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## PREFACE

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This academic journey has been long yet an enriching experience for me. My research interest has taken me to the challenge of combating fuel crisis and creating a sustainable solution. Population explosion and increased urbanization have created overwhelming pressure on renewable energy resources. Environmental pollution, exhaustion of fossil fuels and rise in petrol and diesel prices are issues of great concern and thus, sustainable, renewable, and cost-effective energy sources with low greenhouse gas emissions are being pondered upon all over the world. In the present study, microalgae were selected as a suitable alternative for biofuel production by utilizing the abundant starch present in the microalgae to achieve sustainable development of biofuel. The algal starch can be used as a potential substrate for bioethanol production through SHF and SSF. Initially seven microalgae strains were isolated and only two strains were selected based on high carbohydrate content for further studies. The PCR amplified DNA sequences of two microalgae were found and the BLAST analysis for both microalgae was performed. The phylogenetic tree of both microalgae was also constructed. Based on the significant amount of carbohydrate content two promising and potential microalgae were chosen for elaborate studies.

The physical, chemical and physicochemical conditions were optimized and based on the optimized process parameters, scale-up of the microalgal cultivation was done. Among the various photobioreactors used, the external airlift photobioreactor provided the higher biomass, carbohydrate and starch productivities with 2% CO<sub>2</sub> (v/v) supply. More growth was achieved in this case.

Three strategic carbohydrate enhancement methods i.e. nutrient limiting method, use of cerulenin and cycloheximide were used to maximize the available carbohydrate in the

respective microalgal species. Various pretreatment methods were used to extract the carbohydrate content of the microalgal species and the microalgae cell breakage study was further confirmed by SEM study.

The SSF technique of bioethanol production provided higher bioethanol production due to better substrate utilization. The yield factor for bioethanol production from algal biomass was significant. The unstructured model proposed here for both SSF and SHF predicted the experimental data of starch depletion, cell mass growth, glucose concentration and ethanol production, as high coefficients of determination ( $R^2$  values) for different variables were obtained. The current perspective on bioprocess intensification for bioethanol production would draw the attention towards the incredible potentialities of microalgal biofuel and strategies to improve its production. The aim of this study is to develop various strategies to ameliorate the sustainable production of biofuel through various cell processing strategies.

The work incorporated in the present thesis has been arranged in five chapters. The first chapter contains the general introduction of the subject, its structure and importance.

Chapter two provides the exhaustive review of the up-to-date literature published related to the work on the various aspects of the history of bioethanol production from microalgae, the challenge of microalgal bioethanol production, and various processing strategies used till date. Systematic literature is provided for a better understanding of the present work. Objectives of the present work have also been included in the chapter.

Chapter three discusses the material and methodology used for the entire study. General experiment set up, media formulations, different assay and protocols used in production studies have been described.

The fourth chapter deals with the results obtained during the experiments carried out in chapter three followed by discussions.

Chapter five summarizes the main findings of the above studies and overall conclusions that were obtained.

In the end, the thesis has been appended by an up-to-date list of references. References have been arranged alphabetically according to the surname of the first author.

List of the publications has been attached at the end of the thesis.

In my hope and belief the entire contents of the thesis have been compiled on my research.