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EXPLOITATION OF FUNGAL BIODIVERSITY AS POTENTIAL PIGMENT PRODUCERS A RIVEW ARTICLE

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ABSTRACT

The rapid development of life is leading the demand of colors in biotechnology in field of food, textile, medicine and cosmetics and healthcare products. There is ever growing demand of eco-friendly/non-toxic dyes as coloring agents of food to overcome health hazards. The risks of synthetic colors compel the industries to adapt natural pigments. The search for new sources of natural pigments has increased, day to day because of the toxic effects caused by synthetic dyes. Recently fungal species are being treated as the natural pigment producers with enormous biotechnological applications. Almost all the genus of fungi synthesize various pigments such melanin, phenazines,flavins,carotenoids, violacein, indioankaflavins. So far these pigments are isolated,screened, and characterized for many biotechnological purposes in food, textiles, medicine, cosmetics health care products. However sequencing of pigment producing genes and generation of new varieties of pigments by rDNA technology may lead to revolutionary success in pigment production market in food, textile, medicine, cosmetics and health care products by a natural means. Study on pigment producing fungi using cloning technology may pave a path for ecofriendly generation of varieties of colors which further can be explored in many biological applications.

Keywords: Biotechnology, Foods, Cosmetics, Health Care Products, Fungi, Eco-Friendly

1.1 INTRODUCTION:

Color plays a vital important role in the world which we live. Colors have been used for healing purpose since ages. They play a major role in setting up our mood, emotions, feeling and state of mind. The human eye is the mean that is used to detect color. Colors reflects our personality and thoughts, even it influencesour emotions and actions one cannot hear, taste or feel the color,' only way to recognize the color is to see it. Certain color activates certain psychical reaction of the person.

Color has always had an important implication on the minds of people as far as food is concerned. The color of food is a significant factor in determining its acceptance.A color can affect thinking, change actions, cause react, affects the mood of viewers, attract your attention, change your mood.

The color of food induces mouth-watering. Even early civilizations such as the Romans recognized that the "people eat with their eyes" as well as their palates. A color additive is any dye, pigment or substance which is added to food used to restore (or) reinforce color, lost during storage or to give desired color to food.Color is an important component in the food industry.

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Due to this reason, manufactures should use food package to attract consumer's attention in order to increase their interest in purchasing the product, and to generate sensory and hedonic expectations that match the products real characteristics.

The food coloring are made in a lab with chemicals derived from petroleum, a crude oil products, which also happens to be used in gasoline ,diesel fuel, asphalt and tar.Because of these importance of color in our day to day life, different manufactures used different types of synthetic colors in order to attract the consumers .nevertheless, all packaging elements, including color and shape have to be combined in order to attract consumers in their decision making .A right choice of packing color, back ground image, wrapperdesign, innovative ideas when implated to a products,packaging will create a happy feeling in consumes mind.

Different synthetic colorants are used in different industries such as food textile,pharmaceuticals,cosmetics 93%of visual appearance colors do affect the purchases, 6%texture and 1%soundand smell.Studies have shown that 80% of the recognition of a trade make is due to its color.

1.2 COLOR AND PERCEPTION:

Marketing strategy of food by major manufactures is greatly influenced by color. Color affects almost everything one does in life that is from purchasing items for one's home his/her clothing (or) their food decisions are made while giving color at most importance.

1.3 ADVERSE EFFECTS OF SYNTHETIC COLORS:

Manufactured food is pumped full of toxic chemicals meant to dress it up and entice consumers to buy .we buy.... but there are dangerous consequences.

- Cancer
- ADHD
- Allergies
- Hypersensitivity
- Asthma
- Hyperactivity

1.4 USE OF MICROBIAL DIVERSITY:

Natural dyes are non toxic, non-polluting and less health hazardous .Their antimicrobial nature further adds to their positive effects. Natural dyes can be obtained from various sources like plants, animals and microbes.

Microbial dyes have some advantage over plant and animal based dyes as microbes are fast growing and have the potential of being standardized commercially.

Microbes can produce a large amount of stable pigments such as anthraquinones, carotenoids, flavonoids, quinines and rubramines.

1.5 BOOSTER FOR NATURAL COLORS:

As there is increasing awareness about the harmful effects of usage of synthetic colors and the chemicals obviously demand for natural food colors in the international market abruptly increases .As Japan and all European countries have banned trading the synthetic color made products.

