
**AGRO-WASTE AS SUSTAINABLE COSMETIC PREPARATIONS: A
REVIEW**

Chaithanya. A. P.¹, Hanan Ali Ebrahim²

¹Faculty, department of pharmaceutics. Malik Deenar College of Pharmacy, Kasaragod,
Research scholar BIHER Chennai.

²Research student Department of Pharmaceutics, Malik Deenar College of Pharmacy,
Kasaragod.

Article Received: 18 July 2026, Article Revised: 13 August 2026, Published on: 02 September 2026

***Corresponding Author: Chaithanya. A. P.**

Faculty, department of pharmaceutics. Malik Deenar College of Pharmacy, Kasaragod, Research scholar BIHER
Chennai.

Doi: <https://doi-doi.org/101555/ijarp.2811>

ABSTRACT

Agricultural waste (agro-waste) has emerged as a sustainable source of natural bioactive compounds for cosmetic formulations. Polyphenols, flavonoids, anthocyanins, carotenoids, vitamins, and essential fatty acids are abundant in by-products such as banana peel, banana flower bract, citrus peel, grape pomace, pomegranate peel, coffee grounds, olive pomace, and rice bran. These substances can be used in face washes, creams, face packs, lip balms, lipsticks, sunscreens, and hair care products because of their antioxidant, antibacterial, anti-inflammatory, moisturizing, photoprotective, and anti-aging qualities. Using agricultural waste to make cosmetics encourages a circular economy, lowers pollution levels, and supports waste valorization. The main sources of agricultural waste, their bioactive components, cosmetic uses, and future opportunities for creating sustainable cosmetics are all outlined in this review.

KEYWORDS: Agro-waste, Sustainable cosmetics, Cosmeceuticals, Agricultural by-products, Bioactive compounds, Circular economy, Natural cosmetics.

1. INTRODUCTION

The increasing demand for natural and environmentally friendly cosmetic products has encouraged the use of agricultural waste (agro-waste) as a sustainable source of cosmetic ingredients. Agrowaste, including banana peel, banana flower bract, citrus peel, grape

pomace, pomegranate peel, coffee grounds, olive pomace, and rice bran, is rich in bioactive compounds such as polyphenols, flavonoids, anthocyanins, carotenoids, vitamins, and essential fatty acids. These compounds possess antioxidant, antimicrobial, anti-inflammatory, moisturizing, and anti-aging properties, making them valuable for cosmetic formulations.^[1]

The utilization of agro-waste in cosmetics not only improves the functional properties of products but also supports waste valorization and the principles of the circular economy by reducing environmental pollution. Agro-waste-derived ingredients have been incorporated into face washes, face packs, creams, lotions, lip balms, lipsticks, sunscreens, and hair-care products. This review summarizes the major agro-waste sources, their bioactive constituents, cosmetic applications, and future potential in the development of sustainable cosmetic formulations.^[2]

2. SOURCES OF AGRO-WASTE USED IN COSMETIC PREPARATIONS

Agricultural by-products are increasingly recognized as sustainable sources of functional ingredients for cosmetic formulations. These materials, previously regarded as waste, contain numerous phytochemicals with antioxidant, anti-inflammatory, antimicrobial, moisturizing, and photoprotective activities. Their incorporation into cosmetic products not only improves product performance but also supports waste valorization and the circular economy.

2.1 Banana Flower Bract

Banana flower bracts are an underutilized agricultural by-product generated during banana cultivation. They are rich in anthocyanins, flavonoids, phenolic acids, and tannins, which possess potent antioxidants and free radical scavenging activities. Anthocyanins impart a natural redpurple color, making banana bract extract a promising natural colorant for herbal lip balms, lipsticks, tinted creams, and facial cosmetics. In addition, the antioxidant properties of the extract may protect the skin from oxidative stress and premature aging.



Fig.1. Banana Flower Bracts.

2.2 Banana Peel

Banana peel is another abundant banana-processing by-product with significant potential in cosmetic applications. It contains polyphenols, flavonoids, carotenoids, dopamine, lutein, vitamin C, potassium, and dietary fiber, which contribute to antioxidant, antimicrobial, anti-inflammatory, and moisturizing effects. These bioactive compounds help neutralize free radicals, reduce oxidative stress, and support skin protection against premature aging.

