

**APLIKASI SPEKTROSKOPI *VISIBLE-NEAR INFRARED* (VIS-NIR) DAN
TEKNIK PEMODELAN MULTIVARIAT UNTUK PREDIKSI KADAR
AIR PADA JAHE GAJAH (*Zingiber officinale Roscoe*)**

INTISARI

Oleh:

Raden Roro Azizah Isti Hardikawati

(21/474316/TP/13092)

Penelitian ini bertujuan untuk mengembangkan model prediksi kadar air pada jahe gajah (*Zingiber officinale Roscoe*) secara cepat dan non-destruktif menggunakan spektroskopi Visible-Near Infrared (VIS-NIR) dan teknik pemodelan multivariat. Sebanyak 69 sampel jahe gajah segar dari pasar Kulon Progo digunakan, dengan total 192 data untuk spektra VIS-NIR dan 207 data untuk spektra NIR setelah tiga kali ulangan pengukuran. Kadar air referensi ditentukan menggunakan metode termogravimetri, dengan rata-rata kadar air sebesar 83,43% untuk sampel VIS-NIR (rentang 74,53% – 93,36%) dan 83,40% untuk sampel NIR (rentang 72,12% – 94,98%).

Analisis spektral menunjukkan bahwa baik spektra VIS-NIR (470,19–973,94 nm) maupun NIR (954,17–1637,03 nm) mampu merepresentasikan karakteristik kandungan air. Spektra VIS-NIR mentah menunjukkan puncak reflektansi di sekitar 910 nm (gugus O–H), sementara spektra NIR menunjukkan puncak intensitas pada 1200 nm (C–H 2nd overtone) dan 1405 nm (O–H 1st overtone), serta penurunan intensitas di sekitar 1140 nm setelah praproses Savitzky–Golay orde pertama (SG1) yang mengindikasikan serapan air.

Penerapan *Principal Component Analysis* (PCA) efektif dalam membedakan kadar air jahe gajah. Metode praproses *range normalization* memberikan hasil terbaik untuk PCA pada kedua rentang spektral, dengan *score plot* menunjukkan pemisahan kategori kadar air yang jelas dan *loading plot* mengidentifikasi panjang gelombang penting terkait kandungan air.

Metode *Partial Least Squares Regression* (PLSR) berhasil dikembangkan untuk prediksi kadar air. Untuk spektra VIS-NIR, metode praproses *max normalization* menunjukkan performa terbaik dengan nilai $R^2P = 0,93$, $RMSEP = 0,84$, dan $RPD = 3,91$. Sementara itu, untuk spektra NIR, metode SG1 memberikan hasil paling unggul dengan $R^2P = 0,89$, $RMSEP = 1,23$, dan $RPD = 2,97$. Analisis koefisien beta mengidentifikasi panjang gelombang yang relevan dengan serapan air. Secara keseluruhan, model PLSR terbukti akurat dan efektif untuk prediksi kadar air jahe gajah secara non-destruktif, dengan *max normalization* dan SG1



direkomendasikan sebagai metode praproses terbaik untuk masing–masing rentang spektral.

Kata kunci: Jahe gajah, Kadar air, Spektroskopi VIS–NIR, PCA, PLSR, Non–destruktif.

**APPLICATION OF VISIBLE–NEAR INFRARED (VIS-NIR)
SPECTROSCOPY AND MULTIVARIATE MODELLING TECHNIQUES
FOR PREDICTION OF MOISTURE CONTENT IN GAJAH GINGER
(*Zingiber officinale* Roscoe)**

ABSTRACT

By:

Raden Roro Azizah Isti Hardikawati

(21/474316/TP/13092)

This study aims to develop a rapid and non-destructive model for predicting moisture content in *gajah* ginger (*Zingiber officinale* Roscoe) using Visible–Near Infrared (VIS–NIR) spectroscopy and multivariate modeling techniques. A total of 69 fresh *gajah* ginger samples from the Kulon Progo market were used, yielding 192 data points for VIS–NIR spectra and 207 data points for NIR spectra after three replicate measurements. Reference moisture content was determined using thermogravimetry, with an average moisture content of 83.43% for VIS–NIR samples (range 74.53%–93.36%) and 83.40% for NIR samples (range 72.12%–94.98%).

Spectral analysis showed that both VIS–NIR (470.19–973.94 nm) and NIR (954.17–1637.03 nm) spectra were capable of representing water content characteristics. Raw VIS–NIR spectra showed reflectance peaks around 910 nm (O–H group), while the NIR spectra show intensity peaks at 1200 nm (C–H 2nd overtone) and 1405 nm (O–H 1st overtone), as well as a decrease in intensity around 1140 nm after first–order Savitzky–Golay preprocessing (SG1), indicating water absorption.

The application of Principal Component Analysis (PCA) is effective in distinguishing the water content of *gajah* ginger. The range normalization preprocessing method yields the best results for PCA in both spectral ranges, with the score plot showing clear separation of water content categories and the loading plot identifying important wavelengths related to water content.

The Partial Least Squares Regression (PLSR) method was successfully developed for water content prediction. For VIS–NIR spectra, the max normalization preprocessing method showed the best performance with $R^2P = 0.93$, $RMSEP = 0.84$, and $RPD = 3.91$. Meanwhile, for NIR spectra, the SG1 method provided the best results with $R^2P = 0.89$, $RMSEP = 1.23$, and $RPD = 2.97$. Beta coefficient analysis identified the wavelengths relevant to water absorption.

Overall, the PLSR model proved accurate and effective for non-destructive prediction of *gajah* ginger moisture content, with max normalization and SG1 recommended as the best preprocessing methods for each spectral range.

Keywords: *Gajah* ginger, Moisture content, VIS–NIR spectroscopy, PCA, PLSR, Non-destructive.