Standardizing the near-infrared spectroscopy (NIRS) for low-cost high throughput assessing of phytate and polyphenol contents in sorghum grain

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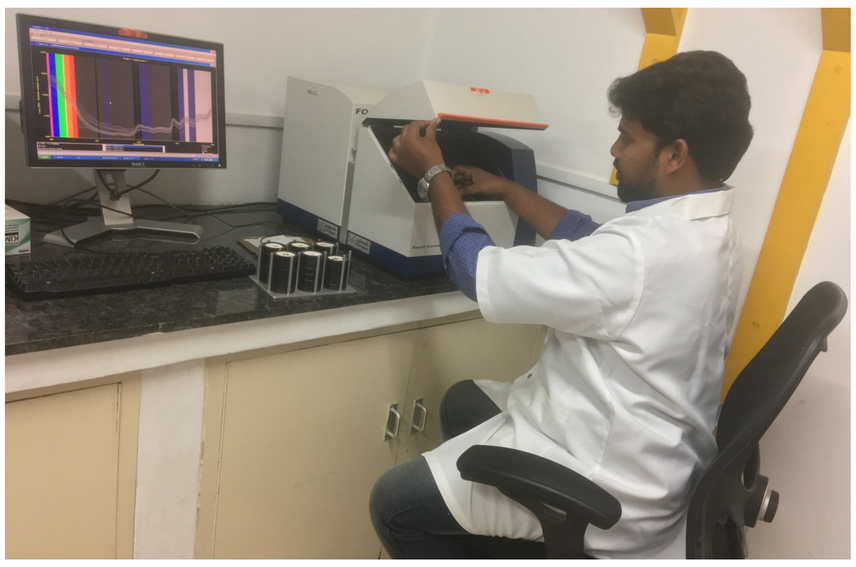
Abstract



Sorghum is a major food, feed and fodder crop globally and a rich source of protein, minerals and vitamins. While biofortification for increased grain Fe and Zn concentration is being mainstreamed in sorghum breeding programs, potential phytates and polyphenol content in sorghum grains is a concern. Phytate and polyphenols strongly chelate minerals including Fe and Zn, and thereby reducing their bioavailability. Consequently biofortification and concomitant reduction of phytate content emerged as the new strategy for increasing micronutrient bioavailability in sorghum. To identify germplasm with low phytate and phenol levels, screening of a large number of diverse samples is required. While wet chemistry screening methods are slow, expensive, and laborious, Near Infrared Spectroscopy (NIRS) could provide a simple, low-cost and high throughput method. The objective of this study was twofold: first to study the variation in polyphenols and phytate levels in high grain Fe and Zn concentration lines to increase the micronutrient bioavailability in a diverse set of sorghum genotypes and; second to assess the use of NIRS in predicting these compounds in sorghum. A calibration curve was developed to estimate each compound and validated with an independent validation set. Calibration curve correlations for phytate and polyphenols were R^2_{cal}= 0.95 and 0.90, respectively. Correlations between NIRS-predicted values and reference values in the validation set were for phytate R^2_{val} = 0.88) and for polyphenols R^2_{val} = 0.79). These indicated that sufficient variation (from 0.57 to 0.96 g/100g and 7.10 to 32.07 mg/g for phytate and polyphenols, respectively. These findings provided a solid base for developing NIRS calibration curves which could be used for rapid determination of Phytate and polyphenols concentrations in whole grain sorghum.

Key Words: Sorghum, phytate, polyphenols, near-infrared spectroscopy.

Objectives

- To Develop and validate calibration model of NIRS for polyphenols and Phytate content in sorghum grain.
- To study the variation in polyphenols and Phytate levels in sorghum.

Methodology

- 591 samples were taken from sorghum mini-core line and CMS hybrids.
- Seeds were grounded and sieved through 1 mm nylon mesh.
- Samples were filled in 50mm diameter round cups and filled cups were scanned twice by NIRS (FOSS XDS Rapid content analyzer) and spectra were collected between 400 and 2500 nm.
- Polyphenols content was estimated by the method of Malik and Singh, (1980).
- Phytic acid was determined by employing the method of Haug and Lantgsch, (1983).
- The data were collected from wet lab and NIRS predicted values were analysed with Software Win ISI 4.6.3.

Results

- Wet lab data of 60 samples for phytate were split in 30 samples for calibration and 30 samples for validation of model.
- Wet lab data 80 samples of polyphenols were split into 40 for calibration and 40 for validation of model.
- The coefficient of determination (R^2) value for calibration and validation for phytate were 0.95 (SE 0.023) and 0.88 (SE 0.046).
- R^2 values for pooled set (60) for global model was 0.98 (SE 0.016).
- Relatively low R^2 value of 0.90 for calibration and 0.79 for validation was observed for Polyphenols (Figure 2).
- R^2 values for pooled set (80) for global model was 0.94 (SE 1.26).