Banana peel extract has attracted attention as a natural ingredient in cosmetic formulations because of its ability to improve skin hydration, soothe irritated skin, and provide antioxidant defense. It has been incorporated into face masks, facial cleansers, moisturizing creams, exfoliating scrubs, soaps, lotions, and anti-aging formulations. ^[6]



Fig.2. Banana Peel.

The use of banana peel in cosmetics is particularly attractive from a sustainability perspective because it is inexpensive, biodegradable, and widely available in tropical regions. Its valorization in cosmetic products helps reduce agricultural waste while supporting the development of ecofriendly and circular economy-based formulations.

2.3 Citrus Peels

Orange, lemon, and grapefruit peels are abundant sources of vitamin C, hesperidin, limonene, and flavonoids. These compounds exhibit antioxidant, antimicrobial, and skin-brightening properties. Citrus peel extracts are widely investigated for incorporation into face washes, facial scrubs, creams, and anti-aging formulations because they help improve skin texture and reduce oxidative damage. ^[3]



Fig.3.Orange Peel.

2.4 Grape Pomace

Grape pomace, consisting of grape skins, seeds, and stems remaining after juice or wine production, contains high concentrations of resveratrol, catechins, quercetin, and proanthocyanidins. These bioactive compounds possess excellent antioxidant and anti-aging activities by protecting collagen and elastin from oxidative degradation. Grape pomace extracts have been incorporated into antiaging creams, facial serums, masks, and sunscreen formulations.^[7]

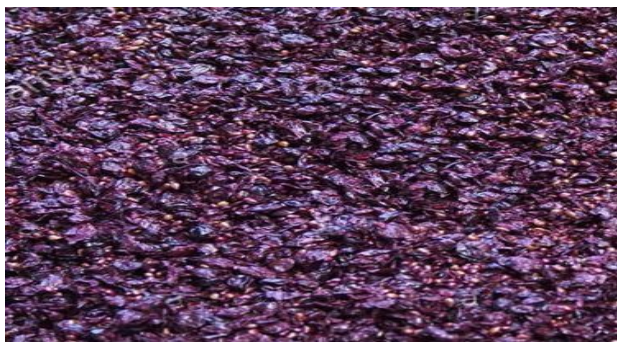


Fig.4.Grape Pomace.

2.5 Pomegranate Peel

Pomegranate peel is a rich source of ellagic acid, punicalagin, tannins, and flavonoids. Numerous studies have reported its antioxidant, antimicrobial, anti-inflammatory, and photoprotective properties. The extract has demonstrated potential in acne care products, anti-aging creams, facial masks, and wound-healing cosmetic formulations.^[5]



Fig.5. Pomegranate Peel.

2.6 Olive Pomace

Olive pomace is generated during olive oil production and contains hydroxytyrosol, oleuropein, tocopherols, and unsaturated fatty acids. These compounds provide moisturizing, antioxidant, and anti-inflammatory effects, making olive by-products suitable for creams, lotions, moisturizers, soaps, and hair-care products. ^[4]

2.7 Rice Bran

Rice bran is rich in γ -oryzanol, tocopherols, tocotrienols, ferulic acid, and essential fatty acids. These constituents improve skin hydration, reduce oxidative stress, and protect against ultraviolet-induced skin damage. Rice bran oil and extracts are frequently used in moisturizers, sunscreens, cleansers, and anti-aging formulations. ^[4]



Fig.6. Rice Bran.

Table 1. Major Agro-Waste Sources and Their Cosmetic Applications.

MAJOR AGROWASTE SOURCES AND THEIR COSMETIC APPLICATIONS		
Agro-waste Source	Major Bioactive Compounds	Cosmetic Applications
Banana flower bract	Anthocyanins, flavonoids	Lip balm, lipstick, face pack
Banana peel	Polyphenols, flavonoids, carotenoids, vitamin C	Face masks, cleansers, scrubs, creams, soaps, lotions
Citrus peels	Vitamin C, flavonoids, limonene	Face wash, creams, scrubs
Grape pomace	Resveratrol, catechins	Anti-aging creams, serums
Pomegranate peel	Ellagic acid, punicalagin	Face masks, acne creams
Olive pomace	Hydroxytyrosol, oleuropein	Moisturizers, lotions
Rice bran	γ -Oryzanol, ferulic acid	Sunscreens, moisturizers

3. BIOACTIVE COMPOUNDS AND THEIR COSMETIC BENEFITS

Agricultural by-products are rich sources of natural phytochemicals that exhibit multiple biological activities beneficial for skin and hair care. These compounds contribute to the efficacy of cosmetic formulations by protecting the skin from oxidative stress, improving hydration, delaying skin aging, and preventing microbial growth. Their multifunctional properties make agro-wastederived extracts promising alternatives to synthetic cosmetic ingredients.

