

Kandy Mae A. Barrera*

Isabela State University, City of Ilagan Campus, Philippines

ABSTRACT

The increasing demand for safer and eco-friendly cosmetic products has led to growing interest in plant-based alternatives to synthetic formulations. However, there is limited research on the development and consumer acceptability of lip tints using natural pigments from locally available plant sources. This study aimed to formulate and evaluate lip tint cosmetics using beetroot, carrot, and dragon fruit as natural coloring agents. An experimental design was employed, including extraction, formulation, and evaluation based on shade, texture, scent, and ease of application, supported by phytochemical, physical, and rheological analyses. Results showed that all formulations were acceptable, with dragon fruit lip tint obtaining the highest acceptability rating (mean ≈ 5.20), while beetroot showed significant differences among respondent groups ($p < 0.05$). The products demonstrated suitable cosmetic properties and short-term stability. These findings indicate that natural pigments can serve as safe, effective alternatives in cosmetic formulation while supporting sustainable product development.

Keywords: Natural colorants, lip tint formulation, phytochemical properties, sensory evaluation, cosmetic acceptability.

Date Submitted: April 10, 2026

Date Accepted: April 17, 2026

Date Published: April 23, 2026

INTRODUCTION

Modern beauty products, commonly referred to as cosmetics, play a significant role in everyday life. Cosmetics are substances applied to enhance or improve an individual's physical appearance. The desire for attractiveness is a universal human trait, with the use of cosmetics dating back to early civilizations. Historically, men used animal skins and plant materials for protection, while women adorned themselves with naturally colored stones and flowers.

Advancements in modern technology have enabled the widespread use of synthetic compounds in cosmetic formulations (Yeouth, 2022). Although most cosmetics are generally considered safe, potential health risks, particularly from long-term exposure, remain a concern. Since many cosmetic products are used daily over extended periods, ensuring their safety through proper regulation of chemical composition and toxicity levels is essential.

*Corresponding author/ Email: kandymae.agcaoili@deped.gov.ph
DOI: <http://doi.org/10.69651/PIJHSS05021031>

Recommended citation:

Barrera, K. M. A. (2026). Formulation and evaluation of lip tint using beetroot (*Beta vulgaris*), carrot (*Daucus carota*), and dragon fruit (*Hylocereus costaricensis*) as natural colorants. *Pantao (The International Journal of the Humanities and Social Sciences)* 5 (2), 2120-2128. <http://doi.org/10.69651/PIJHSS05021031>

Lip cosmetics, in particular, are widely used not only to enhance appearance but also to boost confidence, conform to social standards of beauty, and protect the lips from environmental factors. However, frequent use without adequate knowledge of product ingredients may pose health risks.

Several studies have raised concerns about harmful substances in lip products. The Campaign for Safe Cosmetics (2007), in its report “A Poison Kiss,” found that 61% of 33 tested lipsticks contained detectable levels of lead. Similarly, in 2010, the FDA analyzed 400 lipstick samples and detected lead in all of them, with concentrations higher than those reported in earlier studies. Further, a 2013 study by the University of California, Berkeley identified the presence of heavy metals such as lead, cadmium, chromium, and aluminum in commercially available lip products, some at elevated levels.

In response to these concerns, there has been increasing interest in plant-based cosmetic ingredients. According to Someya (2022), natural materials derived from plants, animals, and minerals have long been used in cosmetics. Currently, cosmeceuticals, cosmetics formulated primarily from plant-based ingredients, are gaining popularity.

This study focuses on three plant sources as natural colorants: beetroot, carrot, and dragon fruit. Beetroot contains a vibrant red pigment widely used in food and cosmetic industries (Agarwal, 2021). Carrots are rich in carotenoids, which provide color and offer skin-enhancing benefits such as moisture retention and improved texture. Dragon fruit contains betalains, water-soluble pigments capable of producing a range of colors from yellow to purple (Ling, 2020), making them viable alternatives to synthetic dyes.

With increasing awareness of the benefits of natural ingredients, global demand for plant-based cosmetics continues to rise. A 2015 study on Filipino consumer behavior showed an 11% increase in personal care product purchases, highlighting growing interest in such products. This trend presents opportunities for countries in the Asia-Pacific region, including the Philippines, to capitalize on their biodiversity and traditional knowledge in producing natural cosmetics (Mohana Priya, 2020).

Despite their widespread use, some cosmetics still contain potentially hazardous substances that may exceed safe limits and cause adverse health effects. Thus, consumers must be informed about the ingredients and their possible impacts.

