Utilization of Algal Pigments in Commercial Product Innovation

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Abstract
This study explores the potential of algal pigments as a versatile and sustainable resource for the development of commercial products. Algae-derived pigments offer unique color profiles and bioactive compounds, making them suitable for applications in various industries, including cosmetics, food, and textiles. The research investigates extraction methods, pigment stability, and formulation techniques to enhance the commercial viability of these algal-based products. The findings showcase the feasibility of utilizing algal pigments as natural alternatives, addressing both environmental concerns and consumer preferences for eco-friendly and ethically sourced ingredients. This study aims to contribute valuable insights to the burgeoning field of sustainable product development.

Keywords: Algal pigments, Bioactive compounds, Natural alternatives.

Introduction

Microalgae are simple, microscopic and photosynthetic organisms, which grow in fresh and marine water systems including rivers, lakes, ponds and seawater, generally rich in carbon compounds because they utilize sunlight to produce carbon dioxide for the production of many bioactive compounds including pigments, proteins, lipids, polysaccharides, lipids and vitamins (Moha-Leon et al., 2018) [5]. They can also produce a wide range of promising compounds including lipids, proteins, vitamins, polysaccharides, pigments, bioactive compounds and antioxidants. These extensive productions of chemical compounds from microalgae lead to finding several industrial and environmental applications including in food, pharmaceutical, cosmetic, nutraceutical and aquaculture industries (Hayes et al., 2018) [3]. Beyond their ecological significance, microalgae hold immense potential in various Beyond their ecological significance, microalgae hold immense potential in various additives, cosmetics, and wastewater treatment.

Microalgae are one of the interesting sources of producing natural pigments and they embody a biotechnologically interesting source because of their wide occurrence of pigments. These algae secrete pigments including chlorophylls (green), carotenoids (red, orange and yellow) and phycobiliproteins (red and blue) (Garcia Gonzalez et al., 2005; Gong and Bassi 2016; Laje et al., 2019) [1,2,4]. Demand for these pigments is more for their extensive applications, but the yield of these pigments is too low to establish the production of pigment from microalgae as economically feasible.

Algal pigments are utilized in cosmetics and personal care products for their natural coloration and skin benefits. They can be found in products like lipsticks, eye shadows, moisturizers, and sunscreen formulations. Many cosmetic products are composed of synthetic chemicals, which may cause side effects

in the body; for example, some pigments may cause damage to cells and some UV filters may even cause tumour formation. Moreover, metals are widely used in cosmetics as pigments for example, in eye shadow, lipstick, blush, and eyeliner. However, some metals, such as cadmium and chromium, are harmful to the human body and may even affect human metabolism. However, the toxicity of cosmetics was not taken into consideration in the early period, which led to a variety of negative adverse effects, including deformities, blindness, and even death. Although there are limitations to their use, these limitations are not entirely effective. The cosmetics that are absorbed by our body may act as carcinogens, reproductive toxins, endocrine disruptors, mutagens, and sources of neurotoxicity.
In general, synthetic dyes are composed of toxic chemical substances such as chromium, lead, mercury, copper, toluene, and benzene, which are harmful to health. Several synthetic colorants originally approved for use in pharmaceuticals, food, and cosmetics research by the Food and Drug Administration (FDA) were later shown to be carcinogenic. Consumers who are concerned about safety are prepared to spend more on cosmetics that contain natural components that are better for their skin. If the products are coloured with natural substances, they have a high market value. Natural pigments can boost a product's marketability while also exhibiting beneficial biological properties, including antioxidant and antimicrobial properties.

Materials and methods

Collection of algal samples

In the present study, for the isolation of microalgae, water samples were collected from a small water space near to Hindusthan College of Arts & Science campus, Coimbatore, district, Tamil Nadu, India. The water sample along with some algal blooms were collected in a beaker using forceps. The collected samples were packed in a clean beaker covered with foil and marked for further identification and the samples were brought to the laboratory for further analysis.

