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Exploring the role of insects in cosmetic industry: Bioactive compounds and extraction techniques: A comprehensive review

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Abstract
Cosmetics alone cannot care for skin and body; it needs a combination of active ingredients to prevent skin damage and aging. Cosmetics are wildly popular with the masses. Since ancient times, people have used natural extracts and resources for health and beauty purposes. Insects such as cochineal insects, bees, silk-producing moths, and lac insects contribute important compounds with different benefits for cosmetic formulations. Cochineal insects give carminic acid, a characteristic color, whereas bees offer honey, beeswax, royal jelly, and propolis, known for their moisturizing, antimicrobial, and anti-aging properties. Silk proteins from silk moths upgrade skin hydration and repair, and lac resin from lac insects serves as a natural resin. These bioactive compounds play a critical part in advancing skin wellbeing, with antioxidant, anti-inflammatory, and hydrating effects. This review explores the use of insect-derived ingredients in the cosmetics industry, centering on types of insects, their bioactive compounds, and extraction techniques. The review also examines different extraction methods to get and purify these compounds. Insect-derived ingredients offer economical, viable options to synthetic ingredients, clearing the way for eco-friendly and innovative cosmetic products.

Keywords: Insects, cochineal insects, bees, *Bombyx mori*, *Kerria lacca*, extraction, applications

Introduction

Cosmetic products containing ingredients of animal origin or, more for the most part, of zoological origin, are called zooceuticals. [1, 2] This term is once in a while utilized, and biocosmetics, cosmeceuticals, or natural beauty care products are talked of more habitually since they contain ingredients of natural origin. In any case, zooceuticals concern all cosmetic items for human use. [3]

The cosmetics industry has seen noteworthy progressions over the decades, driven by customer request for innovative, economical, and viable products. Among the different sources of cosmetic ingredients, insects have developed as a interesting and captivating choice. Whereas the utilize of insect-derived components in cosmetics is not a novel concept, recent interest in natural and eco-friendly choices has restored their significance. From the distinctive colors extracted from cochineal insects to the nourishing properties of bee products, insects offer a wide cluster of bioactive compounds that improve the efficacy and request of cosmetic formulations [4, 5].

The move towards sustainability in the beauty industry has advance highlighted the significance of insects. Not at all like conventional synthetic ingredients, insect-derived materials are frequently renewable, biodegradable, and require less natural assets to create. Furthermore, their utilize adjusts with worldwide endeavors to diminish the biological impression of cosmetic production and react to expanding customer preference for green and clean beauty [1, 2].

Despite these points of interest, the incorporation of insect-derived ingredients in makeup also brings challenges. Ethical considerations, such as the utilize of animal products in a overwhelmingly vegan-conscious market, as well as regulatory hurdles, must be addressed. The adjust between utilizing insects economically and assembly ethical and consumer requests remains a significant point of discussion in the industry [8, 9].

This review aims to investigate the multifaceted part of insects in modern beauty care products, diving into their historical utilize, types of insect-derived ingredients, bioactive properties, and their applications in cosmetic formulations.

1. Historical Background

The utilize of insects in makeup has a long and interesting history that ranges different cultures and civilizations. Insects have been esteemed for their capacity to give interesting and dynamic characteristic materials, which have been saddled in beauty practices for centuries. Understanding this historical background not as it were highlighting the persevering significance of insects in the beauty industry but moreover sets the arrange for their modern applications.

The use of cochineal color can be followed back to the ancient civilizations of Central and South America, especially the Aztecs and Mayans, who profoundly prized it for its strongly red color. Cochineal color was used in regal pieces of clothing, religious ceremonies, and craftsmanship. With the entry of Spanish conquistadors in the 16th century, cochineal got to be a profitable trade, rivalling gold and silver in its economic importance [10].

During the colonial period, cochineal color got to be a noteworthy trade thing for Spain, as European request for high-quality red colors developed. It got to be a noticeable material for colouring textiles, counting textures used by the European first class and sovereignty. The request for cochineal too extended to other applications, counting food and beauty care products, stamping its worldwide reach [11].

