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Analysis and Model-based Optimization of a Pectin Extraction Process

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1 **Abstract**

2 Raw material quality disparity is an unavoidable and systemic variability in the solid-liquid extraction
3 process of pectin manufacturing. A mathematical model is considered for a robust optimization of the
4 process, taking into the account raw material quality uncertainty, for two different scenarios of pectin
5 product quality profiles. Before application, the model is evaluated through local sensitivity analysis. Raw
6 material-specific parameters and non-significant parameters are removed from the parameter set targeted
7 for identification. Furthermore, it is shown that the model outputs are highly sensitive to the peel specific
8 parameters, which inherently vary from peel-to-peel. This impact was further assessed through an
9 uncertainty analysis, which quantified the variability of model predictions due to the raw material
10 parameter uncertainty for three different types of fruit. The model exhibits a good general depiction of the
11 extraction phenomena. Major operating variables, i.e., temperature, pH and batch time, are optimized in a
12 deterministic manner for each fruit to maximize the final pectin concentration while satisfying given
13 requirements. Based on this, a robust optimization strategy is examined to design an optimal operation
14 strategy in consideration of the inherent uncertainty of feedstock and the desired product quality.

15 **Keywords: Pectin; Solid-liquid extraction; Model-based optimization; Model analysis**

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