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Bioactive Compounds from Hermetia Illucens Larvae as Natural Ingredients for Cosmetic Application

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Abstract
Due to the sustainable organic matter bioconversion process used as substrate for its development, the Hermetia illucens (Linnaeus) larvae biomass is considered a source of compounds with high aggregate value and quite a promising market. The materials that can be extracted from H. illucens larvae have opened the door to a diverse new field of ingredients, mainly for the feed and food industry, but also with potential applicability in cosmetics. In this review we succinctly describe the larval development and rearing cycle, the main compounds identified from different types of extractions, their bioactivities and focus on possible applications in cosmetic products.

Keywords: Hermetia illucens larvae, biomass composition, bioactives, cosmetic applications.

Introduction

In the last decade a growing demand for natural and renewable sourced ingredients has been noticed, driving different types of industries, such as animal feed, human foods, pharmaceutical and cosmetics to offer the consumer increasingly innovative products.The sustainable exploitation of natural resources can be further improved if integrated solutions are employed to tackle the problems of overproduction, disposal of solid organic waste and growing demand for natural raw materials. The concept of a closed system of production minimizes residue generation, energetic costs, transportation and greenhouse gas generation. Natural bioactives have been found in nature from diverse sources like plants, animals and different types of microorganisms. Insect mass cultures have become available in recent years as a source for proteins and lipids and are currently considered a promising alternative. There is a sound rationale for this, since insects are highly efficient waste bio converters, induce a low environmental impact, since they emit less climate-damaging greenhouse gases and consume less water, and the risk of zoonosis is reduced. Furthermore, they can be fed with organic waste from various sources and can be reared on small surfaces, therefore, making large-scale industrial breeding possible.In this context, the rearing of the black soldier fly (*H. illucens*) larvae has motivated great interest, and applications in several

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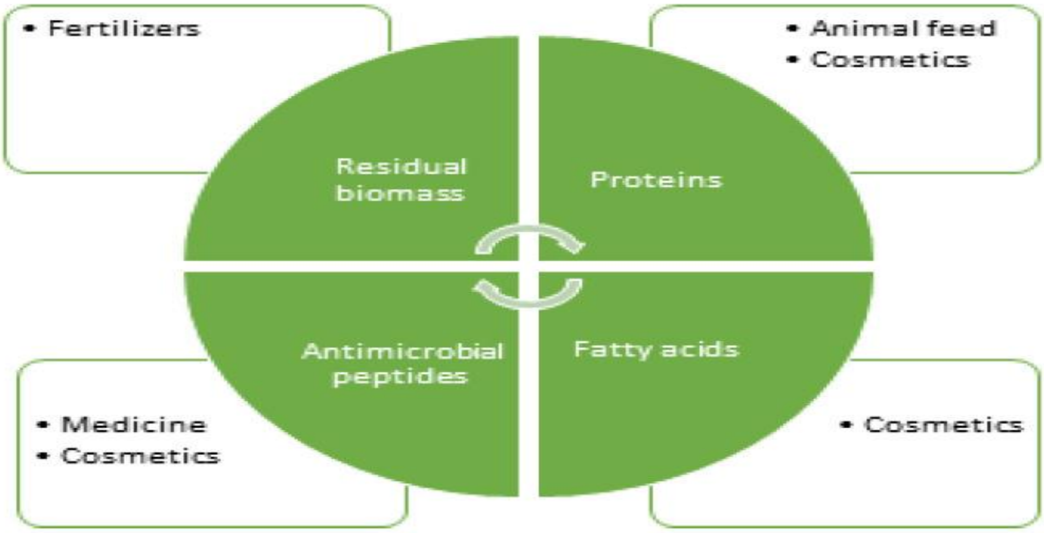
sectors are already envisioned, especially due to their nutritional value (Figur 1).



Figur 1.Flowchart of materials obtained from *Hermitia illucens* larvae and potential industrial applications.