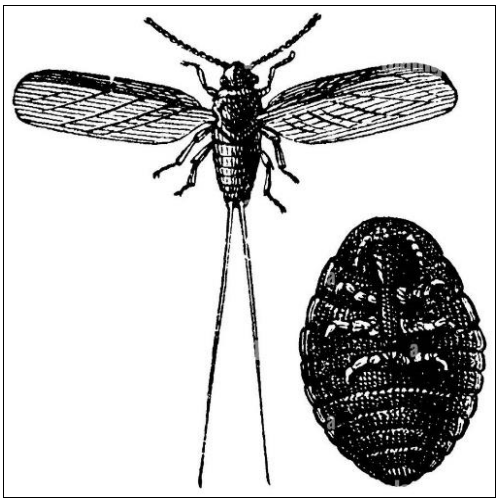
The Industrial Revolution marked a shift in the cosmetic industry with the advent of synthetic dyes and chemicals, which began to replace traditional natural ingredients, including those derived from insects. However, in recent decades, there has been a resurgence in the use of insect-based products, driven by the demand for natural and sustainable alternatives to synthetic ingredients. The rediscovery of insect-derived materials, such as carmine and silk proteins, has revitalized their role in modern cosmetics [12].

2. Types of Insects Used in Cosmetics

Insects are utilized in the cosmetics industry for their ability to produce a variety of unique natural ingredients. These insect-derived materials offer functional benefits, such as pigmentation, emollience, and bioactivity, making them valuable components in a range of cosmetic products.

2.1. Cochineal insects

Cochineal insects (*Dactylopius coccus*) are little, sap-sucking scale insects from the family Dactylopiidae. These insects are eminent for creating carminic acid, the essential compound capable for the dynamic red color known as cochineal, which has been utilized for centuries in different businesses, especially in beauty care products. Local to tropical and subtropical regions of the Americas, these insects are cultivated basically in Peru, Mexico, and the Canary Islands for commercial color production [13, 14].



(a) (b)

Fig 1: (a) Male & (b) Female *Dactylopius coccus.*

2.2. Bees

Bees, belonging to the genus Apis in the family Apidae, are little, productive insects best known for their pivotal part in fertilization and their generation of honey, beeswax, propolis, and royal jelly. These bioactive compounds have been esteemed for centuries, not as it were in conventional medication and culinary employments but moreover in the makeup industry for their moisturizing, defensive, and anti-aging properties. Local to regions over the globe, bees are developed broadly for their hive products in nations such as China, India, and the United States, where they contribute altogether to both agricultural biological systems and cosmetic raw material production [15].

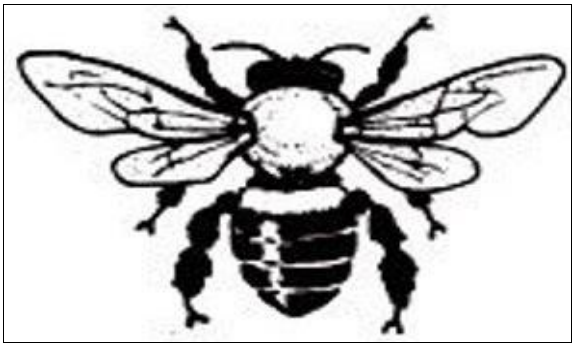


Fig 2: Honey bee.

2.3. Silk-producing moths (*Bombyx mori)*

Silk-producing moths, *Bombyx mori*, are tamed insects from the family Bombycidae, famous for their generation of silk, a common fiber that has been prized for thousands of a long time. The essential bioactive compounds, sericin and fibroin, extracted from silk, are broadly utilized in the makeup industry for their hydrating, anti-aging, and skin-repairing properties. Local to China and generally related with the ancient Silk Road, *Bombyx mori* is presently developed in silk-producing nations such as India, Japan, and Brazil for the large-scale production of both textiles and cosmetics-grade silk proteins [16].

