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Prediction of cooking time for soaked and unsoaked dry beans (*Phaseolus vulgaris L*) using hyperspectral imaging technology

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The cooking time of dry beans varies widely by genotype and is also influenced by the growing environment, storage conditions, and cooking method. Since this trait is influenced by many factors and dynamic during post-harvest storage, high throughput phenotyping methods to assess cooking time would be useful to breeders interested in developing cultivars with desired cooking time and for food processors looking to optimize operations. The objective of this study was to evaluate the performance of hyperspectral imaging (HYPERS) technology for predicting dry bean cooking time. Fourteen dry bean (*Phaseolus vulgaris L.*) genotypes from five markets classes and with a wide range of cooking times were grown in five environments over two years. Cooking time was measured as the time required for 80% of 25 stainless steel piercing rods to pass through pre-soaked or unsoaked bean seeds. Hyperspectral images were taken from whole dry seeds and partial least squares regression models based on the extracted hyperspectral image features were developed to predict: Water uptake; cooking time of soaked beans; and cooking time of unsoaked beans. Relatively good predictions of water uptake were obtained, as measured by the correlation coefficient for prediction (R_{pred}=0.789) and standard error of prediction (SEP=4.4%). Good predictions of cooking time for soaked beans (ranging between 19.9-95.5 min) were achieved giving R_{pred}=0.886 and SEP=7.9 min. The prediction models for the cooking time of unsoaked beans (ranging between 80-147 min) were less robust and accurate (R_{pred}=0.708, SEP=10.6 min). This study demonstrated that hyperspectral imaging technology has potential for providing a nondestructive, simple, fast and economical means for estimating the water uptake and cooking time of dry beans. Moreover, totally independent set of 110 similar dry bean samples confirmed the suitability of the technique for predicting cooking time of soaked beans after updating the PLS model with 20 of the new samples, giving R_{pred}=0.872 and SEP=3.7 min. However, due to the genotypic and phenotypic variability of water absorption and cooking time in dry beans, periodical updates of these prediction models with more samples and new bean accessions, as well as testing other multivariate prediction methods are needed for further improving model robustness and generalization

Biography

Mendoza has experience in the development of optical sensing techniques for the rapid, economic and objective quality assessment of raw and processed foods and particularly bean phenotypes. He has published more than 45 reserach papers in ISI journals, and over the last 8 years he worked as Research Agricultural Engineer for ARS/USDA at Michigan State University. There, his research was focused in the implementation of machine vision, Vis/NIR spectroscopy and hyperspectral imaging approaches for automatically predict end use processing quality traits from raw dry bean seeds. End use characteristics involving appearance, color, textural attributes, and cooking time were his main goals. Currently, he works in the Global Advance Development Food Preservation at AB Electrolux, Stockholm, Sweden.

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