

**Kinetika Kristalisasi Dan Analisis Eksergi Minuman Serbuk Instan
Temulawak-Daun Sirsak Menggunakan Gula Kelapa**
*(Crystallization Kinetics And Exergy Analysis Of Instant Powder Drink Of
Temulawak - Soursop Leaf Using Coconut Sugar)*
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ABSTRACT

Temulawak and soursop leaves are biopharmaceutical commodities that are highly perishable due to their high moisture content, thus requiring appropriate postharvest handling and further processing methods. One form of processing is the production of instant powdered beverages based on coconut sugar through the stages of extraction, heating, stirring, crystallization, and packaging. This study aimed to evaluate the accuracy of crystallization kinetic models, analyze exergy efficiency, and determine the optimal solution concentration. The evaluation of kinetic models was carried out using statistical indicators, including the coefficient of determination (R^2), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Bias Error (MBE), Sum of Squared Error (SSE), Akaike Information Criterion (AIC), and Schwarz Information Criterion (SIC). The study was conducted at three solution concentration levels, namely 1.170 M, 1.462 M, and 1.754 M, using an induction electric stove as the heating system. Process monitoring was performed every two minutes by measuring moisture content, solid content, total soluble solids ($^{\circ}$ Brix), and specific gravity as the basis for determining the crystal fraction.

The results showed that the 1.170 M solution reached crystallization more quickly, within 60 minutes, compared to the 1.462 M and 1.754 M solutions, which

required 66 and 76 minutes, respectively. The Gompertz model provided the best fit for the 1.170 M and 1.754 M concentrations, with R^2 values of 0.987 and 0.989, respectively, while the Avrami model was more accurate for the 1.462 M concentration, with an R^2 value of 0.990. Exergy analysis indicated a decrease in energy efficiency from 10.37% to 6.35% with increasing solution concentration. This study contributes to improving crystallization process control, selecting appropriate kinetic models, and evaluating energy efficiency, thereby supporting product quality improvement, energy efficiency, and informed decision-making in the development of herbal-based instant powdered beverages. The findings of this study are expected to serve as a technical reference for food industry practitioners and small-to-medium enterprises (SMEs) in designing efficient, standardized, and competitive herbal powder beverage production processes in the functional food market.

Keywords: *crystallization kinetics, exergy, temulawak, soursop leaves, coconut sugar, instant beverage*