INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title	:	Forward osmosis for the concentration of black tea extract: insights into the development of draw solute and extraction of essential tea components
Name of Thesis Supervisor(s)	:	Prof. Kaustubha Mohanty and Prof. Senthilmurugan Subbiah
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SHORT ABSTRACT

In liquid food and beverage processing industries, concentrating liquid food extract while maintaining its essential nutritional and sensory qualities is a challenging topic that needs to be addressed. Since the recent outbreak of Covid-19, the notable shift in consumer behaviour toward nutritional foods has attracted researchers to an alternative concentration technique which are capable of concentrating liquid foods while maintaining their nutritional and sensory quality. Forward osmosis (FO) is one of the promising alternatives to concentrate liquid food at low temperatures and pressure.

This thesis focuses on determining the feasibility of the forward osmosis (FO) process for the concentration of freshly brewed black tea extract. Apart from its refreshing taste, thermo-sensitive polyphenolic compounds (such as catechins) also offer several health benefits. The feasibility of the concentration of tea extract using the FO process was investigated in this thesis. The increasing concentration trend of essential tea components (such as tea catechins and L-theanine) exhibits the prospects of concentration of tea extract using the FO process. Once the feasibility of the FO process for black tea concentration was established. The thesis focuses on identifying an appropriate food-grade draw solute for the concentration of black tea extract using the FO process. The efficiency of the FO process was determined in terms of water flux, specific reverse solute flux (SRSF), and the concentration of essential tea components in the final product. Further, to understand the role of the membrane in an efficient FO process, the FO performance of two commercially available HFFO membranes for the concentration of tea extract using the FO process and their role in concentration polarisation were investigated. Once the role of the DS composition and HFFO membrane was established. Using the best-performing multi-component DS composition and HFFO membrane module, an innovative approach for preparing instant tea using the integrating forward osmosis (FO)-crystallization technique was proposed.

A one-dimensional mathematical model was developed for the given process. The developed HFFO model was validated using experimental data to predict the experimental performance of aquaporin FO membrane within allowable error limits. Using the developed model, a series of process flow-sheet simulation studies were performed to investigate the effect of different operating conditions on overall FO performance. Based on the simulation results, a multi-criteria optimisation was developed to attain the maximum permeate and minimum specific reverse solute flux. The feasibility of seawater and high-concentration reject brine as DS was also investigated.

This thesis also provides a detailed overview of the synthesis, characterisation, and FO performance analysis of hydrogel as a draw solute. The regeneration of the hydrogel was investigated against thermal influence, solar radiation, and high-concentration reject brine. The prospect of regeneration of swollen hydrogel using high-concentration brine solution was explored in this study using a three-tier membrane module. Further, the feasibility of hydrogel as a draw solute for the concentration of tea extract using the FO process was also investigated.