

KINETIKA SIFAT FISIK, PEMBENTUKAN INTI, DAN PERTUMBUHAN KRISTAL PADA PENGOLAHAN GULA SEMUT DARI NIRA SEGAR MENGUNAKAN KRISTALISATOR *DOUBLE JACKET* BERPENGADUK TIPE VERTIKAL

INTISARI

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Gula semut merupakan hasil olahan nira palma yang diproses melalui evaporasi dan kristalisasi dengan produk akhir butiran/serbuk. Penelitian yang dilakukan merupakan pengembangan penelitian sebelumnya dengan memodifikasi alat kristalisasi gula semut. Penelitian ini bertujuan untuk menganalisis kinetika sifat fisik, pembentukan inti, dan pertumbuhan kristal pada pengolahan gula semut dari nira segar menggunakan alat kristalisator *double jacket* berpengaduk tipe vertikal.

Proses evaporasi menggunakan *pan* evaporator hingga nira kental, serta pemanasan lanjut dan kristalisasi menggunakan kristalisator *double jacket* hingga diperoleh butiran kristal. Selama proses pengolahan dilakukan pengukuran suhu, brix, dan densitas bahan. Data dianalisis menggunakan persamaan kinetika avrami dan kinetika orde 1 untuk mendapatkan konstanta proses. Laju pembentukan inti dan pertumbuhan kristal berdasarkan analisis densitas populasi. Karakterisasi produk berdasarkan kadar air, warna, rendemen, dan distribusi ukuran partikel.

Hasil penelitian menunjukkan konstanta suhu proses evaporasi sebesar $1,2-3,2 \times 10^{-1} \text{ } ^\circ\text{C}/\text{menit}$; konstanta densitas sebesar $0,86-1,2 \times 10^{-4} \text{ kg}/\text{m}^3\text{menit}$; konstanta brix sebesar $0,001-1,95 \times 10^{-4} \text{ } \%/ \text{menit}$. Konstanta suhu proses kristalisasi sebesar $2,0-5,7 \times 10^{-2} \text{ } ^\circ\text{C}/\text{menit}$; konstanta densitas sebesar $6,2-9,6 \times 10^{-3} \text{ kg}/\text{m}^3\text{menit}$. Konstanta kecepatan nukleasi sebesar $0,48-3,17 \text{ mm}/\text{jam}$; konstanta pertumbuhan kristal sebesar $3,18-9,10 \text{ jumlah kristal}/\text{jam}$; nilai rerata fineness modulus sebesar $5,24-6,55 \text{ } \mu\text{m}$; dan rerata distribusi ukuran partikel sebesar $1,12-1,39 \text{ mm}$. Karakteristik fisik gula semut memiliki kadar air sebesar $1,55-2,43\%$; rendemen sebesar $13,57-24,37\%$; dan secara umum warna gula semut adalah kuning kecoklatan.

Kata kunci: Evaporasi, gula semut, kristalisasi, pemodelan

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KINETICS OF PHYSICAL PROPERTIES, THE FORMATION OF NUCLEATION, AND CRYSTAL GROWTH IN THE PROCESSING PALM SUGAR OF FRESH COCONUT SAP USING A VERTICAL TYPE DOUBLE JACKET STIRRED CRYSTALLIZER

ABSTRACT

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Palm sugar is made from processed palm sap which has been gone through evaporation and crystallization resulted in final product of granules/powder. The research carried out is the development of previous research by modifying the crystallization machine. This research aimed to analyze the kinetics of physical properties, the formation of nucleation, and the crystal growth of palm sugar from fresh sap using a vertical stirred double jacket crystallizer.

The evaporation process was carried out on the pan evaporator until the juice is saturated, furthermore the heating and crystallization was established using a double jacket crystallizer until crystal granules were obtained. During the process, the temperature, brix and density were measured. Data were analyzed using avrami kinetic equations and first order kinetics to obtain the process constants. The formation of nucleation and crystal growth were obtained based on population density analysis. Product characterization was measured based on moisture content, color, yield, and particle size distribution.

The results showed that the temperature constant from the evaporation process was $1.2-3.2 \times 10^{-1} \text{ } ^\circ\text{C}/\text{minute}$; density constant of $0.86-1.2 \times 10^{-4} \text{ kg}/\text{m}^3\text{minute}$; the brix constant is $0.001-1.95 \times 10^{-4} \text{ } \%/ \text{minute}$. The temperature constant in the crystallization process was $2.0-5.7 \times 10^{-2} \text{ } ^\circ\text{C}/\text{minute}$; the density constant was $6.2-9.6 \times 10^{-3} \text{ kg}/\text{m}^3\text{minute}$. The nucleation rate constant was $0.48-3.17 \text{ mm}/\text{hour}$; crystal growth constant of $3.18-9.10 \text{ number of crystal}/\text{hour}$; the average value of the fineness modulus is $5.24-6.55 \text{ } \mu\text{m}$; and the average particle size distribution is $1.12-1.39 \text{ mm}$. The physical characteristics of palm sugar have a water content of $1.55-2.43\%$; yield of $13.57-24.37\%$; and in general the color of palm sugar was brownish yellow.

Keywords: Crystallization, evaporation, modeling, palm sugar

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