H. illucens larvae are seen as a promising option for providing a sustainable feed source of proteins and lipids. This is mainly linked to their high capacity to convert large quantities of organic waste thanks to the variety of enzymes in their digestive tract. However, this material might also become a potential target for the cosmetic sector, since the ***H. illucens*** larvae fatty acids profile resembles those of coconut oil or palm kernel oil, and its biomass contains amino acids and enzymes, which may serve as base ingredients for the development of different products. Thus, using a suitable model of production, the black soldier larvae can act as a great biological control and waste management agent and its biomass can provide compounds with high aggregated-value. Currently, much attention has been directed to research of natural sources of biologically active substances to be used in cosmetic formulations. Increasingly, the cosmetic industry has been challenged to use more natural and sustainable raw materials, since environmental issues have become one of the main factors that determine the growth of this type of products. Moreover, the consumers are increasingly concerned about the safety of the cosmetic formulations, as well as with the composition and origin of the raw materials that make up these products.As previously stated, insect production is a potential market business because it is possible to obtain inexpensive and bioactive high value compounds from their biomass. Though the idea of cosmetic products based in insects would be repulsive to many consumers, it is reasonable to consider that extracting insect materials and using these as cosmetic ingredients may increase consumer acceptance. As previously explained, the content of compounds obtained from insect biomass varies considerably, and depends on the stage of metamorphosis, origin of the insect and its diet. Apart from *H. illucens*, studies addressing the potential use in skin care of different types of insects have explored locusts, house crickets and silkworms . As mentioned above, the ***H. illucens*** larvae biomass is so rich that depend on their fat content it can even provide sufficient energy for animal or human diet, as well as satisfactory amounts of proteins and amino acid requirements . It is also important to highlight the high contents of mono and polyunsaturated fatty acids, polysaccharides and chitin. Furthermore, it contains micronutrients such as copper, iron, magnesium, manganese, phosphorus, selenium and zinc, as well as vitamins. The high content of lauric acid in larvae oil is similar to that of coconut oil, and it should also be noted that many of the beneficial properties of this oil have been attributed to this component. A 12-carbon chain fatty acid, lauric acid is biologically active and has been shown to have potent antibacterial and antiviral activities. Medium chain fatty acids have been reported to have the ability to treat severe bacterial infections that are antibiotic resistant. Lauric acid can be converted into monolaurin, which is known to display antiviral, antibacterial, and antiprotozoal activities . Thus, larvae oil seems promising as a possible alternative preservative. In addition, lauric acid and other fatty acids present in the ***H. illucens*** larvae lipid fraction can act as emulsifiers and stabilizers of disperse systems, and are commonly used in the production of soaps and cosmetics. Verheyen et al. Suggest that due to the high concentration of lauric acid in ***H. illucens*** oil, its application in skin cosmetic formulations could be enhanced to that of other oils of natural origin. The authors also recommended the need for refining to remove phospholipids and unsuitable free fatty acids, as well as to improve its color and odor characteristics.As mentioned above, fatty acids are frequently used in cosmetics, thus other components of ***H. illucens*** larvae oil can be applied, either isolated or as a lipidic structural complex . Palmitic, oleic and linoleic acid, along with other essential fatty acids have been identified as key components in the human epidermis . Oleic acid activates the lipidic metabolism, restoring the skin barrier and enabling the retention of moisture in the *stratum corneum* . Myristic acid is used in cosmetic formulations for thickening and stabilizing emulsions, but it can also restore the cutaneous barrier properties and enhance the permeability of active components into the skin . Palmitic acid and its derivatives are used in creams and lotions as emulsifiers and emollients. Linoleic acid has a physiological role in maintaining the water permeability barrier of the skin, since it is a constituent of acylglycosyl ceramides, which play a structural role in the *stratum corneum* . It has been suggested that linoleic acid deficiency can result in development of dermatitis in adults and children.***H. illucens*** larvae extracts are a promising source of bioactive substances and can play an important role in the development of innovative cosmetics. Due to the sustainability of its rearing, mass cultures of these insects seem to be economically viable. The larvae oil and the protein and chitin content have vast cosmetic applications, and these substances are worth considering as high value co-products. The main challenges associated with their use will be linked with the development of methods to isolate the extracted materials on an industrial scale.

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