Microbial Pigments

Applications in Food and Beverage Industry


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Microbial Pigments: Applications in Food and Beverage Industry offers a comprehensive and updated review of the impact of microbial pigments as value-added products in the food and beverage industry. Microbes produce a range of valuable pigments such as carotenoids, flavins, melanins, quinines, and violacein. The book explores the use of microbial pigments as additives, antioxidants, color intensifiers, and functional food ingredients. It discusses pigment isolation and processing technologies. It covers a range of applications across products like jams, spreads, frozen desserts, and beverages. The book also discusses food safety and toxicology aspects.

Key features

- Explores the various microbial pigments and their sources
- Reviews the pigment isolation, production, and processing techniques
- Discusses the potential application of pigments across a range of products in the food and beverage industry
- Includes the latest innovations and patents awarded in use of microbial pigments as value-added food products

The book is meant for researchers, academic and industry experts in food biotechnology, food processing, and food microbiology.

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Potential Microbial Pigments

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1.1 Introduction

Colours give consumables such as food, clothing and medicine more appealing aesthetic value in the marketplace. Natural pigments have been sourced for centuries, but within recent decades, interest in using them arose because of concerns about the toxicity of synthetic pigments (Joshi et al., 2003). The food, dye, cosmetics and pharmaceutical industries have all made substantial use of synthetic colourants, despite the fact that these colourants have been connected to a wide variety of adverse health effects (Venil et al., 2009). Workers in the synthetic pigment industry are endangered by the carcinogenic precursors that are employed in the production process. Moreover, the manufacturing of synthetic pigments generates possibly hazardous by-products and waste materials. On the contrary, pigments derived from microorganisms offer numerous benefits over their synthetic and inorganic counterparts (Malik et al., 2012). In comparison with chemical synthesis, microorganism-based pigment manufacturing offers several advantages.

Numerous types of algae, fungi, bacteria and yeasts inhabiting a wide range of environments are capable of producing pigments (Figure 1.1A); however, only some of these organisms are thought to be viable

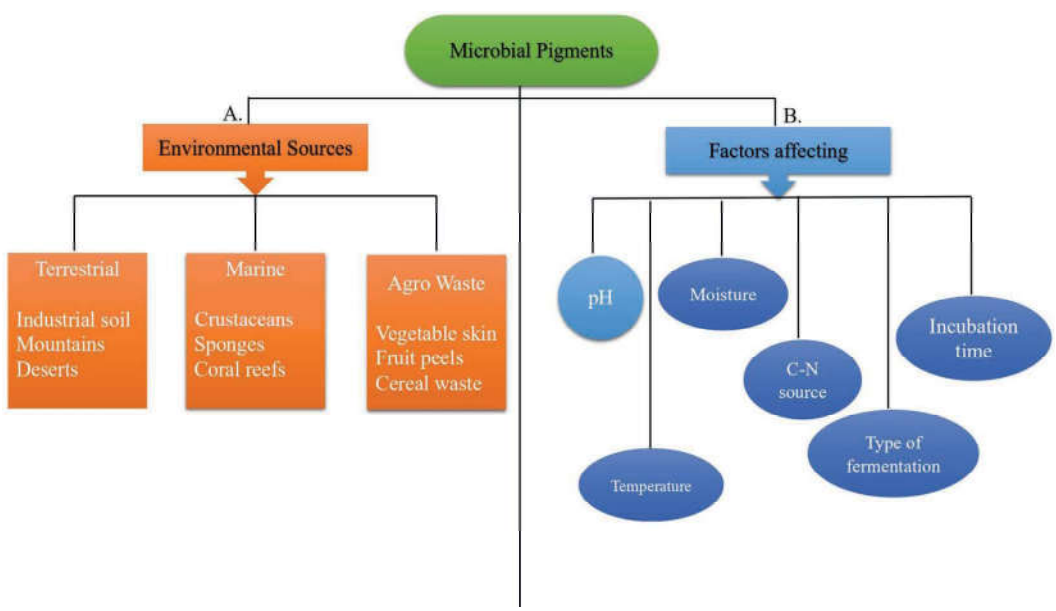

FIGURE 1.1 a) Different environments where pigment-producing microbes are found. b) Factors affecting the production of microbial pigments.

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candidates for the synthesis of pigments for industrial settings. Their pigments are a fantastic choice because they are biodegradable and have low toxicity. In addition to this, they exhibit a wide variety of therapeutic properties, such as antioxidant, anticancer, antiproliferative, immunosuppressive and antidiabetes. As a result, research into the manufacture of pigments by microorganisms has emerged as a promising avenue for a wide range of industries (Babitha et al., 2009). The ideal microbe for the production of pigment should be unaffected by variations in pH, temperature and the concentration of minerals; it should also be capable of utilizing a wide variety of carbon and nitrogen sources. Figure 1.1(B) shows the possible factors which can affect the production of pigments by microorganisms. The majority of bacterial pigment manufacturing is still in the experimental phase.

Because of this, the primary focus of research into bacterial pigments should be on finding efficient and cost-effective production techniques to cut down costs and expand the possible industrial applications of the pigment. Industrial manufacturing has increasingly favoured fermentation over other chemical processes because of its greater efficiency (Kumar et al., 2015). Because microbes have relatively long genes, they are amenable to being modified by genetic engineering. When compared with the more traditional chemical methods of upscaling, the use of genetic engineering enables an exponential increase in the amount of microbial pigment that can be synthesised. The efficiency of the fermentation process has been increased thanks to advances in genetic engineering, and the search continues for a nontoxic microbial pigment that has the potential to result in substantial financial gains for the business case of these industries (Hu et al., 2018).

This chapter discusses the most prevalent microbial pigments, namely phycobilin, carotenoids, flavins, quinines, violacein, melanin, phycobiliproteins, monascins, azaphilones and anthraquinones; their biological functions and the current and potential applications for these pigments. Table 1.1 contains the mentioned pigments and their basic chemical structures, major microbial producers, colours and applications. Figure 1.2 shows various strategies that can be used to enhance the industrial production of pigments.

1.2 Pigments from Microbes

1.2.1 Violacein

There are numerous distinct types of bacteria that can produce violacein, and they can be discovered in a wide variety of environments, ranging from the soil to the ocean. *Chromobacterium violaceum* is one of the bacteria that is researched most in the field of violacein production, despite the fact that different bacterial sources have reported varying yields and factors associated with pigment production. Violacein is an indole derivative that demonstrates multiple biological functions. It is currently gaining increasing significance in a variety of commercial domains, including the pharmaceutical, personal care products and textile sectors (Choi et al., 2021). Violacein has been shown to have pharmacological effects that include anti-inflammatory, antitumour, antiparasitic and immunomodulatory functions. Because of its remarkable ability to exert its influence in a wide range of distinct physiological contexts, as well as the potential therapeutic applications it has already demonstrated *in vitro* and in animal models, in conjunction with the toxicological data, we have reason to believe that further investigation will show violacein to be of great value in the clinical environment.

1.2.1.1 Applications and Biological Properties of Violacein

- As an anaerobic bacterium, *Propionibacterium acnes* thrives in skin pores, feeding off the sebum that builds up in the pores. Acne bacteria secrete an enzyme called lipase that breaks down sebum into free fatty acids that in turn trigger inflammation and pimple formation (Park et al., 2021). The application of violacein suppresses inflammation and reduces the formation of acne.
- Antibiotic violacein has been found to be effective against Gram-positive bacteria such as *Staphylococcus aureus*. However, violacein's biological activity is not restricted to prokaryotes; it is also toxic to bacterivorous protozoa and even some metazoans (Rather et al., 2022).