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1.6 ADVANTAGE OF MICROBIAL PIGMENTS

- Microbial dyes have some advantage over plant and animal based dyes as microbes are fast growing and have the potential of being standardized commercially.
- Microbes can produce a large amount of stable pigments such as anthraquinones, carotenoids, flavonoids, quinines and rubramines.
- Microbial pigments show great anti oxidant, anticancer,anti microbial activities among microbes fungi have the ability to produce potent pigments which can used as coloring agent in different industries.
- Reasons for choosing fungal biodiversity for pigment production
- ➢ Easily cultivated
- ➢ Large scale production
- ➢ Feasibility to use at industrial level
- ➢ Economically low
- ➢ Eco friendly
- ➢ Non hazardous

1.7 METHODS OF PIGMENT EXTRACTION:

Solvent extraction is the conventional method that is usually followed to extract colors from plant materials. Anthocyanin and beta lain pigments, which are water soluble, are extracted from the raw material with water and sometimes with aqueous methanol. For carotenoids extraction, hexane is the solvent of choice and acetone is good choice of solvent for the initial extraction of pigment from the plant material.

After thorough extraction of the plant material, the extract is concentrated and subjected to purification steps by using column chromatography. Identification and quantification of the pigment is performed by spectrophotometer or by high pressure liquid chromatography (HPLC)2 The advancements in extraction of pigments from plant materials were necessary as the use of organic solvents is harmful both for health as well as for environment.

The current advance techniques that are followed in color extraction are as follows:

- o High Hydrostatic Pressure (HHP)
- o Pulsed Electric Field (PEF)
- o Sonication-assisted Extraction
- o Gamma Irradiation
- o Enzymatic Extraction
- o Membrane technology

1.8 BIOTECHNOLOGICAL IMPORTANCE OF FUNGAL PIGMENTS

Among all microbes, fungi have ability to release pigments in large amount. Fungi liberate pigment in cheap culture medium, thus making it feasible to use on industrial level and eco-friendly too. [6]. Some of the fungal pigment applications are given in (Table 1).

Table 1. Some representative species of fungi and their biotechnological applications

Species	Pigment	properties	Application
Monascus sp.	Canthaxanthin, Ankaflavine, Monascorubramine Rubropunctatine	Orange-pink, Yellow, Red Orange	Antioxidants, Anti-inflammatory, Virucidal, Antifungal, anti-tumor, anticholestrol activity
Serratia marcescens	Prodigiosin	Red	Antibacterial, anticancerous activity
Xanthophyllomyces dendrorhous	Astaxanthin	Yellow, red, orange	Food industry
Ashbya gossypii	Riboflavin	Yellow	Food industry
Fusarium oxysporum	Anthraquinone	Blue, violet	Textile industry
Cryptococcus neoformans, aspergillus fumigates	Melanin	brown	Cosmetics, eye glasses, sunscreens, sunblocks, melanoma treatment
Rhodosporidium, ustilago, sclerotium	Carotenoids	Red-orange	In chemicals, pharmaceutical, poultry, food, cosmetics, antioxidant

In medicine

Fungi have latent to produce variety of metabolites which show biological and pharmacological activities. Fungal pigments show great antioxidant, anticancer and antimicrobial activities [24]. The genus Monascus produce great number of pigments, such as Ankaflavin (yellowpigment),Canthaxanthin(orange-pinkpigment), Monascorubramine (red pigment), andRubropunctatine (orange pigment). Medicinal significance of some of the important fungal pigments are discussed following.

Antioxidant activity

Antioxidants are compounds that inhibit oxidation, a chemical reaction that can produce free radicals and chain reactions that may damage the cells of organisms.The serious diseases such as, cardiovascular, autoimmune disorders, cancer and diabetes are associated with presence of free radicals. The fungal pigments such as carotenoid, violacein and naphthaquinone have been reported to produce efficientamount of antioxidant activity due to the presence of such free radical scavenging compounds [27].

Antimicrobial activity

An antimicrobial is an agent that kills microorganisms or stops their growth. Multi drug resistance is major problem in red biotechnology. So, it is moment in time to look more resources of antimicrobials, in order to overcome drug resistance [31, 32]. The fungal pigment shows great antimicrobial activity as well. Due to great drug resistance developed by these pathogenic microorganisms, new discoveries for such antibiotics are needed constantly.

