



Evaluation of Mung Bean (*Vigna radiata*) Sprout and Quantification of Ascorbic Acid Content Using Near-Infrared Spectroscopy and Aquaphotomics

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Mung bean is a leguminous crop with distinct disadvantages in its consumption, namely its anti-nutrient components. Processing techniques especially sprouting process is one of the solution for better nutritional quality, while producing important components such as ascorbic acid. Production of mung bean sprout in large scale does not have definite standard for the sprouting process, thus there is a need for rapid and effective quality check for mung bean sprout. Near-infrared spectroscopy (NIRS) as a sensitive technique is proposed to describe the quality parameters (water content, pH, and ascorbic acid) of mung bean sprout relative to the conventional analytical methods. Mung bean was sprouted for 120 h in 6 h interval, analyzed using conventional methods and NIRS instrument, and evaluated using statistical methods, chemometrics approach (principal component analysis (PCA), discriminant analysis (DA), partial least squares regression (PLSR)), and aquaphotomics analysis by calculating an aquagram in the range of 1300-1600 nm interval. Scanning the bean sprout extract showed classification and 100% accuracy of prediction using DA. The PLSR model developed for quality parameters showed dependable R^2CV of above 0.95 with RMSECV ranging from 0.02%-0.05%. The aquagram showed a trend of strong bound water forming during the sprouting, peaking in 1462, 1477, 1489, and 1513 nm.

Keywords: germination; chemometrics; water spectral pattern

Introduction

Mung bean (*Vigna radiata*) is one of the most significant crop in Asia, but it contains anti-nutrient components in the form of phytate, which reduce the bioavailability of mineral in its consumption [1]. Some processing techniques, especially sprouting have been proven to reduce anti-nutrient components, and increase the quality of mung bean. Sprouting process also reduce flatulence-related sugar, and produce phenolic components and vitamins; especially ascorbic acid [2]. Rapid evaluation of mung bean sprout quality and monitoring of sprouting process over time would prove an objective means of assessment of one of the most important sprouting parameter: time. As water changes and organic acid formation in bean sprout product happened in the function of time, developing rapid analysis and continuous monitoring technique for industrial scale is essential. The use of NIRS within 700-2500 nm interval has been reported to be able to classify bean sprout based on sprouting time for quality purpose [3]. However, the complex aqueous system of the mung bean sprout suggests that water matrix coordinates plays a key role at the molecular level. It is therefore, necessary to understand the changes in the hydrogen bonding network of water molecules occurring in the mung bean during sprouting. [4]. The usage of aquaphotomics is suitable, due to the appropriate sample preparation from the conventional analytical techniques. The objective of this study was to understand the possibility of rapid quality check and observation of mung bean sprouting process through NIRS and aquaphotomics and test the potential of NIR and aquaphotomics to make a correlative model for quality parameters evaluation and ascorbic acid.

Materials and Methods

The bean was sprouted for 120 h in 6 h interval. The bean was soaked with distilled water for 12 h, and rinsed every 12 h. The sprouting was done on cellulose paper in an incubator of a constant temperature (35°C). Grown bean sprout is crushed, mixed with water (1:2 ratio), and filtered with filtration paper. This sample liquid is called the bean sprout extract, used for NIRS scanning. Water content determination was based on AOAC

method, pH and conductivity determination utilized benchtop instrument, and ascorbic acid determination was based on direct redox titration using iodine solution. NIRS measurement was done using DLP NIRScanNano instrument (Texas Instrument, Dallas, Texas, United States) in transmission mode using a quartz cuvette of 1 mm path length. The NIRS scanning was done in triplicate and three consecutive scans. Result from conventional analytical techniques were analyzed using descriptive statistics and one-way ANOVA, followed by differentiation test. The spectral data was analyzed using chemometrics methods (PCA and LDA), correlative model was made using PLSR technique and n-fold cross-validation technique, and aquagram was made from spectral data in the first O-H overtone range (1300-1600 nm).

Results

The aquagram showed a trend of strong bound water formation during germination (Figure 1a.), and its comparison with the ascorbic acid standard (Figure 1b.). PLSR model was made from the spectral data of bean sprout extract, and predicted quality parameters (water content, germination time, and ascorbic acid content). The ascorbic acid content was analyzed for independent prediction of sample with unknown concentration of ascorbic acid. The prediction result was then compared with conventional technique (Figure 1d.)

