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Sustainable Production of Fungal Pigments from Selected Agro-Food Wastes via Submerged Fermentation Process using *Fusarium proliferatum* Strain 08405: A Biovalorization Approach

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Abstract

Biovalorization utilizes biological processes to convert waste materials into valuable products, enhancing sustainability and resource efficiency. This study focuses on developing and optimizing a sustainable approach to the production of fungal pigments via submerged fermentation (SMF) process using *Fusarium proliferatum* strain 08405. The fermentation substrates included banana peel waste, affected *Sesbania grandiflora* leaves and stems, and used tea dust waste. Key physico-chemical properties of the substrates, such as pH, moisture content, total organic carbon, and total ash content were analyzed using standard methods. The fungal cultures were incubated under optimal conditions at 25℃ and 160 rpm for 14 days. Pigments were extracted using cold, buffered methanol (98%, 2% ammonium acetate, 0.5 M) and characterized by colour observation, UV-Vis spectroscopic analysis, and Fourier-transform infrared (FTIR) spectroscopic analysis. Toxicity, antibacterial, and antioxidant properties of the pigments were assessed to determine their potential for industrial applications. The pigment yields from banana peel, *Sesbania*, and tea wastes were 375.2±22.8 mg/L, 161.4±7.8 mg/L, and 102.2±6.8 mg/L, respectively. Significant differences ($p<0.05$) in pigment yields were observed between different substrate types. The pigments exhibited a yellowish orange colour, with UV-Vis spectra showing a λ_{max} between 200-300 nm and a minor peak around 500 nm. FTIR analysis revealed characteristic peaks for functional groups, including OH-stretching (3000-3500 cm^{-1}), CH-stretching (2800-2950 cm^{-1}), carbonyl C=O stretch (1630-1980 cm^{-1}), C-O stretch for quinones (1060-1590 cm^{-1}), aromatic ring C=C stretching (1500-1600 cm^{-1}), and CH-bending (650-800 cm^{-1}), suggesting the presence of a Naphthoquinone type pigment. The *Artemia salina* toxicity bioassay indicated a low mortality rate (13-20%) for extracted pigment samples, compared to 100% for the positive control. Antibacterial activity demonstrated inhibition zones ranging from 1.5±0.1 cm to 2.1±0.1 cm for *Staphylococcus aureus* and 1.4±0.1 cm to 1.7±0.1 cm for *Escherichia coli*. The antioxidant assay showed increased DPPH inhibition with higher pigment concentrations, indicating strong free radical scavenging activity. This study presents a novel and sustainable method for producing fungal pigments via submerged fermentation using selected agro-food wastes and *Fusarium proliferatum* strain 08405, an approach not previously documented.

Keywords: *Agro-food waste, Biovalorization, Fungal pigment, Fusarium proliferatum strain 08405, Submerged fermentation process*