3.1 POLYPHENOLS

Polyphenols are among the most abundant bioactive compounds found in agro-waste such as banana peel, grape pomace, pomegranate peel, olive pomace, and citrus peels. They possess strong antioxidant activity by scavenging reactive oxygen species (ROS), thereby protecting skin cells from oxidative damage induced by ultraviolet (UV) radiation and environmental pollutants. Polyphenols also inhibit collagen degradation, contributing to improved skin elasticity and reduced wrinkle formation. ^[1]

3.2 FLAVONOIDS

Flavonoids are naturally occurring antioxidants present in citrus peels, banana peel, banana flower bract, and grape pomace. They exhibit anti-inflammatory, antimicrobial, and photoprotective properties, making them suitable for cosmetic products intended for sensitive and acne-prone skin. Flavonoids also help maintain the skin barrier and reduce redness caused by inflammation. ^[10]

3.3 ANTHOCYANINS

Anthocyanins are water-soluble pigments responsible for the red, purple, and blue coloration of many fruits and flowers. Banana flower bracts, grape skins, and certain berry residues are excellent sources of anthocyanins. Besides providing natural coloration for cosmetic products such as lip balms and lipsticks, anthocyanins possess potent antioxidant activity that protects skin cells from oxidative stress and premature aging. ^[11]

3.4 CAROTENOIDS

Carotenoids, including β -carotene and lutein, are found in banana peel, tomato pomace, and carrot residues. These pigments protect the skin against UV-induced damage and contribute to improved skin tone. Their antioxidant properties also help reduce lipid peroxidation and maintain healthy skin. ^[12]

3.5 VITAMINS AND ESSENTIAL FATTY ACIDS

Many agricultural by-products contain vitamins C and E along with essential fatty acids that support skin hydration, collagen synthesis, and barrier function. Citrus peels are particularly rich in vitamin C, while rice bran and olive pomace provide beneficial fatty acids and vitamin E, which enhance skin moisturization and improve the stability of cosmetic formulations. ^[9]

3.6 NATURAL EXFOLIANTS

Some agro-wastes provide both chemical and physical exfoliating properties. Spent coffee grounds and finely powdered fruit peels act as biodegradable exfoliating agents that help remove dead skin cells, improve skin texture, and promote smoother skin. Unlike synthetic plastic microbeads, these natural exfoliants are environmentally friendly and biodegradable.

Table.2. Cosmetic Benefits of Major Bioactive Compounds.

COSMETIC BENEFITS OF MAJOR BIOACTIVE COMPOUNDS		
Bioactive compound	Major agro-waste sources	Cosmetic benefits
Polyphenols	Banana peel, grape pomace, pomegranate peel	Antioxidant, anti-aging
Flavonoids	Banana peel, citrus peel, banana flower bract	Anti-inflammatory, antimicrobial
Anthocyanins	Banana flower bract, grape skins	Natural colorant, antioxidant
Carotenoids	Banana peel, tomato pomace	UV protection, skin brightening
Vitamin C	Citrus peels	Collagen synthesis, skin brightening
Essential fatty acids	Rice bran, olive pomace	Moisturizing, skin barrier repair

The incorporation of these naturally occurring bioactive compounds into cosmetic formulations enhances product functionality while reducing reliance on synthetic additives. Their combined antioxidant, antimicrobial, moisturizing, and photoprotective activities make agro-waste a valuable and sustainable resource for the development of innovative cosmetic products.

4. APPLICATIONS OF AGRO-WASTE IN COSMETIC FORMULATIONS

The growing preference for natural and sustainable cosmetic products has accelerated the utilization of agro-waste-derived bioactive compounds in various cosmetic formulations. These ingredients offer multiple biological activities, including antioxidant, antimicrobial, moisturizing, anti-inflammatory, photoprotective, and anti-aging effects, while reducing environmental pollution through waste valorization.