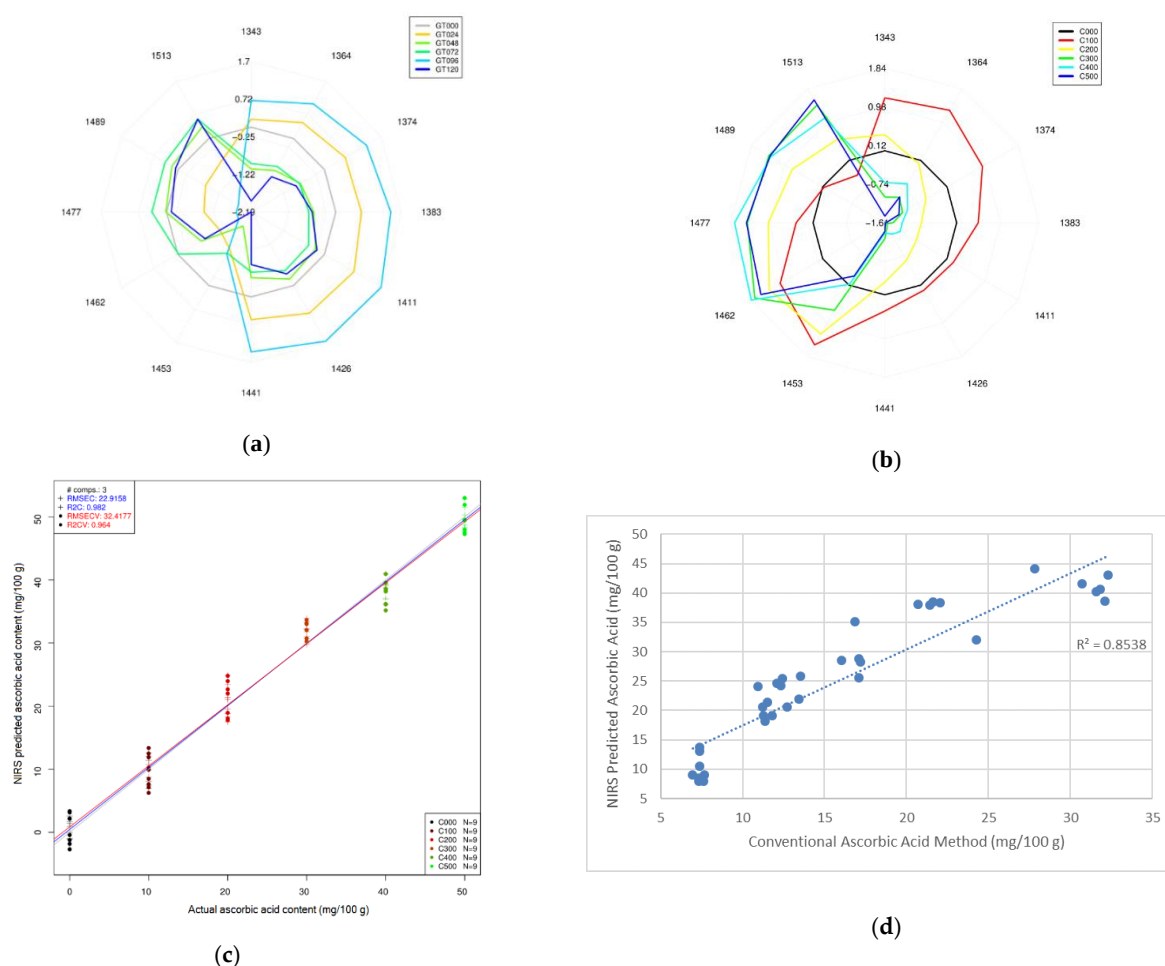


Figure 1. Aquagram (1300-1600 nm) and PLSR plot, after Savitzky-Golay smoothing (SG) and standard normal variate (SNV) pretreatment of the spectra: (a) Aquagram plot of sprouted mung bean sprout with 24-hour interval; (b) Aquagram plot of ascorbic acid (0-500 mg/100 g); (c) Regression of ascorbic acid prediction; (d) Ascorbic acid content plot of NIR predicted values against conventional technique result.

Conclusions

The result from the experiment showed NIR reliability for mung bean sprout quality evaluation, where it prominently predicted water content of mung bean sprout and its sprouting time parameter. Further prediction

of ascorbic acid showed satisfactory prediction capability, as well as similarity to the prediction by conventional techniques. PLSR regression models showed high accuracies even after cross-validation (R2CV) and low errors (RMSECV) for predicting water content, germination time and ascorbic acid. Aquagrams from aquaphotomics evaluations showed similarity in trend. Both mung bean sprout and ascorbic acid initially showed the abundance of weaker bonded water molecules (first and fourth quadrant), and stronger bonded water (1513 nm) was observed under higher concentration of ascorbic acid, and longer germination time. This indicated the potential of ascorbic acid detection for complex food matrixes on a sub-percent level.

References

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