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Optimising the Use of Near Infrared Reflectance Spectroscopy (NIRS) to Predict Nutritional Quality in Cowpea (*Vigna unguiculata*) Leaves for Human Consumption

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Abstract

In eastern Africa, reliable laboratory services are scarce and relatively expensive. Near infrared reflectance spectroscopy (NIRS), as a non-destructive, rapid mass screening technique, has shown an impressive throughput of analyses, once robust calibration equations are developed. Legume leaves like those of cowpea (*Vigna unguiculata*) are very popular as leafy vegetables in eastern Africa. A calibration equation for crude protein (CP) was developed within the framework of the ProNIVA project (Promotion of Neglected Indigenous Leafy and Legume Vegetable Crops for Nutritional Health in eastern and southern Africa) largely financed by the German BMZ. The available equation was based on 107 samples selected from a broad spectrum of accessions from Tanzanian environments. The present study addresses the optimization of NIRS to perform analysis of nutritional parameters (*i.e.*, CP) in a range of cowpea accessions grown under different experimental environmental conditions in East Africa and compare them with locally grown varieties in farmers' fields and those sold in selected Kenyan and Tanzanian markets. In total, 561 samples representing a wide range of environments in Tanzania and Uganda as well as genotypic variation (10 accessions in addition to about 10 landraces) were scanned using a FOSS 6500 spectrophotometer. Sample processing involved sun-drying and freeze-drying, while milling was done using a standard lab grinder and a coffee grinder. 167 samples were selected for reference analysis and to expand the existing calibration set of 107 samples, based on their spectral characteristics, with a 26 PCA-Factor-model using WinISI II version 1.50 software. The obtained calibration set of 274 samples was expanded with a further 20 samples (10 with the highest and 10 with the lowest CP content), which were selected from the remaining 394 samples. A modified partial least-squares (PLS) regression with cross validation was used to confirm the equations and identify possible spectral outliers (H-value >3, where H is the Mahalanobis distance). The calibration equation obtained permits determination of CP content in a broad range of cowpea leafy vegetable originating from typical East African agro-environments. This will save resources for laboratory analysis while obtaining reliable values for nutritional quality of cowpea leaves.

Keywords: African leafy vegetables, calibration equation, cowpea, crude protein, eastern and southern Africa, multi-location trial, NIRS, nutritional quality, *Vigna unguiculata*