Beyond personal use, plant-based cosmetics also contribute to sustainable development. The production of natural lip tints can support community-based livelihoods, promote entrepreneurship (especially among women and youth), and encourage environmentally responsible practices. By replacing synthetic dyes with renewable plant extracts, such products contribute to both economic and ecological sustainability.

This study aims to develop a plant-based lip tint that is safe, environmentally friendly, and effective. If successful, this product could benefit consumers, the beauty industry, and local communities.

Color plays a crucial role in enhancing the appeal of products such as cosmetics, food, and pharmaceuticals. It significantly influences consumer perception and purchasing decisions. Due to concerns about the toxicity and carcinogenic potential of synthetic dyes, there has been a shift toward natural pigments derived from microorganisms and plant-based phytochemicals.

Natural pigments are increasingly preferred due to their safety, reliability, and additional benefits, such as antioxidant and potential anti-cancer properties. One such example is anthocyanins, which provide color while offering health benefits. Consequently, the demand for herbal-based cosmetic products continues to grow.

However, global cosmetic regulations remain complex and require stricter enforcement to ensure product safety. Strengthening cosmetovigilance systems and adopting global standards can help minimize health risks associated with cosmetic use (Khan et al., 2019).

Based on these considerations, this study explores the feasibility of using beetroot, carrot, and dragon fruit as natural colorants in lip tint formulation. The research involves product development, testing, and evaluation.

The framework of the study follows an input–process–output structure. The input includes the necessary knowledge, materials, tools, and equipment for formulation. The process involves the preparation of lip tint formulations, followed by sensorial evaluation and physical and chemical analyses. The output consists of the developed lip tint products: beetroot lip tint, carrot lip tint, and dragon fruit lip tint.

Statement of the problem

This study aimed to determine the acceptability and sensorial evaluation of lip tint cosmetics made from natural coloring agents. Specifically, it sought to answer the following questions:

1. What are the processes involved in formulating and developing beetroot lip tint, carrot lip tint, and dragon fruit lip tint?
2. What are the physical and chemical analyses of the beetroot lip tint, carrot lip tint, and dragon fruit lip tint?
3. What is the general acceptability of the developed lip tint in terms of shade, texture, scent, and ease of application?
4. What is the level of acceptability of the developed lip tint products as perceived by high school students, college students, teachers, and experts?
5. Is there a significant difference in the level of acceptability of the lip tint products among the different samples as perceived by respondents from the identified groups?
6. What is the shelf life of the developed lip tint products?
7. What is the production cost of the developed lip tint products?

METHODOLOGY

This study employed an experimental research design to develop and evaluate lip tint formulations using natural plant-derived colorants from beetroot, carrot, and dragon fruit. These plant sources were selected due to their rich pigment content and potential cosmetic benefits. Multiple formulations were produced by combining each plant extract with different fragrance variants to allow comparative evaluation of the resulting products.

Fresh fruits were carefully selected, washed with distilled water to remove impurities, peeled, and cut into small uniform pieces. The samples were processed using a juicer to extract pigments. The extracted juice was filtered to remove fibrous materials and allowed to stand to facilitate sedimentation. Only the clear supernatant was used in the formulation to ensure product consistency.

The formulation process involved blending the fruit extracts with vegetable glycerin, xanthan gum, oregano oil, stevia oil, sodium benzoate, and selected fragrance oils. Vegetable glycerin was incorporated to enhance moisture retention and improve texture, while xanthan gum functioned as a thickening and stabilizing agent. Oregano oil provided antioxidant properties, stevia oil contributed mild sweetness, and sodium benzoate served as a preservative to inhibit microbial growth. Fragrance oils were added to improve the sensory characteristics of the product. The mixtures were homogenized using appropriate laboratory tools until a uniform consistency was achieved and were then transferred into sterile containers for analysis.

Laboratory analyses were conducted to determine the chemical and physical properties of the developed lip tints. Phytochemical screening was performed using thin-layer chromatography to identify the presence of bioactive compounds. Specific reagents were used to detect metabolites such as phenolic compounds and alkaloids, and the results were observed under ultraviolet light. Physical parameters, including pH, total dissolved solids, and electrical conductivity, were measured using standard laboratory instruments. Rheological properties, such as viscosity and spreadability, were also evaluated to assess product stability and application performance.

