InnoVationinfo

ISSN: 2581-7566

Volume 6: 2

Journal of Applied Microbiological Research

J Appl Microb Res 2023

Industrial Application of Bacterial Pigments

Girma Waktola*

Department of Biology, College of Natural and Computational Science, Wollega University, Ethiopia

Abstract

Bacteria are rich resources of natural pigments and can be formed by some bacteria. The bacterial species such as, *Staphylococcus aureus, Pseudomonas aeruginosa, Sarcina maxima, Serratia marcenscens, Micrococcus roseus* and *Micrococcus luteus* produce large number of pigments. Bacteria can produce various pigments such as carotenoids, melanins, quinones, flavins, monascins, prodigiosins, violacein and indigo. Carotenoids are yellow to orange red pigments present in varieties of plants, bacteria and fungi. Recently, carotenoids are used commercially for nutraceuticals, cosmetic and pharmaceutical purposes. The pigments produced by chromo bacteria can be used for applications in dairy, pharmaceutical, food and textile industries. Bacterial pigments potential clinical applications of pigmented secondary metabolites in treating several diseases and have certain properties like antibiotic, anticancer and immunosuppressive compounds. As florescence indicators the bacterial pigment dark spots appear where radicals have reacted with the pigment causing the overall Florescence emission to decrease over time, this assay can then be used to predict the rate of peroxy radical scavenging in human plasma. The potential of using pigment from *Serratia marcescens* to color five types of fabric namely polyester microfiber, acrylic, polyester, silk and cotton using tamarind as mordant. Chromo bacterium produce violaceum violet pigment violacein and its dyeing efficiency in different fabrics such as pure cotton, pure silk, jacquard rayon, pure rayon, acrylic, polyester, silk satin and cotton in textile industry.

Keywords: Pigment; Industrial application; Florescence indicator; Therapeutics and food coloring.

Introduction

Microbial pigments are the feature attribute of some bacteria to produce pigments which may be useful in recognition. Bacterial pigments tender shows potential possibility for various applications due to their improved biodegradability and higher compatibility with the environment [1]. Microbial pigments have broad area of application, mainly in food industries, pharmaceutical industries and textile industries. Food grade pigments such as β-carotene, Arpink Red, Riboflavin lycopene and Monascus pigments are used in food industry. In pharmaceutical industry pigments like Anthocyanin, Prodigiosin and Violacein are widely used to treat diseases. Several microbial pigments

Article Information

Article Type: Review Article

Article Number: JAMBR 167

Received Date: 07 March, 2022

Accepted Date: 14 July, 2023

Published Date: 21 July, 2023

***Corresponding author:** Girma Waktola, Department of Biology, College of Natural and Computational Science, Wollega University, Nekemte, Ethiopia.

Citation: Waktola G (2023) Industrial Application of Bacterial Pigments. J Appl Microb Res. Vol: 6 Issu: 2 (01-04).

are also used in textile industry [2]. Pigments are molecules that have color. Pigments are the natural coloring extracted from living organisms that serves as coloration. Pigments materials that change the color of reflected or transmitted light as the result at wave length. Some bacteria produce pigment as part of their normal metabolism including black, white, brown, golden, silver, florescent green, yellow or blue [3].

The microorganisms such as Pseudomonas aeruginosa, Staphylococcus aureus, Serratia marcenscens, Sarcina maxima, Micrococcus luteus, Micrococcus roseus, etc. produce large number of pigments and they were isolated from various sources [3]. Microorganisms can produce various pigments such as carotenoids, melanins, quinones, flavins, monascins, prodigiosins, violacein and indigo. Carotenoids are yellow to orange red pigments present in varieties of plants, bacteria and fungi. Recently, carotenoids are used commercially for nutraceuticals, cosmetic and pharmaceutical purposes [4]. The various types of pigments produced by microorganisms are carotenoids, melanins, flavins, monascins, violacein and indigo [5]. Bacterial pigments have many applications in current day to day life. The pigments produced by chromo bacteria can be used for applications in dairy, pharmaceutical and food [6].

Applications of Bacterial Pigments

Natural pigments are important alternate to the synthetic dyes in lots of industrial applications including cosmetics, textile, food, pharmaceutical and aquaculture industry. Besides coloring benefits, many natural pigments posses antimicrobial properties [7]. Bacterial pigments have wide area of application, principally in food industries, pharmaceutical industries and textile industries. Food grade pigments such as Monascus, β-carotene, Riboflavin lycopene and Arpink Red pigments are used in food industry. In pharmaceutical industry pigments like Anthocyanin, Prodigiosin and Violacein are widely used to treat diseases. Several bacterial pigments are also used in textile industry [2].