4.1 FACE WASH

Agro-waste extracts such as banana peel, citrus peel, green tea residues, and pomegranate peel are incorporated into herbal face washes because of their cleansing, antioxidant, and antimicrobial properties. Polyphenols and flavonoids present in these extracts help remove excess sebum, reduce microbial growth, and protect the skin from oxidative stress without causing excessive dryness.

4.2 FACE PACKS AND FACIAL MASKS

Face packs prepared from banana peel powder, orange peel powder, grape pomace, and rice bran provide gentle exfoliation, improve skin texture, and enhance skin brightness. Their high antioxidant content protects against free radical-induced skin damage while improving skin hydration and elasticity. Such formulations are widely investigated for anti-aging and skinrejuvenating applications.

4.3 MOISTURIZING CREAMS AND LOTIONS

Olive pomace, rice bran, avocado seed residues, and pomegranate peel extracts are rich in essential fatty acids, tocopherols, and phenolic compounds that improve skin hydration and strengthen the skin barrier. These ingredients are incorporated into moisturizing creams and lotions to enhance skin softness and reduce transepidermal water loss.

4.4 LIP BALMS AND LIPSTICKS

Natural pigments and antioxidants obtained from banana flower bracts, grape skins, beetroot residues, and pomegranate peel have attracted considerable attention as alternatives to synthetic colorants. Anthocyanins from banana flower bracts provide attractive natural

coloration while offering antioxidant protection. Banana peel extract has also been investigated as a moisturizing ingredient because of its polyphenol and vitamin content.

4.5 SUNSCREEN PREPARATIONS

Polyphenols, flavonoids, and carotenoids obtained from tomato pomace, citrus peels, grape pomace, and rice bran exhibit photoprotective properties by reducing ultraviolet (UV)-induced oxidative damage. Although these extracts cannot completely replace conventional UV filters, they can improve the antioxidant capacity of sunscreen formulations and provide additional skin protection.

4.6 HAIR CARE PRODUCTS

Coffee by-products, rice bran, olive pomace, and fruit peel extracts have been incorporated into shampoos, conditioners, and hair masks. Their antioxidant and conditioning properties help protect the scalp, improve hair texture, and reduce oxidative damage caused by environmental pollutants.^[13]

Table. 3. Cosmetic Applications of Major Agro-Waste Sources.

COSMETIC APPLICATIONS OF MAJOR AGRO-WASTE SOURCES		
AGRO-WASTE	COSMETIC PRODUCT	FUNCTION
Banana peel	Face wash, face pack, cream	Antioxidant, moisturizing, antimicrobial
Banana flower bract	Lip balm, lipstick	Natural colorant, antioxidant
Orange peel	Face scrub, cleanser	Exfoliating, skin brightening
Grape pomace	Anti-aging cream, serum	Antioxidant, collagen protection
Pomegranate peel	Face mask, acne cream	Antimicrobial, anti-inflammatory
Coffee grounds	Facial scrub, body scrub	Natural exfoliant, antioxidant
Olive pomace	Moisturizer, lotion	Emollient, skin barrier repair
Rice bran	Sunscreen, moisturizer	UV protection, hydration

Overall, agro-waste-derived ingredients provide multifunctional benefits that improve the quality, safety, and sustainability of cosmetic formulations. Their incorporation into cosmetic products supports the principles of green chemistry and the circular economy by converting agricultural residues into valuable bioactive ingredients.

5. CHALLENGES AND FUTURE PERSPECTIVES

Despite the growing interest in agro-waste-derived cosmetic ingredients, several challenges must be addressed before their widespread commercial application. One of the major

limitations is the variability in the composition of bioactive compounds, which depends on factors such as plant variety, geographical location, climatic conditions, maturity stage, and post-harvest processing.

This variability may affect the consistency and efficacy of cosmetic formulations.

Another challenge is the stability of natural bioactive compounds. Phenolics, flavonoids, anthocyanins, and carotenoids are susceptible to degradation when exposed to light, oxygen, heat, and variations in pH, resulting in reduced antioxidant activity and undesirable color changes during storage. Appropriate extraction techniques, stabilizers, encapsulation technologies, and optimized packaging are therefore required to maintain product quality.