Anti-cancerous activity

Cancer is an uncontrolled growth of abnormal cells and often metastasizes to other parts of the body. It is a serious health challenge [39]. The microbial pigment reported to possess cell cycle inhibition and induce apoptosis [40, 41]. Monascus pigment, monascin showed great inhibitory activity against carcinogenesis against mouse skin, Hep G2 and A549 human cancer cell lines.

In food industry

Synthetic colors are used in attractive appearance of industrial food. The synthetic pigments showed bad effect on health .The quality of food is not so good which is the main reason that food processers are turning from synthetic to natural colors [45, 46]. Among microorganisms; fungi produce safe and efficient pigments for food processing. Red pigment extracted from Monascus sp, used in food processing industries [47].

For textile

Textile industry plays a spine role in economy of any country [49]. In developed countries 1.3 million tons of synthetic dyes and dye precursors are being used per year [45]. In that about 2000000 tons of dyes are wasted as effluents during dyeing and finishing process. Natural pigments extracted from microbes are very good source of such eco-friendly dyes [51]. Amongst microorganism; fungal pigment show more feasibility for such applications.

For cosmetics

The kingdom fungi consist of numerous biologically important active compounds. Many species of basidiomycete's fruiting bodies are being used in traditional medicines and cosmetics. The cosmetic industry is most costly and it is constantly looking for new and natural products. Melanin is produced and extracted by many fungal species are widely used in cosmetics, eyeglasses, sunscreens, sun blocks.

Conclusion

The kingdom fungi belong to varied group of prokaryotes.. Almost all groups of microbes, fungi produce pigments of different colors and characteristics and it is bio-active compound.Many fungal pigments show a great performance in textile, food and cosmetics industries. These pigments carry antibacterial, antifungal, anti-cancerous and antioxidant potential. The health hazards and environmental concerns of synthetic pigments compel researchers to work and find substitute of such synthetic pigments. To overcome hazards of such issues, extracting fungal pigment and its use could be best solution, as it takes less efforts and cost.By taking all these considerations in to account and to meet the global demand of color for various industrial sectors many scientists thought that why can't we produce these important pigments naturally by exploiting fungal species rather than to suffer from hazardous synthetic/artificial coloring products.For these production of fungal pigments, the fungal species should be isolated and screened for the identification of potential pigment –producing filamentous fungi.Exploiting the fungal biodiversity for natural pigments extraction is much more benefit to the society.

References

1. Hari RK, Patel TR & Martin AM (1994). An overview of pigment production in biological systems: functions, biosynthesis, and applications in food industry. Food Reviews Inter 10(1): 49- 70.
2. Baurenfeind JC (1981). Natural food colors. In: Baurenfeind, JC, Ed., Careotenoids as colorants and vitamin A precursors, Academic Press, New York, pp 1-45.
3. Delgado-Vargas F, Jiménez AR & Paredes-López O (2000). Natural pigments: carotenoids, anthocyanins, and betalains-characteristics, biosynthesis, processing and stability. Critical Reviews in Food Sci and Nutrition 40(3): 173-289.
4. Keller NP, Turner G & Bennett JW (2005). Fungal secondary metabolism from biochemistry to genomics. Nature Reviews Microbiol 3(12): 937.
5. Babitha S, Soccol, CR & Pandey A (2007). Effect of stress on growth, pigment production and morphology of Monascus sp. in solid cultures. J of Basic Microbiol 47(2): 118-126.
6. Durán N, Teixeira, MF, De Conti R & Esposito E (2002). Ecological-friendly pigments from fungi. Critical Reviews in Food Sci and Nutrition 42(1): 53-66.
7. Caro Y, Venkatachalam M, Lebeau J, Fouillaud M &Dufossé L (2017). Pigments and colorants from filamentous fungi. In Fungal metabolites. Springer International Publishing pp 499-568.
8. Gulrajani ML & Gupta D (1992). Introduction to natural dyes. Indian Institute of Technology, New Delhi.
9. Krishnamurthy KV, Siva R &Senthil TK (2002). Natural dye-yielding plants of Shervaroy Hills of Eastern Ghats. In Proceedings of National Seminar on the Conservation of the Eastern Ghats, Environment Protection Training andResearch Institute, Hyderabad pp.151- 153.
10. Norton RA (1997). Effect of carotenoids on aflatoxin B1 synthesis by Aspergillus flavus. Phytopathol 87(8): 814-821.
11. 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 (1): 71-78
12. Babitha S (2009). Microbial pigments. In Biotechnology for agro-industrial residues utilization. Springer Netherlands pp 147-162.
13. Dufossé L, Galaup P, Yaron A, Arad SM, Blanc P, Murthy KNC &Ravishankar GA (2005). Microorganisms and microalgae as sources of pigments for food use: a scientific oddity or an industrial reality. Trends in Food Sci&Technol 16(9): 389-406.
14. Dufosse L, Fouillaud M, Caro Y, Mapari SA &Sutthiwong N (2014). Filamentous fungi are large-scale producers of pigments and colorants for the food industry. Current Opinion in Biotechnol 26: 56-61.
15. Avalos J & Limón MC (2015). Biological roles of fungal carotenoids. Current Genetics 61(3): 309-324.
16. Babitha S (2009). Microbial pigments. In Biotechnology for agro-industrial residues utilization. Springer Netherlands pp 147-162.

