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Extraction of dye from marine macroalgae

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Abstract: This research work deals with the production of dye pigment from a green seaweed *Sargassum myriocystum* using solvent extraction method. The powdered seaweed was subjected to methanol extraction and ethanol extraction solvent systems. Phytochemical analysis indicated the presence of cholorophyll, carotenoids and flavonoids. The dye solution was subjected to UV spectroscopy and the dye pigment was characterized using scanning electron microscope .The dye finds application as a food colorant and in dye sensitized solar cells because of the presence of photosynthetic pigments.

Introduction:

Dyes extracted from natural resources are being researched upon because of its biodegradability and non polluting nature. Discharge of textile effluents using chemical dyes causes inevitable pollution of water resources which calls for further treatment methods [1]. Many small scale dyeing units have been closed in India because of ground water contamination. Dyes from natural sources in India have an ancient history interwoven with its culture, with natural dyeing being practiced since Bronze Age[2]. Most natural food colorants come from the division *Magnoliophyta* (flowering plants) of the plant kingdom[3]. Seaweeds (macroalgae) have many commercial applications like foodstuffs, animal feed, cosmetics, pollution abatement, and therapeutics [4]. Currently, algae find a promising future as an alternate fuel. But the cost of algal biodiesel offset its chances of commercialization. Sheehan et al. Sheehan, J. et al showed that cultivation and harvest costs represent around 88% of the production cost of lipids. Reducing or offsetting the cost of cultivation and harvesting is critical to reducing the total production cost of microalgal oil[6]. Many high-value contents of algal cell, including pigments, can be regarded as economically valuable co-products that effectively offset the production costs of lipids[7]. *Sargassum myriocystum*, a brown seaweed is rich in Mono unsaturated fatty acids (MUFA) and Poly unsaturated fatty acids (PUFA) and can be used for pharmaceutical, food and fuel industry[8].It has a high concentration of chlorophyll which can be extracted as a dye . Seaweeds and marine planktons are one of the most abundant photosynthetic species containing c-type chlorophylls (Chls)[9] Algal forms are the richest source of pigments and can be produced in renewable manner, since they produce some unique pigments sustainably[10]. This paper deals about the preparation of dye extracted from the seaweed. More recently, some researchers have envisioned the enormous possibilities of algae and microalgae as potential source of bioactive compounds; particularly, some microalgae have been studied as a potential natural source of different functional compounds [11] while some macroalgae have been suggested as a new and unlimited source of new functional food ingredients [12]

Methodology:

Materials

The seaweed was collected from Rameshwaram beach, Gulf of mannar. The raw materials were washed with distilled water and sun dried for 48 hours. Then they were dried in an oven at 60 ºC for 12 hours. The dried

raw materials were powdered using mortar and pestle and sieved. Methanol, ethanol used were of analytical grade.

Figure 1. Sargassum myriocystum

Kingdom : Plantae (plants)
Phylum /Division : Phaeophyta (brown algae)
Class : Phaeophyceae
Order : Fucales
Family : Sargassceae
Genus : Sargassum
Species : *Sargassum myriocystum*

Experimental

Solvent extraction was done to remove the dye pigments.100 gm of powdered raw material was soaked in methanol and ethanol solvents in the ratio 1:10(w/v) ratio. Dye was extracted by two methods. The powdered seaweed and the solvent was boiled in a beaker which was placed on a heating mantle at a temperature of 60º C by method 1 for 4 hours. The hot solution was filtered through a Whatmann No.1 filter paper to remove the biomass. By method 2 the raw materials were solvent extracted without using heat and was soaked for 48 hours in the solvents. The dye solution is filtered using a whatmann filter paper to remove the biomass. The solvent from both meyhods was evaporated using a rotary evaporator. The dye solution is extracted till the solubility of the pigment decreases in the solvent systems. The excess alcohol is removed in a rotary evaporator and the alcohol can be recycled back to the process. The dye solution obtained is pure without any contamination and was store in a refrigerator for further studies. Phytochemical analysis was performed on the dye solution.

Results and Discussion

The dye solution was procured from the seaweed by two methods using methanol or ethanol as solvent system. Method 1 is application of heat to the mixture and method 2 is without heating. The dye solution was dark green in colour. It can be inferred from table 1, that application of heat resulted in higher yield of the dye extract than without heating. This is in confirmation with earlier research.

Table 1 .Estimation of dye extract yield in (%wt.)