Figure.1 Collection of samples

Cultivation of algal sample

Further, the collected samples were cultivated for 100ml in BG-11 High-media in 250ml conical flask for 4 batches. The broth is sterilized in an autoclave. After sterilization, allow the broth to cool at room temperature. then add a pinch of Amphotericin-B as an anti-fungal agent and chloramphenicol as an anti-bacterial agent. To avoid contamination. Then the broth is incubated for 15-20 days at 24 degrees Celsius. The incubated flask was manually shaken regularly for the proper nutrients supply and the biomass were collected.

Pigment extraction

The pigment is extracted by maceration process. This is the conventional method of pigment extraction. In the process the biomass and the solvent are taken in Equal ratio of volume 5ml. Acetone is the used solvent to extract the pigment from the micro algae. A series of petri plates were taken and the algae sample and acetone were added with equal volume of 5ml on each in all the petri plates. Then plates were kept without disturbing them for 3 days until all the solvent acetone completely evaporated.

Results

Microscopic identification of morphology

The microscopic view of microalgae was observed under 40X magnification. The structure is observed as thallus is multicellular with each cylindrical cell joined together with chloroplast filled inside the cells.

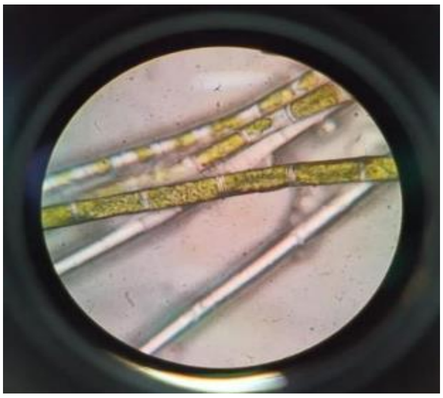


Figure.2 Microscopic image of microalgae

Pigment extraction

After 2 days of incubation in room temperature the other components in algae were evaporated except pigment. The pigment was scraped with the help of a spatula. The solvent in the pigment helps to avoid denaturation of pigment.

Figure.3 Extracted pigment

Quality test

UV-spectrophotometer analysis:

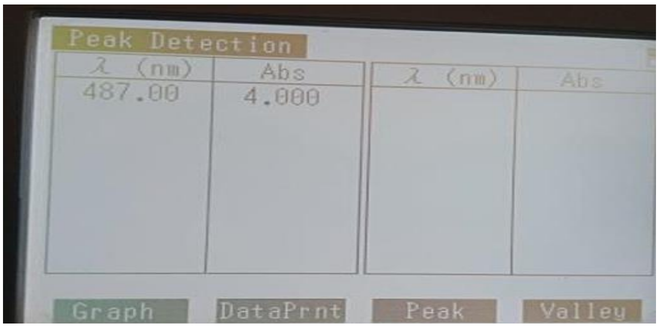


Figure.4 UV Spectrophotometer absorbance reading

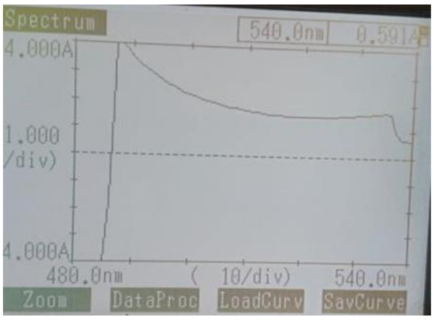
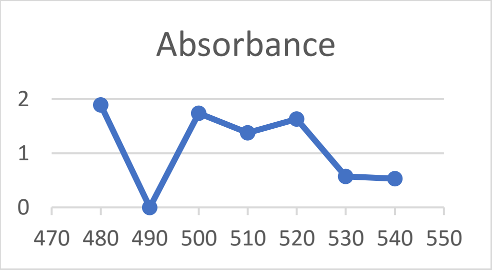


Figure.5 UV Spectrophotometer absorbance graph

The sample was dissolved in DMSO solvent and it was transferred into UV spec cuvette. The blank serves as DMSO solvent in another cuvette. chlorophyll was observed between the nanometre ranges from 480 nm to 540 nm. The highest peak value is observed at 487 nm in UV spec. This concludes that the maximum absorbance is done in 487 nm of the given sample that results in the peak of the graph. Therefore, the sample is concluded as the chlorophyll pigment.