Bacterial pigments as food colorant

The development of foods with a pretty appearance is an important target in the food industry. Increasingly, food producers are whirling to natural food colors, since certain artificial color additives have demonstrated negative health issues following their consumption. Due to the lack of availability of natural food colorants, its demand is much sought especially in the food industry. This demand can be fueled by research to offer a more natural healthy way of coloring foods and provide a clean label declaration [8]. It is therefore, essential to explore various natural sources of food grade colorants and their potentials. Though many natural colors are accessible, bacterial colorants play a significant role as food coloring agent, because of its production and easy down streaming process.

Industrial production of natural food colorants by bacterial fermentation has several advantages such as cheaper production, easier extraction, higher yields through strain improvement, no lack of raw materials and no seasonal variations [9]. Microorganisms could be made to produce colorants in high yield by inserting genes coding for the colorant, even colorants not naturally produced by microorganisms (e.g., turmeric) could be made in this way. These pigments are looked upon for their secure use as a natural food colorants and will not only help human health but also conserve the biodiversity, as harmful chemicals released into the environment while producing synthetic colorants could be stopped [10].

Bacterial pigments as fluorescence based indicators

Bacterial pigments with florescence are used in laboratories to label antibodies and also indicate the progress at specific reactions. Pigment to chlorophyll is photosynthetic bacteria. It is essential because it captures light energy and then transfers it to the chlorophyll reaction centre. One application at phycoerythin as a fluorescence based indicator is to detect the rate of damage caused by free peroxy radicals. As peroxy radicals are added to the pigment dark spots appear where radicals have reacted with the pigment causing the overall Florescence emission to decrease over time, this assay can then be used to predict the rate of peroxy radical scavenging in human plasma.

Bacterial pigments in pharmaceutical industry

Most studies are investigating microorganisms that have shown the efficacy and the potential clinical applications of pigmented secondary metabolites in treating several diseases and they also have certain properties like antibiotic, anticancer, and immunosuppressive compounds. Significant progress has been achieved in this field, and investigations of bioactive compounds produced by these microbes are rapidly increasing. As such, the number of compounds isolated from bacteria is increasing faster when compared with other sources [11]. Anthocyanins are involved in a wide range of biological activities that affect positively the health properties and decrease the risk of cancer, reduce inflammatory insult and modulate immune response [12]. Bacterial pigments defense from UV rays, acts as antioxidant, protects from extreme heat and cold, functions as anticancer and antimicrobial, acquisition of nutrients like nitrogen, carbon and iron [13].

The genus, Streptomyces or Serratia can produce a red substance of pyrrolylpyromethene skeleton, which is one of following substances: prodigiosin, metacycloprodigiosin, desmethoxy prodigiosin, and prodigiosin 25-C. These substances have been known to have an antibiotic and antimalarial effect, especially prodigiosin 25-C that shows immunosuppressant activity [14]. One major industrial application at bacterial pigments has nothing to do with the pigments visual properties. Some bacterial pigments are used to promote human health providing key nutrients and compounds that are needed by the body. Carotenes including the well-known compound β - carotene are a group at pigment responsible for many beneficial effects towards human health. β–carotene and astaxanthin (a xanthophyll) are produced by many kinds of bacteria and are essential in maintaining the yellow color of theretinal

macula, giving it the ability to act as sun block on certain parts of the retina [15].

Bacterial pigments in textile industry

The bright red pigment prodigiosin from Vibrio spp. and recommended that it could be applied to dye numerous fibers including wool, acrylics, nylon and silk [16]. The potential of using pigment from Serratia marcescens to color five types of fabric namely polyester microfiber, acrylic, polyester, silk and cotton using tamarind as mordant [17]. However, the dyeing performances are different, depending on the types of fiber. From the colorfastness testing, the dyed fabrics have the ability to preserve its color under numerous external conditions such as washing, perspiration and rubbing [18]. Dyeing will be performed by a simple procedure consisting of either dipping in the pigment extract or boiling with the bacterial cells. Color variation can be achieved by varying the rising time and the temperature of the dye bath. The red pigment prodigiosin and violet pigment violacein and its dyeing efficiency in different fabrics such as pure cotton, pure silk, jacquard rayon, pure rayon, acrylic, polyester, silk satin and cotton. Their results suggested that prodigiosin could be used to dye acrylic and for violacein intense colorations was observed in pure rayon, jacquard rayon and silk satin [19].

The applications of prodigiosin and violacein in batik making are a fashionable gown like dress worn mostly by woman in South East Asian region. The most popular motifs include flowers, leaves and geometrical design. The preferred samples were first drafted onto the fabric by a "Batik-Tulis" maker i.e., the painter, using pencil. Then, melted wax (mixture of beeswax and paraffin wax) was applied over the drafted design using a technique called "canting". The beeswax holds the fabric while paraffin wax will allow cracking, which is a typical characteristic of batik. Wherever the wax has seeped through the fabric the dye will not penetrate. The fabrics were dyed using the extracted bacterial pigments using the brushing technique after waxing process [2,19].