S.No.	Mode of operation	Methanol	Ethanol
1.	With Heating	73(%)	55(%)
2.	Without Heating	48(%)	19(%)

$$\text{Yield of dye extract (\%)} = \frac{\text{Weight of powdered seaweed} - \text{Weight of residue}}{\text{Weight of powdered seaweed}} * 100\% \quad (1)$$

The yield of extract was estimated using equation 1. The dye solution was subjected to UV-spectroscopy for absorption measurement at wavelength of 400-800 nm. It can be seen from figure 2 that at a wavelength of 420 nm and 680 nm, the peaks indicate the presence of flavanoids and chlorophyll.

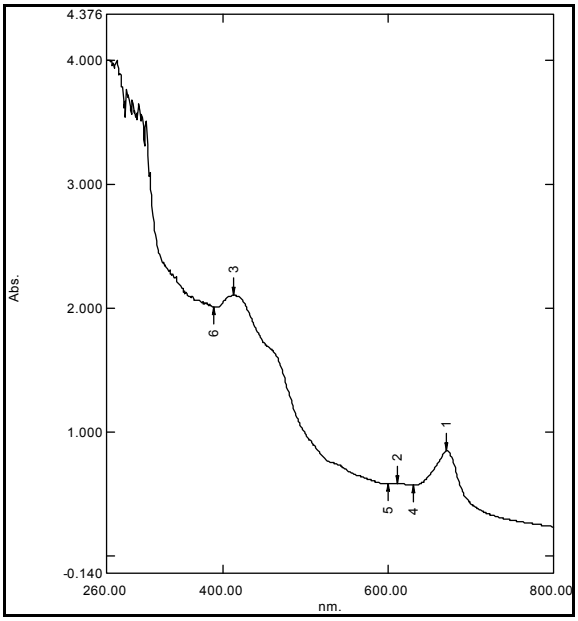

Figure 2. UV spectroscopy of dye solution

The dye solution was heated to recover pigments. The pigment was subjected to scanning electron microscopy to determine its morphology as shown by figure 3.The images suggest a crystalline structure.

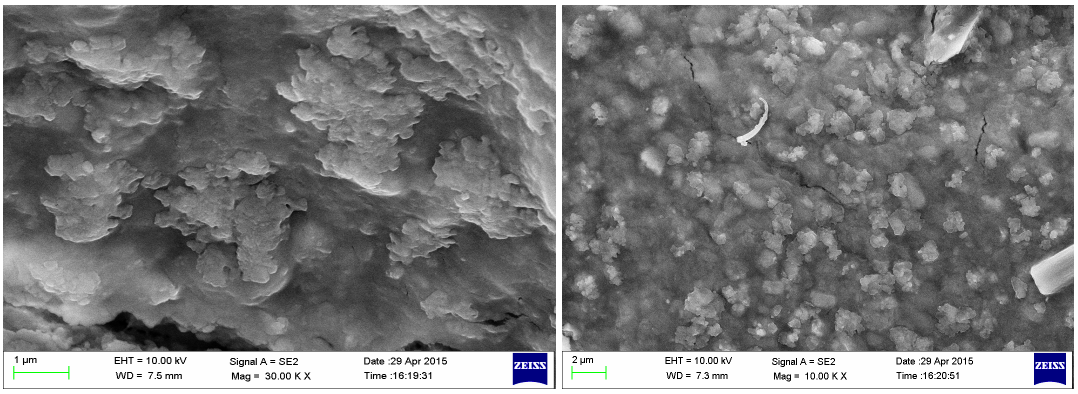

Figure 3.SEM images of dye pigment

Table 2: Phytochemical analysis of dye solution

Phytochemical	Dye solution
Chlorophyll	+
Carotenoids	+
Flavonoids	+
Glycosides	+

The dye extracted from *Sargassum myriocystum* was extracted at a pH of 4 and was subjected to phytochemical analysis. From table 2, it can be inferred that the dye solution extracted from *Sargassum myriocystum* seaweed contains phytochemicals which makes it a suitable candidate as a food colorant or in solar cells.

Conclusion

For eco friendly and harmless effluents from textile industries, it is advisable to use dyes of natural origin than synthetic dyes. It reduces pollution of water bodies and ensures healthy aquatic life. From the research work, it can be concluded that the dye extracted from the marine seaweed *Sargassum myriocystum* has potential application as a food colorant. Since it has photosynthetic pigments like chlorophyll and carotenoid it also finds application in dye sensitized solar cells. Currently, algae are researched upon as a potential biofuel resource. But the cost offsets the economical production of biofuel. Value added materials like dyes and pigments extracted from the seaweeds can make the cost of biofuel economical.

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