Sensory evaluation was conducted using a structured questionnaire administered to a group of respondents composed of high school students, college students, teachers, and experts. The respondents assessed the developed lip tint formulations based on shade, texture, scent, and ease of application.

The collected data were analyzed using appropriate statistical tools. Descriptive statistics, including the mean and standard deviation, were used to determine the average level of acceptability and the variability of responses. Inferential statistics were applied using one-way analysis of variance (ANOVA) to determine whether significant differences existed in the level of acceptability among the different formulations and respondent groups. When significant differences were identified, Tukey's Honestly Significant Difference (HSD) test was employed as a post hoc analysis to determine which specific groups differed significantly.

RESULTS AND DISCUSSION

Product development outcomes

The development of the lip tint products followed a systematic process involving fruit selection, extraction, formulation, and packaging. Variations in the final products were primarily influenced by the type of natural colorant used, namely beetroot, carrot, and dragon fruit. Each formulation incorporated fragrance variations, which contributed to differences in sensory characteristics. The results demonstrated that the choice of plant-based pigment significantly affected the overall quality, appearance, and acceptability of the lip tints.

Phytochemical properties and functional implications

Phytochemical analysis revealed the presence of key bioactive compounds across all formulations, particularly flavonoids, tannins, and phenolic compounds. These compounds are widely recognized for their antioxidant properties and their role in enhancing product stability.

Beetroot-based formulations exhibited a higher concentration of polyphenolic compounds, suggesting stronger antioxidant potential and pigment stability. Dragon fruit formulations showed high levels of essential oils and moderate levels of phenolic compounds, indicating contributions from both natural extracts and added fragrance components. Carrot-based formulations displayed variability in phytochemical composition, particularly in pigment-related compounds, which influenced their coloration and chemical behavior.

These findings align with previous studies indicating that plant-derived pigments such as anthocyanins and betalains are effective natural colorants in cosmetic formulations (Anggraini & Ginting, 2019). Additionally, flavonoids have been identified as important cosmeceutical ingredients due to their antioxidant and skin-protective properties (Andrabi, Kumar, & Sawhney, 2024). Tannins and phenolic compounds further contribute antimicrobial, anti-inflammatory, and protective functions (Moura de Melo et al., 2023; Jewell, 2019).

Physical and chemical characteristics

The formulated lip tints exhibited properties suitable for cosmetic application. All samples demonstrated mildly acidic conditions, indicating compatibility with the natural pH of the lips and reduced likelihood of irritation.

Distinct color variations were observed based on the plant source: dragon fruit produced purple hues, beetroot resulted in brownish tones, and carrot yielded bright orange shades. These differences reflect the dominant natural pigments present in each plant, such as betalains, anthocyanins, and carotenoids.

Texture analysis showed that dragon fruit formulations had a lighter and smoother consistency, while beetroot formulations were thicker and more viscous. Carrot-based formulations exhibited intermediate characteristics. These variations suggest that plant composition significantly influences the rheological behavior of cosmetic products.

Rheological stability

The lip tint formulations generally demonstrated acceptable stability in terms of consistency and spreadability. Beetroot-based products showed greater resistance to changes in viscosity, indicating stronger structural stability. Dragon fruit formulations were moderately stable but more sensitive to interactions with fragrance components. Carrot formulations exhibited greater variability, particularly in certain variants that showed changes in consistency over time.

Overall, the findings suggest that plant-based formulations can achieve acceptable rheological stability when properly formulated, although stability may vary depending on the specific plant source and additive interactions.

Sensory evaluation and consumer acceptability

The sensory evaluation results indicated varying levels of acceptability among the three lip tint variants. Beetroot-based products received consistent and moderately positive ratings across all evaluated attributes, particularly in ease of application. These findings are supported by Shinde et al. (2025), who reported that beetroot-based cosmetic formulations exhibit favorable texture, stability, and safety for daily use.

Carrot-based lip tints demonstrated more variability in acceptability. While generally rated as acceptable, their performance depended largely on the fragrance variant, with certain scents receiving more favorable responses. This pattern is consistent with findings by Hayati (2016), which highlight the importance of sensory attributes such as fragrance in influencing consumer preference.

Dragon fruit-based lip tints achieved the highest and most consistent acceptability ratings across all attributes. These formulations were particularly favored for their sensory qualities, indicating strong consumer appeal. Similar findings were reported by Yulyuswarni et al. (2018), who emphasized the effectiveness of dragon fruit as a natural colorant in cosmetic products.

