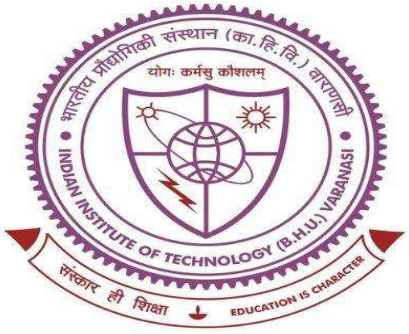
Design and Development of Microalgae based Wastewater treatment process by Machine Learning Tools



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By

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Chapter 8

(Overall Conclusion and Future Perspective)

8.1. Overall Conclusions

In the present work, datasets constructed for NRE, PRE, and biomass production by extracting the experimental results from the papers published were analysed by two machine learning algorithms, Decision Tree and Association Rule Mining. Decision Tree analysis was used to predict different combinations of input variables leading to high biomass production and nutrient removal efficiency. At the same time, Association Rule Mining was applied to study the individual effects of input variables and determine their level leading to high biomass production and nutrient removal efficiency. Predictor important function revealed that initial inoculum level and nutrient concentration were highly influential input variables affecting microalgae growth in wastewater. Computational and experimental verification concluded that machine learning presents a sustainable approach for optimising microalgae-based wastewater treatment. Rules extracted from the current study can be used to design future experiments. They can even be used in pilot and large-scale studies without further laboratory experiments. Cost-benefit analysis revealed that the sole application of LEDs for microalgae cultivation is not feasible. However, the decrease in the cost compared to previous studies indicates that the LED's efficiency is improving yearly. The commercialization of microalgae cultivation exploiting LEDs solely for low-cost products will be possible in years to come. The coupling of an Arduino-based automated control system with the photovoltaic-powered photobioreactor and modified low-emission film might eliminate the need for external electrical energy to a great extent. This will substantially reduce input costs during LED's operation for microalgae cultivation.

8.2. Future Perspectives

The current study will provide directions for future research in many ways. Firstly, by using the optimized values of various parameters computed in the present study, optimization of other important parameters such as air flow rate, organic carbon content, dissolved oxygen

concentration, the wavelength of the light source and many more can be done. Secondly, a similar methodology can be used to optimise lipid production by microalgal cells, utilising wastewater as a media source. In addition to parameters affecting biomass production, lipid production is also influenced by other parameters, including extraction technique, wastewater salinity, pretreatment method and cultivation stage. Also, the co-cultivation of species belonging to *Chlorophyceae* and *Trebouxiophyceae* in wastewater will result in high biomass production.

Moreover, the finding of the present study will motivate both industries and society. Industries can use the results of optimization studies for setting up microalgae cultivation facilities to treat their effluents and generate additional resources in the form of microalgal biomass. Industries will need no additional laboratory experiments and results can be directly implemented at pilot and large scale. Generating renewable energy sources from microalgae biomass will reduce the load on fossil fuels. So, it will reduce air and water pollution.