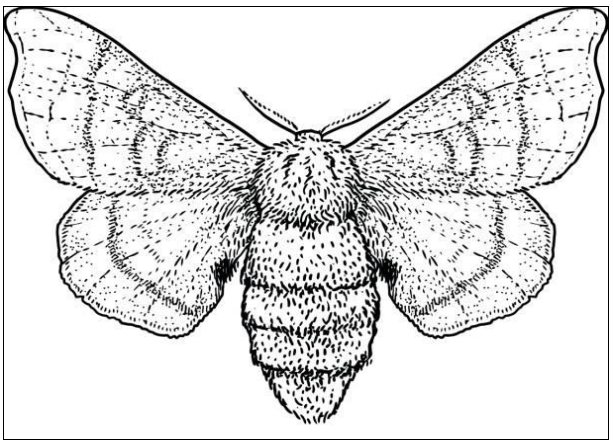
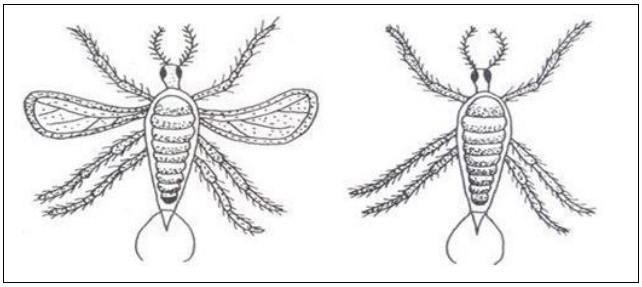


Fig 3: *Bombyx mori*

2.4. Lac insects (*Kerria lacca)*

Lac insects, *Kerria lacca*, are little scale insects from the family Kerriidae, famous for their secretion of a natural resin known as shellac. This resin, which is handled into pieces or liquid shapes, is utilized in different businesses, counting beauty care products, where it serves as a natural film-forming specialist in items like nail shines and hair sprays. Local to forested regions of India and Southeast Asia, lac insects are fundamentally cultivated in India and Thailand, where their resin production underpins a flourishing industry that bridges conventional practices and modern commercial applications [17].



(a) (b)

Fig 4: *Kerria lacca* (a) Male with wings (b) Male without wings

3. Bioactive Compounds in Insect-Derived Ingredients their role and Applications in Cosmetics industry

Insect-derived ingredients are rich in bioactive compounds that provide a range of benefits in cosmetic formulations. These compounds include pigments, proteins, waxes, and antimicrobial agents, which contribute to the functional, therapeutic, and aesthetic properties of cosmetic products.

Table 1

Sr. No.	Source	Composition	Role	Application	References
1	Cochineal Insects	Carmine is derived from carminic acid, a red anthraquinone compound	Red color, Pigments.	Lipsticks, blushes, and eyeshadows.	18
2	Honey Bees	A blend of sugars, amino acids, vitamins, and enzymes	Antimicrobial and hydrating effects. Soothes and softens the skin, making it ideal for sensitive or irritated skin.	Face masks, cleansers, and moisturizers	19
	Propolis (Bees)	Flavonoids, phenolic acids, and terpenes.	Antimicrobial and antioxidant properties, skin healing and protection against environmental damage.	Acne treatments, wound-healing ointments, and serums	20
	Beeswax (Bees)	A mixture of fatty acids, esters, and hydrocarbons.	Emollient and Humectant.	Lip balms, creams, and ointments.	21
	Royal Jelly (Bees)	Rich in proteins, amino acids, lipids, and vitamins.	Stimulates cell regeneration, reduces wrinkles, and provides anti-inflammatory benefits.	Commonly used in anti-aging and revitalizing skincare products.	22
3	Silk Proteins (Silk Moths)	Sericin and fibroin	**Sericin:** Forms a protective film on the skin and hair, enhancing hydration and elasticity. **Fibroin:** Penetrates the skin, promoting collagen synthesis and improving skin texture.	Found in anti-aging creams, serums, and hair conditioners for their hydrating and strengthening properties.	23
4	Lac insects (*Kerria lacca*)	Shellac	Natural film-forming agent.	Nail shines and hair sprays.	24

4. Extraction Techniques for Insect-Derived Ingredients

4.1. Cochineal Insects

The Conventional extraction method is by drying the cochineal, which can be done by daylight or drying. After drying, the insects are ground into powder. The powder is at that point blended with water or other solvents such as ethanol or methanol to encourage the extraction of carminic acid. The blend is warmed and mixed to advance the release of colour. This method is very simple and has been utilized for centuries, but diverse colours and quality levels can be produced [25].