17. Capon RJ, Stewart M, Ratnayake R, Lacey E & Gill JH (2007). Citromycetins and bilains A–C: new aromatic polyketides and diketopiperazines from Australian marine-derived and terrestrial Penicillium spp. J of Natural Products 70(11): 1746- 1752.
18. Li Y, Li X, Lee U, Kang JS, Choi HD &Sona BW. (2006). A new radical scavenging anthracene glycoside, asperflavinribofuranoside and polyketides from a marine isolate of the fungus Microsporum. Chemical and Pharma Bulletin 54(6): 882-883.
19. Li DL, Li XM & Wang BG (2009). Natural anthraquinone derivatives from a marine mangrove plant-derived endophytic fungus Eurotiumrubrum: structural elucidation and DPPH radical scavenging activity. J of Microbiol and Biotechnol 19(7): 675-680.
20. Xia XK, Huang HR, She ZG, Shao CL, Liu F, Cai XL & Lin YC (2007). 1H and 13C NMR assignments for five anthraquinones from the mangrove endophytic fungus Halorosellinia sp. (No. 1403). Magnetic Resonance in Chem 45(11): 1006-1009.
21. Ali I, Prasongsuk S, Akbar A, Aslam M, Lotrakul P, Punnapayak H &Rakshit SK. (2016). Hypersaline habitats and halophilic microorganisms. Maejo Inter J of Sci and Technol 10 (3): 330-345.
22. Rani MHS, Ramesh T, Subramanian J &Kalaiselvam M. (2013). Production and characterization of melanin pigment from halophilic black yeast Hortaeawerneckii. Inter J Pharma Res Rev 2(8): 9-17.
23. Chattopadhyay P, Chatterjee S & Sen SK (2008). Biotechnological potential of natural food grade biocolorants. African J of Biotechnol 7(17).
24. Tuli HS, Prachi C, Vikas B & Anil KS (2015). Microbial pigments as natural color sources: current trends and future perspectives. J of food science and Technol 52(8): 4669-4678.
25. Hsu LC, Hsu YW, Liang YH, Kuo YH & Pan TM (2011). Anti-tumor and antiinflammatory properties of ankaflavin and monaphilone A from Monascuspurpureus NTU 568. J of Agri and Food Chem 59(4): 1124-1130.
26. Andersen DO, Weber ND, Wood SG, Hughes BG, Murray BK & North JA (1991). In vitro virucidal activity of selected anthraquinones and anthraquinone derivatives. Antiviral Res 16(2): 185-196.
27. Durán M, Ponezi AN, Faljoni-Alario A, Teixeira MF, Justo GZ & Duran N (2012). Potential applications of violacein: amicrobial pigment. Medicinal Chem Res 21(7): 1524-1532
28. Lawrence L. Garber, Eva M. Hyatt, Richard G. Starr: The effects of food color on perceived flovor, Journal of Marketing Theory and Practice, 59, (2000)
29. M. Madhava Naidu, H.B. Sowbhagya: Technological Advances in Food Colors, Chemical Industry Digest., (2012) 3. Sahar S.A. Soltan, Manal M.E.M. Shehata: The Effects of Using Color Foods of Children on Immunity Properties and Liver, Kidney on Rats, Food and Nutrition Sciences, 3, 897-904, (2012)
30. Adam Burrows J.D., Palette of Our Palates: A Brief History of Food Coloring and Its Regulation, Comprehensive Reviews in Food science and Food Safety, 8, 394. (2009)
31. Charles Spence, Carmel A. Levitan, Maya U. Shankar, MassimilianoZampini: Does food color influence taste and flavor perception in humans?, Chem. Percept, DOI 10.1007/s12078-010-9067-z, 3, 68, (2010)

