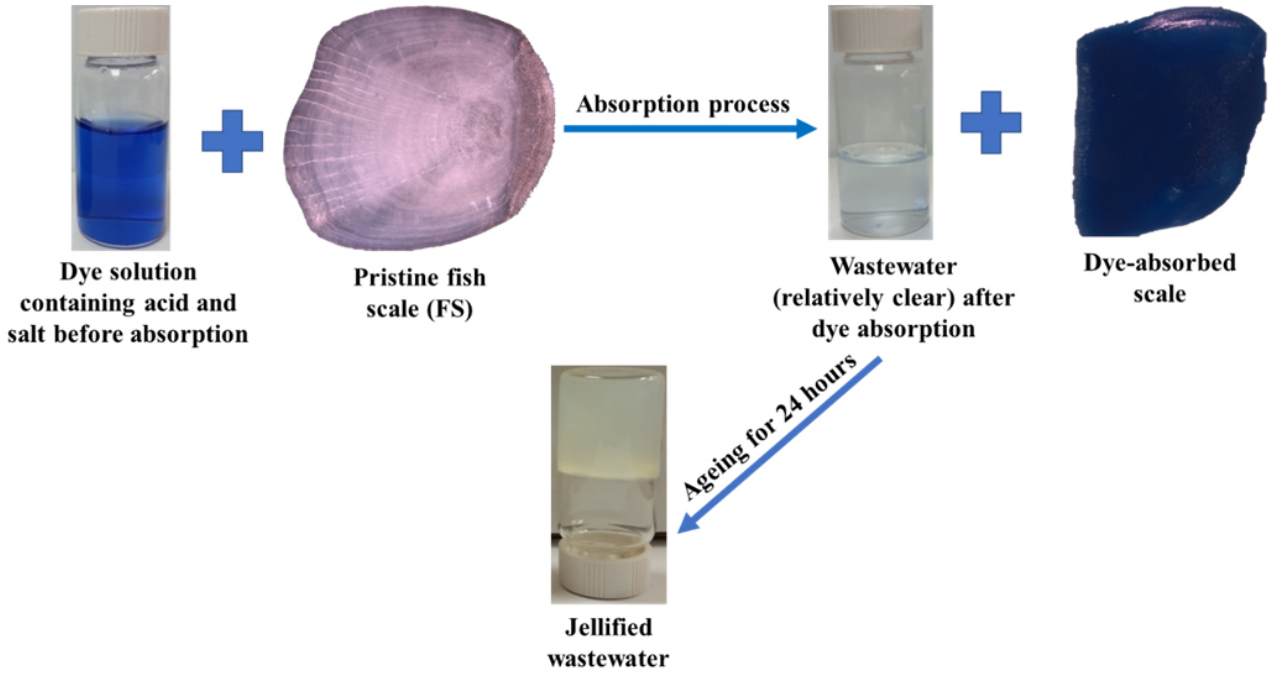
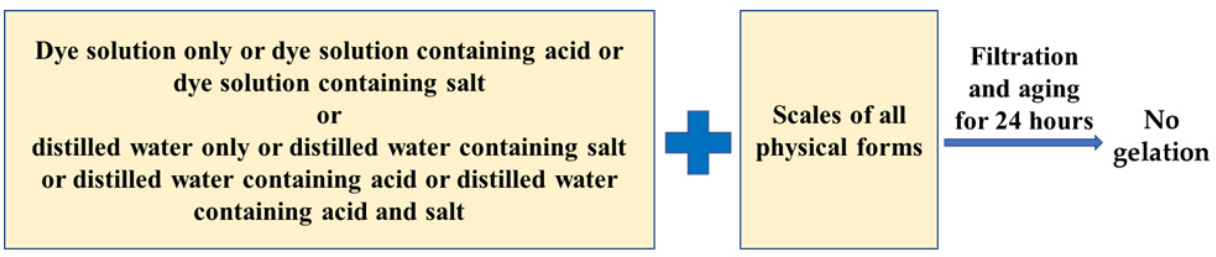
Gelation of textile effluent by fish scales: An innovation in liquid waste management

Fish wastes (such as heads, bones, skin, scales, fins, and viscera) often might account up to three fourths of the total fish weight and are dumped carelessly into land or sea, resulting in a negative environmental impact. These wastes are generated as a byproduct during the fillet processing in the fish industries. The research, primarily intended to use the most discarded fish waste, scales as a potential bio-sorbent for the removal of anionic (negatively charged) dyes (acid dyes: Acid Red 1, Acid Blue 45, and Acid Yellow 127) from textile wastewater, came out with promising outcomes. The proteins, an important component of the fish scales, contain charged chemical groups that enabled them to absorb dye molecules from the wastewater. However, the present discussion includes a phenomenon that was beyond the dye absorption process; the gelation, an additional and unexpected finding observed after dye absorption process.



A



B

Fig. 1. Experimental conditions specific to gelation; setup leading to gelation (A), and retrospective experimental setup leading to failure in achieving gelation (B).

Here, we used the scales of black drum fishes (Pogonias comes) collected from a local fish processor at Franklin, Louisiana, USA. The scales were washed thoroughly with normal tap water and dried at room temperature. The dried scales were pulverized and separated according to their sizes. However, for absorption purpose, we chose large or whole scales only. Sample dye solutions were prepared following to the standard wool fiber dyeing recipe 150 mg/L dye, 62.5 mg/L salt (Na_2SO_4), and 7.5 mg/L acid (H_2SO_4). Then the 20 ml dye solution was treated with 1 g (1:20; material liquor ratio) of the scales in a closed system with heating at 60 °C for an hour with continuous stirring. Finally, the dye-scale mixtures were centrifuged for five minutes to have clear supernatant. The amazing and unexpected phenomenal gel formation was observed when the clear supernatant was aged for 24 h at room temperature. In order to understand the underlaying reasons for the gel formation, some retrospective experiments were constructed using a series of replica for wastewater treated with different sizes of pulverized scales; but they were unable to form a gel as illustrated in the Figure (B). The performance of fish scales as a prospective gelling agent was assessed by different instrumental (FTIR and rheological) analyses.

From the instrumental analysis, we assumed that the presence of collagen in the whole fish scales was responsible for the gelation of the treated wastewater. The results also suggest that the jellified wastewater can be processed as as thin films, which might have promising applications in medical and biomedical, cosmetic and food industries. For instance, researchers used gelatin from tilapia wastes to formulate Panna Cotta products. The way of obtaining gelatinous products described in the present study is easier in terms of time, chemicals, and process convenience; therefore, it could be a very promising method for future studies. Nonetheless, this gel cannot be used in food processing directly due to the presence of hazardous materials like acids, salts, and residual dyes. However, this gelation process can be utilized as potential technique for liquid effluent management in the textile industry. The gel can be dried and disposed of properly as a solid waste, which will reduce the overall volume of the waste, as well as improve the ecofriendly waste management system. Future studies can be conducted to investigate the underlaying chemistry of gel formation and discover potential applications of the gel.

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