Graph 1. UV spec absorbance value at various nanometre

Table 1 Absorbance in UV spectrophotometer

nm	Absorbance
480	1.896
490	0.001
500	1.739
510	1.378
520	1.636

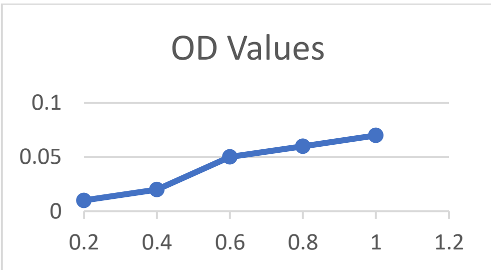
530	0.572
540	0.531

Protein analysis

Bradford test:

Table.2 colorimeter readings for Bradford

Test tube	**Volume of working standard(ml)**	**Concentration of working standard(µg)**	**Volume of distilled water(ml)**	**Volume of reagents and incubation**	**O.D at 595 nm**
B	-	-	1.0	5 ml of Bradford	**0.01**
S1	0.2	20	0.8	reagent	0.02
S2	0.4	40	0.6	+ incubation at	0.05
S3	0.6	60	0.4	RT for 5 minutes	0.06
S4	0.8	80	0.2		0.07
S5	1.0	100	-		0.09
T	1.0		-		0.02



Graph 2. Bradford values

Toxicity test

Haemolytic test

After incubation no haemolysis was observed in the blood agar plate. So, this concludes that the pigment contains no toxic.

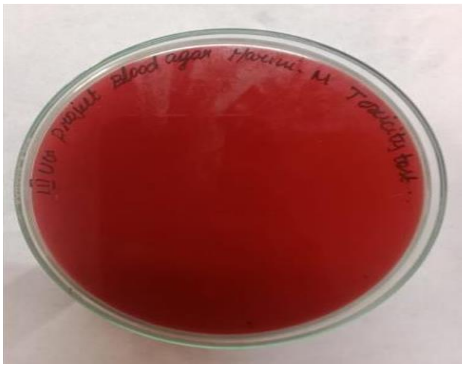


Figure.6 Blood agar plate with no haemolysis

Final product

In the nail polish base that has been purchased from the market. Into the base the extracted algal pigment is added and mixed the content well. Then the nail polish stability and smoothness are determined by applying the nail polish in the bare nails and allow to set for a few minutes.

Figure 7. algal pigment nail polish

Discussion

Algal pigment offers a promising alternative to traditional synthetic colorant and tapping into the growing demand for eco-friendly beauty products. The incorporation of algal pigment into nail polish formulation not only plays a major role in environment concern but it also gives opportunity in cosmetic research and development. The vibrant colour of green provides an extensive range of options for nail polish colour. This pigment contains lots of bioactive properties, potentially offering additional skincare benefits to consumers. Generally, in nail polish the green colour was obtained using chromium oxide. The prolonged usage of this synthetic dye may cause health issues like respiratory problems, eye irritation etc. So, these alternative algal pigments are nontoxic, easily available, and it contains many health benefits. The integration of algal pigment into nail polish formulation also contributes to sustainable goals within the cosmetic industry. The use of algal pigment lies within the principles of the circular economy by utilizing renewable resources and reducing the synthetic dyes commonly found in traditional cosmetic formulation. Algal pigments are used to add exotic colours to soaps. Algal is a source of pigment for various hair colour products due to its long-lasting properties. The pigment of algae can be stored till 99 days, addition of solvent like acetone in this pigment extends the shelf life of the pigment in cosmetics. Usually, algae do not contain any toxins in normal growth time.

Conclusion

Utilizing algal pigment in the production of nail polish offers several advantages, including sustainability, vibrant colour options, and potential health benefits. Algal pigments provide a renewable and environmentally friendly alternative to synthetic dyes, reducing the ecological footprint of the nail polish industry. Moreover, algal pigments can offer unique and attractive hues, expanding the colour palette available to consumers. Additionally, algae contain beneficial compounds such as antioxidants and vitamins, which may offer nail health benefits. However, challenges such as scalability, cost-effectiveness, and stability in formulations need to be addressed in the production process. Overall, the incorporation of algal pigment in nail polish production holds promise for creating eco-friendly and aesthetically pleasing products that align with consumers' growing demand for sustainable beauty options.

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