4.2. Bees (Apis species)

For Bees, honey is extracted by evacuating the honeycomb from the hive and uncapping the cells. The honey is then extracted by centrifugal force or drained from the comb. The extracted honey is sifted to expel wax, bee parts, and other debris. Depending on the item, the honey can be pasteurized to increase shelf life, in spite of the fact that crude honey may be preferred for its higher nutrient content. Beeswax is obtained by scratching the wax from the honeycomb after honey extraction. The wax is at that point softened, regularly utilizing a twofold evaporator or steam, to separate it from any residual honey and other impurities. The dissolved wax is sifted through fine mesh or activated carbon to expel contaminants. Royal jelly is collected from the queen bee cells utilizing extraordinary devices or suction gadgets without hurting the bees. The collected royal jelly is ordinarily stored in refrigerated conditions to keep up its bioactivity. Propolis is scratched from the interior surfaces of beehives where bees deposit the resin. Propolis is at that point broken down in solvents such as ethanol or methanol, which offer assistance extract its active compounds. After extraction, the solution is sifted to evacuate impurities, and the propolis extract is concentrated as required [26, 27, 28].

4.3. Silk-producing moths (*Bombyx mori)*

For Silk proteins, silk fibers are coated with sericin, which is expelled by boiling the silk cocoons in an alkaline solution to separate the fibroin. After degumming, the fibroin is dissolved in solvents like lithium bromide or calcium chloride to break it down into a fluid shape suitable for assist utilize in cosmetic products. The fibroin solution is at that point dried into powders, films, or gels, depending on the product necessities [29].

4.4. Lac insects (*Kerria lacca)*

For Lac insects, lac resin is obtained by scratching it from tree branches secured with the emission of the lac insects. The resin is at that point handled by heating it to isolated any impurities and to make it simpler to handle. The collected lac is refined by further heating to filter it and evacuate residual debris. The last product can be in the form of lacquer or a fluid resin, depending on the desired use [30].

Conclusion

In conclusion, the utilize of insect-derived ingredients in the cosmetics industry speaks to a special crossing point of nature and development. The review has investigated the different sorts of insects utilized, counting cochineal insects, bees, silk-producing moths, and lac insects, each contributing important bioactive compounds that enhance the efficacy of cosmetic formulations. Cochineal insects are famous for their characteristic red color, carminic acid, whereas bees give an array of beneficial substances such as honey, beeswax, royal jelly, and propolis, all of which have momentous moisturizing, antimicrobial, and anti-aging properties. Silk proteins from silk moths offer moisturizing and skin-repairing benefits, while lac resin from lac insects serves as an fabulous natural resin for different cosmetic applications.

The bioactive compounds determined from these insects play a critical part in advancing skin wellbeing, moving forward hydration, and offering anti-inflammatory and antioxidant effects. The differing applications of these ingredients include moisturizers, anti-aging creams, lip balms, and different other skincare and beauty products. Through viable extraction procedures, counting crushing, melting, boiling, and solvent extraction, these ingredients are productively obtained and filtered for utilize in cosmetics.

Overall, insect-derived ingredients give economical, viable, and innovative options to synthetic compounds in the cosmetics industry, with continued research and development required to completely harness their potential. By combining convention with modern extraction methods, the cosmetics industry can offer products that not only benefit consumers but moreover contribute to the preservation and ethical use of natural resources.

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Conflict of Interest
Author declares that they have no conflict of interest.

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