INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The contemporary need for clean and sustainable renewable energy demands a shift towards harnessing diverse biomass resources for thermochemical conversion. Citrus fruits, particularly sweet lime scientifically recognized as *Citrus limetta* (CL), generates substantial waste in the form of peel and pulp after juice extraction. This dissertation addresses the disposal challenge by focusing on the liquefaction of these fruit wastes under less severe conditions of temperature (240-280 °C) and pressure (90-130 bar). Methanol, a high-polarity hydrogen-donor solvent, was chosen for its efficacy in biomass hydrogenation, yielding biocrude and biochar with properties akin to traditional fossil fuels. Varied biomass-to-solvent ratios resulted in a 12.5 wt. % biocrude yield from *Citrus limetta* peel at 240 °C, showing an increase compared to similar citrus fruit wastes. The generated biocrude from *Citrus limetta* pulp achieved a notable energy density of 26.76 MJ kg^{-1} at a constant temperature of 260 °C and a 1:4 biomass-to-solvent ratio. GC-MS analysis revealed a higher area percentage of phenol derivatives in the biocrude, indicating the decomposition of the thermally stable lignin biopolymer during liquefaction. Co-liquefaction of *Citrus limetta* peel and pulp co-feed exhibited synergy, enhancing the biocrude yield to 13.47 wt. % at 240 °C and a 1:2 biomass-to-solvent ratio. The rise in temperature during co-liquefaction yielded a maximum higher heating value (HHV) of 27.6 MJ kg^{-1} at 280 °C, surpassing single-feed liquefaction. GC-MS and proton nuclear magnetic resonance (^{1}H NMR) results confirmed a biocrude rich in aromatics, alkanes and aliphatics. Biochar energy densities in the range of 14.45 MJ kg^{-1} to 20.62 MJ kg^{-1} suggested its application as a source for thermochemical conversion. Additionally, Brunauer Emmett Teller (BET) results underscored the porous nature of solid biochar and its utility as low-cost adsorbents in soil remediation and catalysts for thermochemical conversion. Finally, in evaluating biocrude energy density, *Citrus limetta* pulp demonstrated higher efficiency than the peel under conditions of 280 °C and a biomass-to-solvent ratio of 1:4. In situations where separating pulp and peel would be impractical, co-liquefaction of *Citrus limetta* peel and pulp could possibly be recommended for optimal biofuel production.