INTERNATIONAL JOURNAL OF
Clinical and Pharmaceutical Innovations
An International Peer Reviewed Open Access Journal

Review Article

ISSN (Online): 3142-8665
CODEN (USA): IJCPSM
IMPACT FACTOR: 3.345

2026, Volume 1, Issue 8, Page No: 177-180.

HERBAL DRUGS IN THE MANAGEMENT OF ACNE: A REVIEW

***Utkarsha Hanumant Lavate, Sakshi Tukaram Virkar**

India.

Article Info: **Received:** 25 September 2026, **Revised:** 15 October 2026, **Accepted:** 05 November 2026

***Corresponding Author: Utkarsh Lavate**

India.

DOI: https://doi.org/10.5281/zenodo.24072417

Citation:
*Utkarsha Hanumant Lavate, Sakshi Tukaram Virkar. (2026). Herbal Drugs In The Management Of Acne: A Review. International Journal of Clinical and Pharmaceutical Innovations, 1(8), 177-180.

ABSTRACT
Cosmetic packaging protects formulations from contamination, oxidation, leakage and loss of volatile ingredients, but it can also contribute to resource consumption and post-consumer waste. The challenge is particularly complex because cosmetic containers must satisfy aesthetic, sensory, compatibility, dispensing and hygiene requirements. This review examines sustainable cosmetic packaging through a circular-economy lens, focusing on packaging reduction, reuse and refill systems, design for recycling, recycled polymers, and emerging bio-based or biodegradable materials. It also considers life-cycle assessment (LCA) as a method for comparing alternatives across raw-material production, manufacture, transport, use and end-of-life. Published studies indicate that no single material or strategy is universally superior: environmental outcomes depend on product type, packaging mass, number of reuse cycles, collection and recycling infrastructure, transport distances, and consumer behaviour. Refillable systems may reduce impacts when containers are reused sufficiently often, while lightweighting and mono-material designs can improve some life-cycle outcomes. Biodegradable materials require careful assessment of actual disposal conditions and should not be treated as automatically preferable. The review identifies key technical and evidence gaps, including limited comparable quantitative data, the need to protect product safety and stability, and the risk of unsupported environmental claims. A practical decision framework is proposed for selecting packaging based on product protection, circularity, LCA evidence, user convenience and end-of-life feasibility.

KEYWORDS: Sustainable cosmetics; cosmetic packaging; circular economy; life-cycle assessment; refillable packaging; recyclability; biodegradable polymers.

1. INTRODUCTION

Cosmetic products—including skin-care creams, shampoos, make-up, fragrances and sunscreens—often rely on packaging to preserve quality throughout storage and use. Packaging may provide a barrier to moisture, oxygen and light, enable controlled dispensing, and reduce direct contact with the product. At the same time, multi-component pumps, mixed-material closures, labels, coatings and decorative finishes can complicate sorting and recycling. The sustainability question is therefore not simply whether a package is made from plastic, glass or a bio-based material, but how the complete packaging system performs across its life cycle.[1–4]

Recent reviews have described sustainability across the cosmetic product life cycle and highlighted a growing interest in circular-economy practices, including the use of secondary raw materials, improved packaging, and valorisation of by-products.[1,2] Research focused specifically on cosmetic packaging has used LCA to

compare packaging options and to identify trade-offs between reuse, recycling and material reduction.[3–5] These findings support a product-specific approach rather than a universal claim that one packaging material is always the most sustainable.

2. AIM AND OBJECTIVES

Aim: To review current circular-design strategies for cosmetic packaging and discuss how LCA can guide evidence-based selection of sustainable packaging systems.

Objectives: (i) describe key sustainability challenges in cosmetic packaging; (ii) compare reduction, reuse/refill, recycling and bio-based alternatives; (iii) explain the role and limitations of LCA; (iv) identify product-safety, regulatory and consumer-related barriers; and (v) propose practical recommendations for cosmetic product developers.

3. Review Methodology

This article is structured as a narrative literature review using relevant peer-reviewed review articles and research papers identified through bibliographic and publisher search results. Priority was given to publications addressing cosmetic life-cycle sustainability, circular economy, cosmetic packaging design, environmental impact assessment, and recycling or reuse of packaging. The core evidence includes papers published from 2022 to 2025, with particular attention to open-access research where available.[1–7] This draft does not claim to be a fully systematic review: no exhaustive database search, duplicate screening, formal risk-of-bias assessment or PRISMA flow diagram was conducted. For a college submission requiring a systematic method, the search should be repeated in databases such as PubMed, Scopus, Web of Science or Google Scholar, with documented search strings and inclusion criteria.

4. Sustainability Challenges in Cosmetic Packaging

4.1 Product protection and material complexity

Cosmetic packaging must be compatible with the formulation and maintain product quality during storage and consumer use. Fragrances, oils, surfactants, pigments and active ingredients can interact differently with packaging materials. Airless pumps and multi-part dispensers may improve dosing or limit exposure, yet their mixed components can be difficult to separate at end-of-life. Any sustainability change must therefore be assessed alongside stability, microbiological quality, leakage, usability and consumer safety.