32. BetinaPiquerasFiszman, Agnes Giboreau, Charles Spence: Assessing the influence of the color of the plate on the perception of the complex food in a restaurant setting, Flavour Journal, 2, (2012)
33. Ree E: Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact8. Costa Magoulas: How color affect food choices?, University of Nevada, (2009)
34. Amy Mahony: Effect of color on odour, flavorand acceptance properties of food and beverages, M.Tech Thesis, B.S., Chapman University, (2001)
35. Giuseppe (Joe) Mazza: Anthocyanins and heart health, Ann Ist super sAnItà, 43(4), 369 (2007)
36. Kimberly Hamblin Hart, Paulalan Cox: A cladistic approach to comparative Ethnobotany: Dye plants of the southwestern United States, Journal of Ethnobiology, 20(2), 303 (2002)
37. Pandey R.M. and Upadhyay S.K.: Food Additive, www.intechopen.com (2013)
38. Vacciniummyrtillus (Bilberry), Alternative Medicine Review, 6(5), (2001)
39. F. Delgado-Vargas, A.R. Jiménez, O. Paredes-López: Natural pigments: carotenoids, anthocyanins and betalins—characteristics, biosynthesis, processing and stability. Critical Reviews in Food Science and Nutrition, 40(3), 173, (2000)
40. Mott MacDonald, Project Profile on Natural Food Colors – Marigold, Annatto, iNDEXTb (2000)
41. Aura Sturzoiu, Marta Stroescu, AnicuţaStoica, TănaseDobre: Betanine extraction from beta vulgaris – experimental research and statistical modeling, U.P.B. Sci. Bull., Series B, 73(1), (2011)
42. Bernard Weiss: Synthetic food colors and neurobehavioral hazards: The view from environmental health research, Environmental Health Perspectives, 120, (2012).
43. Sincich. F: Citrulluscolocynthis (L.) Schrad, Bedouin traditional medicine in the Syrian Steppe, Rome, FAO, 114 (2002)
44. European Medicines Agency Evaluation of Medicines for Human Use, London, 12 November 2009, Doc. Ref.: EMA/HMPC/101303/ (2008)
45. Rajashekaran J. Nair, Devija Pillai, Sophia M. Joseph, Gomathi. P, Priya V. Senan, Sherief P.M: Cephalhopod research and bioactive substances, NISCAIR online periodicals repository (NOPR), 13-27, (2011)
46. Chengaiah B., Mallikarjuna Rao K., Mahesh Kumar K., M. Alagusundaram C. MadhusudhanaChetty, Medicinal importance of natural dyes – a review, International Journal of PharmTech Research, 2(1), 144 (2010)
47. Mersereau D. and Di Tommaso A., The biology of Canadian weeds. 121. Galiummollugo L., Canadian Journal of Plant science, 453, (2002)
48. Chiba S, Tsuyoshi N, Fudou R, Ojika M, Murakami Y, Ogoma Y, Oguchi M &Yamanaka S, *J Gen ApplMicrobiol*, 52 (2006)201-207.
49. Nagia F A & EL-Mohamedy R S R, *Dyes Pigm*, 75 (2007) 550-555.
50.Youssef M S, El- Maghraby O M O &Ibrahimn YM, *Int J Botany*, 4 (2008)349-360.

51. Daniel J D, Silvana T S, Plinho F H & Adriano B, *Process Biochem*, 42 (2007)904-908.

52. Ferreira- Leitao V S, Andrade de Carvalho M E & Bon E P S, *Dyes Pigm*, 4 (2007)230-236.