Conclusion

Bacterial pigments are the feature attribute of some bacteria to fabricate pigments which may be useful in identification. Bacterial pigments tender shows potential avenues for various applications due to their improved biodegradability and higher compatibility with the medium and environment. The importance of pigment manufacture from bacteria encompass easy and fast growth in the cheap culture medium, colors of different shades and independence from weather conditions. Bacteria are employed for the industrial production of various pigments by using fermentation technology. These microbial pigments have broad area of application, mainly in food industries, pharmaceutical industries and textile industries. Bacterial colorants play a significant role as food coloring agent, because of its production and easy down streaming process. Fluorescence based indicator is to detect the rate of damage caused by free peroxy radicals. As peroxy radicals are added to the pigment dark spots appear where radicals have reacted with the pigment causing the overall Florescence emission to decrease over time. Anthocyanins are involved in a wide range of biological activities that affect positively the health properties and decrease the risk of cancer, reduce inflammatory insult and modulate immune response. The genus, Streptomyces or Serratia can produce a red substance of pyrrolylpyromethene skeleton, which is one of following substances: prodigiosin, metacycloprodigiosin, desmethoxy prodigiosin, and prodigiosin 25-C. Serratia marcescens produces the red pigment prodigiosin and Chromobacterium produce violaceum violet pigment violacein and their dyeing efficiency in different fabrics such as pure cotton, pure silk, jacquard rayon, pure rayon, acrylic, polyester, silk satin and cotton in textile industries.

References

1. Megha W, Shabib K (2018) Isolation, Characterization of Pigment Producing Bacteria from various food samples and testing of antimicrobial activity of bacterial Pigments. DAV International Journal of Science 7: 2277-5536.
2. Kumar A, Shankar HV, Singh J Sh D, Kumar M (2015) Microbial pigments: production and their applications in various industries. International journal of pharmaceutical, chemical and biological sciences 5: 203-212.
3. Rokade MT, Pethe AS (2016) Isolation and identification of chromomeric bacteria from various sources. European Journal of Pharmaceutical and Medical Research 3: 295-299.
4. Klein-Marcuschamer D, Ajikumar PK, Stephanopoulos G (2007) Engineering microbial cell factories for biosynthesis of isopernoid molecules: beyond lycopene. Trends Biotechnol 25: 417-424.
5. Dufosse L (2009) Pigments. Encyclopedia of Microbiology 4: 457-471.
6. Samyuktha S, Naphade SM (2016) Isolation and identification of pigment producing bacteria and characterization of extracted pigments. International journal of applied research 2: 657-664.
7. Bintimohd AS (2016) Production of natural pigment with antimicrobial activity from a marine bacterium, pseudoalteromonas rubra. Thesis for the degree of Doctor of Philosophy.
8. Aberoumand A (2011) A review article on edible pigments properties and sources as natural biocolorants in foodstuff and food industry. World J Dairy Food Sci 6: 71-78.
9. Malik K, Tokkas J, Goyal S (2012) Microbial pigments: a review. Int J Microbial Res Technol 1: 361-365.
10. Neeraj N, Neera M, Sayan C (2011) Microbial pigments with health benefits – a mini review. Trends Biosci 4: 157-160.
11. Soliev AB, Hosokawa K, Enomoto K (2011) Bioactive pigments from marine bacteria: applications and physiological roles. Evid Based Complement Alternat Med 2011: 670349.
12. Wang J, Mazza G (2002) Effects of anthocyanins and other phenolic compounds on the production of tumor necrosis factor alpha in LPS/ IFN gamma-activated RAW 264.7 macrophages. J Agric Food Chem 50: 4183-4189.
13. Prakash VP (2016) Microbial pigment as a potential natural colorant for contributing to mankind. Research Trends in Molecular Biology.
14. Kim H, Han SB, Lee OW, Lee K, Park S, et al. (2003) Use of prodigiosin for treating diabetes mellitus. US patent 6: 638-968.
15. Achala A, Chitralekha, Sen Roy, Neha, Snehalatha V (2018) Screening of pigment producing bacterial isolates from diverse sources and the effect of extracted pigments on potential pathogens. International Journal of Advanced Scientific Research 1: 1-7.
16. Alihosseini F, Ju KS, Lango J, Hammock BD, Sun G (2008) Antibacterial colorants: characterization of prodiginines and their applications on textile materials. Biotechnol Prog 24: 742-747.

17. Yusof NZ (2008) Isolation and applications of red pigment from Serratia marcescens. Universiti Technology Malaysia [BSc thesis].

18. Shirata A, Tsukamoto T, Yasui H, Hata T, Hayasaka S, et al. (2000) Isolation of bacteria producing bluish-purple pigment and use for dyeing. Jpn Agric Res Q 34: 131-140.

19. Ahmad AS, Ahmad WYW, Zakaria ZK, Yosof NZ (2012) Applications of bacterial pigments as colorant: the Malaysian perspective. New York: Springer Briefs in Molecular Science.