4.2 Resource use and end-of-life pathways

Packaging impacts arise from material extraction and processing, conversion into containers, transport, cleaning or refill operations, and disposal. The actual outcome depends on local waste collection and sorting systems. A technically recyclable package may not be recycled if it is too small, contaminated, made from inseparable materials, or unsupported by local infrastructure. Conversely, reusable packaging may need additional material and transport, making the number of successful reuse cycles a critical variable.[3,5]

4.3 Environmental claims and greenwashing

Terms such as 'green', 'natural', 'eco-friendly' and 'biodegradable' can be interpreted inconsistently. Reviews of certification frameworks note that differing standards may confuse consumers and make comparisons difficult.[6] Environmental claims should be specific, substantiated and transparent about conditions—for example, whether a package is recyclable in commonly available systems or biodegradable only in a specified industrial facility.

5. Circular Design Strategies

5.1 Reduce and lightweight

Reducing unnecessary packaging mass, avoiding oversized secondary cartons, and designing efficient shapes can lower material demand and transport burdens. However, excessive lightweighting can compromise drop resistance, dispensing or product protection and may increase product loss. The correct target is minimum material use consistent with the required performance, not minimum weight at any cost.

5.2 Reuse and refill systems

Refillable containers can spread the environmental burden of a durable outer package over several product uses. Their performance depends on the number of reuse cycles actually achieved, the mass and material of the original container, refill-pack design, cleaning requirements, transport, and return rates. A 2022 LCA study of plastic cosmetic packaging reported that reuse and recycling strategies can produce different outcomes and that their relative performance is sensitive to design choices.[5] Refill systems should be validated for hygiene, dosing accuracy, consumer convenience and formulation compatibility.

5.3 Design for recycling and mono-materials

Packages designed with compatible material families, separable components, easily removable labels and minimal decorative coatings are generally easier to sort and recycle than complex laminates or inseparable assemblies. A 2024 LCA study compared initiatives for reducing the environmental impacts of plastic cosmetic packaging and reinforces the importance of evaluating multiple attributes rather than relying on a single material label.[3] Mono-material design is not sufficient by itself: collection, sorting, recycling capacity and the quality of recovered material remain important.

5.4 Recycled content

Post-consumer recycled (PCR) plastic can reduce demand for virgin feedstock, but suitability depends on material quality, colour, odour, trace contaminants, mechanical performance and regulatory requirements for the intended use. Cosmetic packaging applications require compatibility and safety assessment, especially when the package has direct contact with the

formulation. PCR content should be specified and verified, and the potential environmental benefit should be assessed against any additional processing or rejection losses.

5.5 Bio-based and biodegradable materials

Bio-based polymers may be derived partly or wholly from renewable feedstocks, while biodegradable polymers are designed to break down under specified conditions. These properties are not interchangeable: a bio-based material may not be biodegradable, and a biodegradable material may require industrial composting conditions that are not available locally. A 2025 review of next-generation cosmetic packaging discusses materials such as polylactic acid (PLA), polyhydroxyalkanoates (PHA), cellulose-based materials and wood–plastic composites, while noting the need for suitable testing and transition planning.[7] Their performance should be assessed for barrier properties, durability, processing energy, feedstock impacts and realistic end-of-life routes.

5.6 Circular economy and upcycled inputs

Circular-economy approaches can also involve using suitable by-products from food and other industries as cosmetic ingredients or packaging feedstocks. A 2024 literature review found that input valorisation from agri-food waste and by-products was a prominent area of circular-economy research in cosmetics, while packaging and output-valorisation options were less extensively investigated.[2] Such approaches require consistent sourcing, contaminant control, quality specifications and evidence that the proposed use provides a net benefit.

6. Life-Cycle Assessment as a Decision Tool

LCA evaluates potential environmental impacts across a defined product system. For cosmetic packaging, a fair comparison should define the functional unit—for example, packaging needed to deliver and protect a stated quantity of usable product—and specify the system boundary, data sources and end-of-life assumptions. Relevant impact categories may include climate change, energy and water use, resource depletion, and waste-related impacts. ISO 14040 and ISO 14044 provide internationally recognised principles and requirements for LCA studies.[8,9]

A packaging comparison should test realistic scenarios. For refill systems, the analysis should vary the number of reuse cycles and account for refill packaging and transport. For recycling, it should state collection and recycling assumptions. For biodegradable materials, it should model the disposal pathway that is actually available. Sensitivity analysis is important because conclusions may change when transport distance, recycled content, electricity mix, container mass or recycling rate changes. LCA supports decisions but does not replace product-safety, quality, cost or consumer-acceptance assessments.