In general, the results indicate that dragon fruit formulations offer the highest consumer satisfaction, while beetroot provides stable and reliable performance, and carrot formulations present moderate but variable acceptability.

Acceptability across respondent groups

Analysis across different respondent groups revealed distinct preference patterns. Beetroot lip tint showed variability in acceptability depending on the group, indicating that demographic factors influence perception. Carrot lip tint exhibited consistent but moderate acceptance across all groups, suggesting broad but limited appeal. In contrast, dragon fruit lip tint demonstrated consistently positive evaluations across all respondent categories, including experts, indicating strong universal appeal.

These findings highlight the importance of consumer segmentation in cosmetic product development, as preferences may vary based on age, experience, and user expectations.

Statistical differences and post hoc findings

Statistical analysis revealed that only the beetroot lip tint showed significant differences in acceptability among respondent groups, indicating that perceptions of this product vary across demographics. In contrast, carrot and dragon fruit formulations showed no significant differences, suggesting more consistent acceptance across groups.

Post hoc analysis further indicated that college students differed significantly in their evaluation of beetroot lip tint compared to other groups, generally showing lower preference. This observation is supported by Bilal and Ahmad Bhat (2020), who noted that consumer attitudes toward cosmetic products may vary based on awareness, preferences, and lifestyle factors.

Shelf-life evaluation

Shelf-life observations indicated that all formulations maintained desirable qualities during the initial period of storage. Over time, however, changes in color, scent, and texture were observed, particularly in beetroot and carrot formulations. These products showed fading of color, weakening of aroma, and changes in consistency.

In contrast, dragon fruit formulations demonstrated greater stability, maintaining their color and texture for a longer duration. These results suggest that dragon fruit-based formulations may offer better shelf stability compared to other plant-based alternatives.

Production cost and commercial viability

The cost analysis indicated that all formulations can be produced at relatively low cost, making them economically viable for small-scale production. Compared to commercially available lip tint products, the developed formulations offer a more affordable alternative while maintaining acceptable quality.

These findings suggest strong potential for commercialization, particularly in markets that favor natural, plant-based cosmetic products.

The results of this study demonstrate that plant-based lip tints formulated from beetroot, carrot, and dragon fruit are viable alternatives to synthetic cosmetic products. Among the three, dragon fruit emerged as the most promising option due to its superior acceptability, stability, and overall performance. Beetroot provided strong functional and antioxidant properties, while carrot offered moderate but variable results.

The integration of natural pigments not only enhances cosmetic appeal but also contributes to product safety, sustainability, and consumer preference for natural ingredients.

CONCLUSION

The results of this study show that lip tints made from natural colorants such as beetroot, carrot, and dragon fruit are generally acceptable in terms of shade, texture, scent, and ease of application. Among the three, the dragon fruit lip tint received the highest level of acceptance from the respondents, making it the most preferred formulation.

Differences in the level of acceptability were observed among the groups of respondents, which may be influenced by their level of knowledge, experience, and age. Despite these differences, all formulations were found to be suitable for cosmetic use based on the results of phytochemical analysis, physical testing, and stability assessment. The presence of natural compounds such as flavonoids and phenols suggests that these plant-based ingredients not only provide color but may also offer added benefits like protection and antioxidant effects.

The products also showed potential for commercial use, as they remained usable for up to four weeks under normal conditions. However, improvements are still needed to enhance product quality and safety. Future studies should include microbial testing to ensure that the products remain safe over longer storage periods. It is also important to explore suitable preservatives that can extend shelf life without affecting the natural properties of the ingredients.

Further improvements in the formulation are recommended, such as adjusting the amount of extracts, moisturizers, and fragrances to achieve more consistent results and reduce production costs. The use of more advanced equipment and testing methods can also help improve the accuracy of results, especially in measuring thickness and color concentration. In addition, the antioxidant properties of the ingredients should be tested to confirm their benefits.

There is also an opportunity to experiment with combining different natural colorants to create better shades and improve product performance. Simple process improvements, such as controlled heating during mixing, may help achieve a more uniform texture. More studies can also be done using different concentrations and fragrance combinations to further improve the product.

Lastly, this study highlights the potential of using locally available plants for cosmetic production. This can help farmers, small entrepreneurs, and educators create additional sources of income while promoting the use of natural and sustainable products. Schools and research offices can also support this kind of innovation by encouraging further studies and product development.

In general, continued research and testing are needed to improve these natural lip tints and support their use as safe, effective, and affordable cosmetic products.