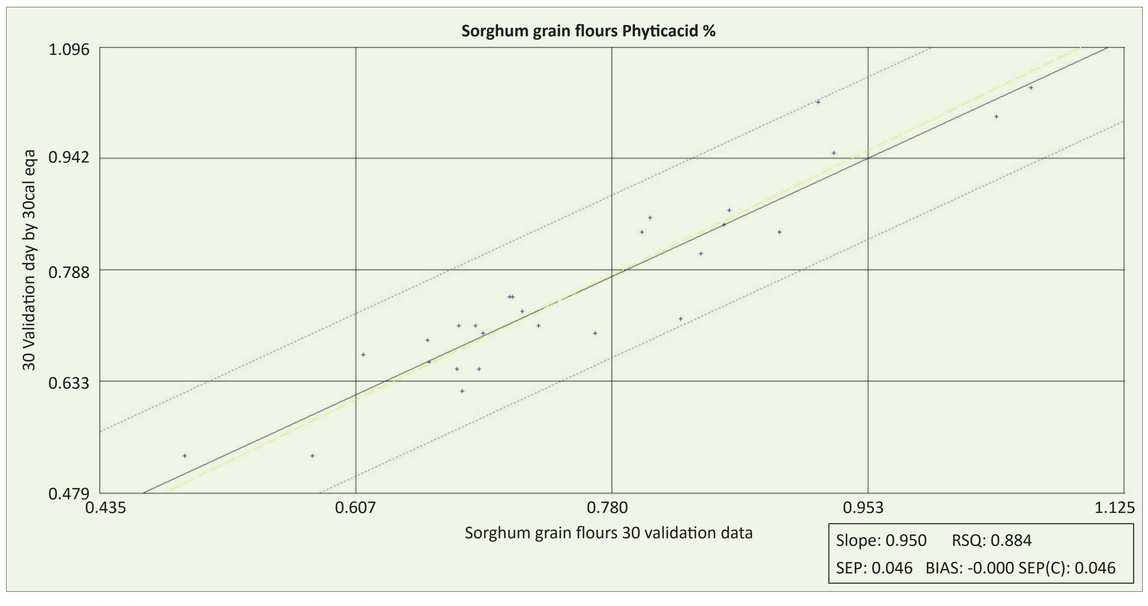


Figure 2: Polyphenols validation.

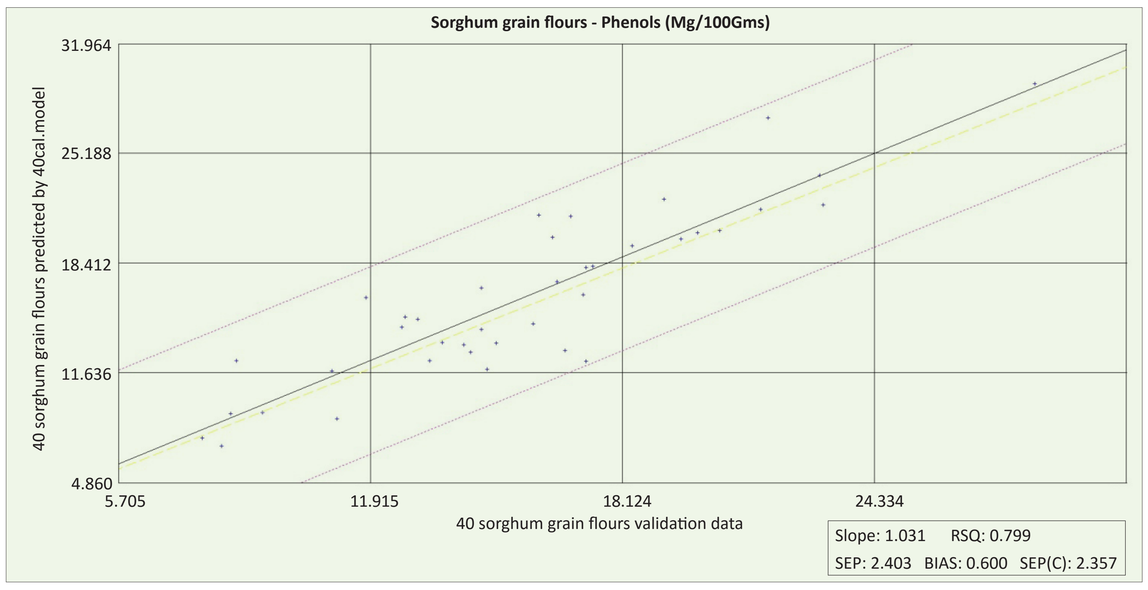


Figure 1: Phytate validation.

Conclusion

- NIRS spectroscopy can predict polyphenols and phytate content with high accuracy, rapid tool and will make analysis of these traits much more affordable.

References

Haug, W. and Lentzsch, H.J. 1983. Sensitive method for the rapid determination of Phytate in cereals and cereal products. Food Sci. Agri., 34: 1423-1426.

Malik, C.P. and Singh, S.B. 1980. In: Plant enzymology and histoenzymology, Kalyani Publishers, New Delhi, p. 53.

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