7. Comparison of Major Strategies

Strategy	Potential benefit	Key limitation / check
Lightweighting	Lower material use and transport burden	Must retain strength, barrier and dispensing performance
Reuse/refill	Spreads durable-container impacts over multiple uses	Benefit depends on actual reuse cycles, return rate and logistics
Mono-material design	Can simplify sorting and recycling	Local collection and recycling infrastructure still required
PCR content	May reduce virgin material demand	Quality, traceability, colour and contact-safety requirements
Bio-based / biodegradable	Potential renewable feedstock or specific end-of-life benefits	Not automatically lower-impact; disposal conditions and LCA matter

8. Safety, Quality and Regulatory Considerations

Sustainability measures must not compromise the safety, stability or intended performance of cosmetic products. Changes in packaging can affect oxygen and moisture exposure, evaporation, leaching, sorption of ingredients, microbial protection and consumer handling. Product developers should conduct compatibility, stability, transport and usability testing appropriate to the formulation and packaging system. Regulatory requirements vary by market and product category; claims and packaging choices should be reviewed against applicable local rules and substantiated evidence. This review is educational and does not substitute for regulatory advice.

9. Research Gaps and Future Directions

Important research needs include: (i) more comparable, transparent LCA datasets for complete cosmetic packaging systems; (ii) real-world data on refill return rates and repeat-use behaviour; (iii) better design for recycling of pumps, closures, labels and small containers; (iv) evaluation of recycled materials for cosmetic compatibility and quality; (v) testing of bio-based and biodegradable materials under realistic disposal conditions; and (vi) greater attention to affordability, accessibility, supply-chain impacts and consumer understanding. Recent reviews also point to gaps in quantitative evidence and to the need for broader social and economic perspectives alongside environmental assessment.[1,6]

10. Proposed Practical Decision Framework

A manufacturer or student evaluating a package can use

the following sequence: (1) define the product-protection and dispensing requirements; (2) eliminate unnecessary components and material; (3) check whether reuse/refill is practical and hygienically robust; (4) prefer designs compatible with real local recycling pathways where feasible; (5) assess recycled or bio-based materials for quality and compatibility; (6) compare options using a transparent LCA with sensitivity analysis; and (7) communicate only specific, verifiable environmental claims. This sequence helps prevent a narrow focus on one attribute—such as recycled content or biodegradability—from obscuring the performance of the whole system.

11. CONCLUSION

Sustainable cosmetic packaging requires a balance between environmental performance, product protection, consumer convenience, cost and end-of-life feasibility. Circular design strategies—including material reduction, refill and reuse, mono-material construction and appropriate recycled content—offer practical routes to improvement, while bio-based and biodegradable materials may be useful in selected applications. Their value cannot be assumed from a label alone. Life-cycle assessment, supported by transparent assumptions and real-world disposal data, is essential for identifying trade-offs and avoiding misleading comparisons. For B.Pharm students, this topic connects formulation compatibility, packaging science, quality assurance, environmental sustainability and regulatory awareness, making it a relevant and contemporary review subject.

REFERENCES

1. A sustainable life cycle for cosmetics: From design and development to post-use phase. Sustainable Chemistry and Pharmacy, 2023; 35: 101178. doi:10.1016/j.scp.2023.101178. Available at: https://doi.org/10.1016/j.scp.2023.101178
2. Exploring circular economy in the cosmetic industry: Insights from a literature review. Environmental Impact Assessment Review, 2024; 105: 107443. doi:10.1016/j.eiar.2024.107443. Available at: https://doi.org/10.1016/j.eiar.2024.107443
3. Vassallo N, Refalo P. Reducing the Environmental Impacts of Plastic Cosmetic Packaging: A Multi-Attribute Life Cycle Assessment. Cosmetics, 2024; 11(2): 34. doi:10.3390/cosmetics11020034. Available at: https://doi.org/10.3390/cosmetics11020034
4. Dube M, Dube S. Towards Sustainable Color Cosmetics Packaging. Cosmetics, 2023; 10(5): 139. doi:10.3390/cosmetics10050139. Available at: https://doi.org/10.3390/cosmetics10050139
5. Reusability and recyclability of plastic cosmetic packaging: A life cycle assessment. Resources, Conservation & Recycling Advances, 2022; 15: 200098. doi:10.1016/j.rcradv.2022.200098. Available at: https://doi.org/10.1016/j.rcradv.2022.200098
6. Current regulatory and market frameworks in green cosmetics: The role of certification. Sustainable Chemistry and Pharmacy, 2022; 30: 100851. doi:10.1016/j.scp.2022.100851. Available at: https://doi.org/10.1016/j.scp.2022.100851
7. The new generation of cosmetics packaging: A paradigm shift. Global Transitions, 2025; 7: 223–246. doi:10.1016/j.glt.2025.04.004. Available at: https://doi.org/10.1016/j.glt.2025.04.004
8. International Organization for Standardization. ISO 14040:2006. Environmental management—Life cycle assessment—Principles and framework. Geneva: ISO; 2006.
9. International Organization for Standardization. ISO 14044:2006. Environmental management—Life cycle assessment—Requirements and guidelines. Geneva: ISO; 2006.
10. Alviri H, Lynes J, Habib K. Beyond green chemistry: a comprehensive review of how sustainability has been integrated into cosmetic research. Global Sustainability, 2025; 8: e16. doi:10.1017/sus.2025.5. Available at: https://doi.org/10.1017/sus.2025.5