REFERENCES

- Andrabi, S., Kumar, R., & Sawhney, A. (2024). Flavonoids: A key component of cosmeceuticals. ScienceDirect. <https://www.sciencedirect.com>
- Ansar, A., Annekhan, A., Krishnan, R., et al. (2025). Natural colorants in lipstick formulations: Insights into alkanet root-based preparations and evaluations. EPRA International Journal of Multidisciplinary Research (IJMR).
- Azwanida, N. N., et al. (2014). Utilization and evaluation of betalain pigment from red dragon fruit (*Hylocereus polyrhizus*) as a natural colorant for lipstick. Jurnal Teknologi.

Ben-Nun, L. (2016). Medical effects of cosmetics. B.N. Publication House.

Bhat, B. A., & Bhat, S. S. (2020). Awareness and attitude of female college students towards herbal cosmetic products in Central Kashmir. *Galore International Journal of Applied Sciences and Humanities*.

Chaudhari, N. P., et al. (2018). A review on herbal lipstick from different natural coloring pigments. *Indian Journal of Drugs*.

Eshmail, P. M., et al. (2016). Physicochemical, microbiological, and sensory properties of low-fat yoghurt fortified with carrot powder. *International Journal of Agricultural and Biological Engineering*. <https://doi.org/10.3965/j.ijabe.20160901.1874>

Farida, H. (2016). Formulation and evaluation of herbal lipsticks from carrot (*Daucus carota* L.). *International Journal of Pharmacy and Pharmaceutical Sciences*.

Hadi, I., Shinta, T. A., & Putra, T. A. (2025). Formulation and evaluation of lip balm from beet extract (*Beta vulgaris* L.). *Fundamental and Applied Pharmaceutical Science*.

Hayati, F. (2016). Formulation and evaluation of herbal lipsticks from carrot (*Daucus carota* L.). *International Journal of Pharmacy and Pharmaceutical Sciences*.

Hossain, M. F., et al. (2021). Cultivation, nutritional value, and health benefits of carrot. *International Journal of Horticultural Science and Technology*.

Jewell, T. (2019). What is phenol? Healthline. <https://www.healthline.com>

Kale, R. G., et al. (2018). Evaluation of physical and chemical composition of beetroot (*Beta vulgaris* L.). *ResearchGate*.

Karsidin, & Fauzia, et al. (n.d.). Hedonic test of lipstick combination of red dragon fruit peel extract (*Hylocereus polyrhizus*) and beetroot tuber extract (*Beta vulgaris* L.) as natural colorant. *Media Farmasi Indonesia*.

Khan, S. (2021). Benefits of beetroot for skin and hair. *Healthshots*. <https://www.healthshots.com>

Mahalder, K., & Mohiuddin, S. (2020). Factors influencing consumer perception toward cosmetics.

Mawazi, S. M., et al. (2022). Lipstick history, formulations, and production: A narrative review. *Cosmetics*. <https://www.mdpi.com>

Modi, D. (2022). Formulation and evaluation of herbal lipstick from beetroot and carrot juice. *International Journal of Pharmacy and Pharmaceutical Research*.

Mohana Priya, M., et al. (2020). Use of natural pigments as colorants in cosmetics: A review. *Journal of Emerging Technologies and Innovative Research*.

Moura de Melo, M., Aquino-Martins, V., da Silva, R., et al. (2023). Biological and pharmacological properties of tannins and potential applications. Food Chemistry. <https://www.sciencedirect.com>

Perween, T., & Meena, K. (2018). Dragon fruit: An emerging fruit crop. Journal of Pharmacognosy and Phytochemistry.

Que, F., Hou, X. L., & Wang, G. L. (2019). Advances in research on carrot (*Daucus carota* L.). Horticulture Research. <https://www.nature.com>

Raut, S., Shere, S., & Surushe, P. (2025). Formulation of herbal lipstick using dragon fruit, beetroot, and turmeric powder. International Journal of Sciences and Innovation Engineering.

Reyes, R. K. (2019). Red dragon fruit peel as a natural food coloring agent. Ascendens Asia Journal of Multidisciplinary Research.

Shinde, S., Suroshe, G., Gore, P., et al. (2025). Formulation and evaluation of herbal lip gloss from beetroot. International Journal of Novel Research and Development.

Spritzler, F. (2019). Dragon fruit: Nutrition facts and benefits. Healthline. <https://www.healthline.com>

Yeouth. (2022). The truth behind synthetic ingredients in cosmetics. <https://yeouth.com>