



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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The potent utilization of cheap and renewable biomass for the production of fuels and value-added bio products is important for addressing the problems related to fossil fuel depletion. Microalgae has emerged as an excellent resource in this regard but the excessive cost of nutrients is a vital restriction for producing economically viable algal fuels. Substitution of the chemical growth medium of microalgae with low cost organic biomass such as food or agricultural waste substrate could help in dealing the cost related problems associated with cultivation of microalgae and also in dealing with heaps of agricultural and food waste generated daily. The suitability of potato, banana and sweet lime peel hydrolysate were evaluated for microalgae cultivation. Different pre-treatment processes were carried out for all the three peels and the best conditions yielding higher amount of glucose concentration were further hydrolyzed by enzyme. Response surface methodology (RSM) was used to optimize the hydrolysis conditions to attain high glucose concentration. The three parameters chosen for the study were; time (h), temperature ( $^{\circ}\text{C}$ ) and the rotation frequency or agitation speed of the incubator (revolutions per minute i.e. RPM).  $46.17 \pm 0.77 \text{ g L}^{-1}$ ,  $29.84 \pm 0.57 \text{ g L}^{-1}$  and  $35.90 \pm 0.43 \text{ g L}^{-1}$  of glucose yield were obtained for potato, banana and sweet lime peels respectively under optimum conditions. The waste peels were further characterized through proximate and ultimate analysis, compositional analysis, FESEM, EDX, FTIR and pH study. Two indigenous microalgae strains *Chlorella sorokiniana* KMBM\_I (Strain "I") and *Chlorella sorokiniana* KMBM\_K (Strain "K") were tested for their growth and adaptability in the peel wastes. Growth kinetic parameters of the strains were analyzed in varying culture conditions.

A new insight can be obtained with this study as it integrates the concept of lipid extracted microalgal biomass residue utilization (LEMBR) approach along with waste disposal thereby serving in the management of these wastes. Biorefineries follow the concept of zero waste production and are very energy efficient. The spent biomass after extraction of lipids were reused and recycled for sustainable biofuel synthesis. For microalgal based bioethanol production, the defatted biomass after lipid extraction was hydrolyzed and the obtained hydrolysate was fermented to generate bioethanol. This is a significant step in the production of sustainable biofuels through reuse and recycling of spent microalgal biomass. The isolates demonstrated a remarkable amount of lipid, protein and carbohydrate. The strains also exhibited notable amount of pigments like chlorophyll-a, chlorophyll-b and carotenoids. Experimental results indicated that a waste-based refinery could lead to efficient production of value-added products from microalgae utilizing the organic wastes, in turn contributing to the establishment of a "green society". The highest biomass yield of  $2.56 \pm 0.09 \text{ g L}^{-1}$  and lipid content of  $26.34 \pm 0.24 \%$  was observed when the microalgal strain "K" was cultivated in the mixed peel extract of potato, banana and sweet lime. This lipid can be further processed to produce biodiesel while the spent defatted LEMBR were utilized to produce bioethanol of  $7.16 \pm 0.43 \text{ g L}^{-1}$ . This study demonstrates the potential of indigenous native species of microalgae, for a biorefinery that generates lipids, bioethanol and various value-added products. The study demonstrated sustainable bioenergy production with simultaneous value added bioproducts generation from microalgae through waste peel valorization. This bioconversion facilitates the way for emergence and creation of algae based biorefinery through the production of biofuels and bioproducts. Further, this waste peels based microalgal biorefinery concept could aid in the establishment of "zero waste" strategies with proper scale up techniques.