# APLIKASI SPEKTROSKOPI *FOURIER TRANSFORM NEAR-INFRARED* (FT-NIR) UNTUK DETEKSI PENAMBAHAN GULA SEMUT KELAPA DAN GULA MERAH BUBUK PADA GULA SEMUT AREN

## INTISARI

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Gula semut kelapa (GSK) dan gula merah bubuk (GMB) terbuat dari nira kelapa (*Cocos nucifera*), sedangkan gula semut aren (GSA) terbuat dari nira aren (*Arenga pinnata Merr*). GSA memiliki harga jual lebih tinggi dibandingkan GMB dan GSK, sehingga memungkinkan terjadinya pencampuran gula kelapa ke dalam gula aren. Dalam penelitian ini GSA sebagai bahan utama, sedangkan GMB dan GSK sebagai bahan pencampur. Penelitian ini bertujuan untuk mendeteksi penambahan bahan pencampur GSK dan GMB ke dalam bahan utama GSA menggunakan spektroskopi FT-NIR dengan dua metode kemometrika yaitu *partial least square regression* (PLSR) dan *principal component analysis* (PCA). Konsentrasi penambahan bahan campuran dimulai dari 0 sampai 90%. Spektrum reflektansi diambil menggunakan NIRFlex N-500 with Solids Cell N500-001, Buchi, Switzerland pada bilangan gelombang 4000-10000 $cm^{-1}$. Sampel sebanyak 154 spektra yang terdiri dari 77 spektra campuran (GMB dan GSA) dan 77 spektra (GSK dan GSA). Setiap kelompok sampel spektra, dibagi menjadi dua kelompok dengan 60% data (52 spektra) sebagai data kaliberasi dan 30% data (25 spektra) sebagai data prediksi. Spektra dianalisis menggunakan Unscrambler X versi 10.4 menggunakan spektra asli dan spektra hasil pre-proses data diantaranya $1^{st}$ *Savitzky Golay Derivative*, *Normalization*, *Standard Normal Variate* (SNV), *Multiplicative Scatter Correction* (MSC), dan *Baseline*. Hasil PLSR terbaik diperoleh dengan metode $1^{st}$ *Savitzky Golay Derivative* dengan koefisien determinasi kalibrasi ($Rc^2$) sebesar 0.97 dan *root mean square error of caliberation* (RMSEC) sebesar 5.36%, koefisien determinasi prediksi ($Rp^2$) sebesar 0.85 dan *root mean square error of prediction* (RMSEP) sebesar 11.91% untuk deteksi penambahan GSK ke dalam GSA. Sedangkan untuk pencampuran GMB diperoleh dengan metode MSC dengan $Rc^2$ sebesar 0.92 dan RMSEC sebesar 8.85% dan menghasilkan $Rp^2$ sebesar 0.92 sedangkan RMSEP sebesar 8.84%. Penelitian ini mampu mengelompokkan sampel berdasarkan konsentrasi bahan pencampur menjadi 3 kelompok yaitu tingkat penambahan rendah (0-20%), sedang (30-60%), dan tinggi (70-100%). Hasil PCA terbaik untuk mengelompokkan sampel berdasarkan konsentrasi bahan pencampur GSK ke dalam GSA diperoleh dengan metode $1^{st}$ *Savitzky Golay Derivative* menggunakan PC3 dan PC6 dengan total varian PC sebesar 98%. Sedangkan untuk pencampuran GMB diperoleh dengan metode MSC menggunakan PC5 dan PC6 dengan total varian PC sebesar 99%.

Kata kunci: FT-NIR; gula semut aren, kelapa; gula merah bubuk; PLSR;PCA.

# APPLICATION OF FOURIER TRANSFORM NEAR-INFRARED (FT- NIR) SPECTROSCOPY FOR DETECTION OF ADDITION COCONUT SUGAR AND BROWN SUGAR IN PALM SUGAR

## ABSTRACT

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Coconut sugar (GSK) and powdered brown sugar (GMB) are made from coconut sap (*Cocos nucifera*), while palm sugar (GSA) is made from palm sap (*Arenga pinnata Merr*). Usually palm sugar has a higher selling price than palm sugar and powdered brown sugar made from coconut sap, thus allowing the mixing of coconut sugar into palm sugar due to economic reason. In this study, palm sugar was categorized as the main ingredient, while palm sugar and powdered brown sugar made from coconut were categorized as additive ingredients. This study aims to detect the addition of GSK and GMB admixtures into the main ingredients of GSA using FT-NIR spectroscopy and using two chemometric methods, namely partial least square regression (PLSR) and principal component analysis (PCA). The concentration of addition of mixed materials vary from 0 to 90%. The reflectance spectrum was taken using a NIRFlex N-500 with Solids Cell N500-001, Buchi, Switzerland at a wave number of 4000-10000 cm-1. The sample consisted of 154 spectra consisting of 77 mixed spectra (GMB and GSA) and 77 spectra (GSK and GSA). Each group of spectral samples was divided into two groups, i.e. 60% data (52 spectra) used as calibration and 30% data (25 spectra) used as prediction. Spectra were analyzed using Unscrambler X version 10.4 using original and pre-processed spectra data including 1st Savitzky Golay Derivative, Normalization, Standard Normal Variate (SNV), Multiplicative Scatter Correction (MSC), and Baseline. The best PLSR results were obtained using the 1st Savitzky Golay Derivative method with a calibration determination coefficient ($Rc^2$) of 0.97 and a root mean square error of calibration (RMSEC) of 5.36%, a prediction determination coefficient ($Rp^2$) of 0.85 and a root mean square error of prediction (RMSEP). ) of 11.91% for detection of addition of GSK into GSA. Meanwhile, for mixing GMB obtained by MSC method with $Rc^2$ of 0.92 and RMSEC of 8.85% and yielding $Rp^2$ of 0.92 while RMSEP of 8.84%. This study was able to classify samples based on the concentrations of the additive material into 3 groups, namely low (0-20%), medium (30-60%), and high (70-100%). The best PCA results for grouping samples based on the additive concentration of GSK into GSA was obtained using the 1st Savitzky Golay Derivative method using PC3 and PC6 with a total PC variance of 98%. Meanwhile for the addition of GMB was obtained by MSC method using PC5 and PC6 with a total PC variant of 99%.

Keywords: FT-NIR; palm sugar, coconut; powdered brown sugar; PLSR; PCA.