The extraction and purification of bioactive compounds also require standardized, environmentally friendly, and cost-effective methods. Green extraction technologies such as ultrasound-assisted extraction, microwave-assisted extraction, enzyme-assisted extraction, and supercritical fluid extraction have shown promising results by improving extraction efficiency while minimizing solvent consumption and environmental impact.

Regulatory approval and safety evaluation remain essential for the commercialization of agrowaste-derived cosmetic ingredients. Comprehensive studies on toxicity, skin irritation, allergenicity, and long-term stability are necessary to ensure consumer safety and comply with cosmetic regulations.

Future research should focus on developing multifunctional cosmetic formulations using agrowaste extracts, improving extraction technologies, and employing advanced delivery systems such as nanoemulsions, liposomes, and phytosomes to enhance the stability and bioavailability of natural bioactive compounds. Such approaches will contribute to the development of highperformance, sustainable, and environmentally friendly cosmetic products.

6. CONCLUSION

Agricultural waste represents a valuable and sustainable source of bioactive compounds for cosmetic applications. By-products such as banana peel, banana flower bract, citrus peels, grape pomace, pomegranate peel, coffee grounds, olive pomace, and rice bran are rich in polyphenols, flavonoids, anthocyanins, carotenoids, vitamins, and essential fatty acids that provide antioxidant, antimicrobial, anti-inflammatory, moisturizing, photoprotective, and anti-aging properties.

The incorporation of these natural ingredients into cosmetic formulations including face washes, face packs, creams, lotions, lip balms, lipsticks, sunscreens, and hair-care products

not only enhances product functionality but also promotes waste valorization and environmental sustainability. The use of agro-waste aligns with the principles of the circular economy by converting low-value agricultural residues into high-value cosmetic ingredients. Although challenges related to stability, standardization, extraction efficiency, and regulatory compliance remain, recent advances in green extraction technologies and novel delivery systems offer promising opportunities for future research and commercialization. Therefore, agrowaste-derived ingredients have significant potential to become key components of next-generation sustainable cosmetic formulations.

7. REFERENCES

1. Silva C, et al. From Waste to Dermocosmetic Value: A Narrative Review of AgroIndustrial Residues in Skincare Innovation. *Applied Sciences*. 2026;16(10):4777.
2. Mouro C, et al. Agro-Industrial Side Streams in Cosmetics: From Raw Materials to ScaleUp and Life Cycle Assessment Within a Circular Economy Framework. *Cosmetics*. 2026;13(3):109.
3. Dias MI, et al. Use of Waste from the Food Industry and Applications of the Fermentation Process to Create Sustainable Cosmetic Products: A Review. *Sustainability*. 2024;16:2757.
4. Zillich OV, Schweiggert-Weisz U, Eisner P, Kerscher M. New Trends in Cosmetics: ByProducts of Plant Origin and Their Potential Use as Cosmetic Active Ingredients. *Cosmetics*. 2015;2(2):82–92.
5. Dini I, Laneri S. The New Challenge of Green Cosmetics: Natural Food By-Products as Cosmetic Ingredients. *Cosmetics*. 2021;8(2):47.
6. S GK, John JA. Banana by-products as an emerging and sustainable source of bioactive compounds — insights and applications. *Biomass Conversion and Biorefinery*. 2025 Aug 26;. Grape Pomace - an overview | ScienceDirect Topics [Internet].
7. Gómez-García R, et al. Bioactive Compounds from Agro-Industrial Waste for Cosmetic Applications. *Molecules*. 2021.
8. Gullón B, et al. Valorization of Agri-Food By-Products as Natural Ingredients for Cosmetic Applications. *Industrial Crops and Products*. 2022.
9. Lourenço SC, Moldão-Martins M, Alves VD. Antioxidants of Natural Origin in Cosmetic Formulations. *Molecules*. 2019.
10. Pereira A, Maraschin M. Banana By-Products as a Source of Bioactive Compounds: A Review. *Molecules*. 2024.

11. Schieber A, Stintzing FC, Carle R. By-Products of Plant Food Processing as Sources of Functional Compounds. Trends in Food Science & Technology. 2001.
12. Galanakis CM. Recovery of High Added-Value Components from Food Wastes: Conventional, Emerging Technologies and Commercialized Applications. Trends in Food Science & Technology. 2012.