THE APPLICABILITY OF NIRS FOR ESTIMATING MULTIPLE SEED QUALITY COMPONENTS IN ETHIOPIAN MUSTARD

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ABSTRACT

A mutagenesis programme was carried out in order to increase variability in *Brassica carinata* quality components. In this programme, several thousands of samples had to be analyzed in a short time for as many constituents as possible. Near-Infrared Reflectance Spectroscopy (NIRS) technique has made possible to do this with low cost and a good level of accuracy for screening purposes. Furthermore, this technique is non-destructive (whole grains are analyzed) and allows to analyze small samples. NIRS has successfully been used for estimating protein and oil contents, seed colour, specific weight, thousand seeds weight, total glucosinolates, erucic acid and other major fatty acids. Best calibrations were obtained using Modified Partial Least Squares method with second derivative transformation of spectra.

INTRODUCTION

Ethiopian mustard (*Brassica carinata* Braun) is cultivated as oilseed in the Indian subcontinent and Ethiopia. Previous works have made evident the interest of this species as a potential crop in dry climate areas, like Southern Spain, due to its high yield and drought tolerance (Fernández-Martínez and Domínguez, 1982; Fereres et al., 1983). A previous step for the introduction of *Brassica carinata* in these areas is the improvement of its nutritional characteristics, specially the reduction of erucic acid and glucosinolates levels.

Mutagenesis has been used successfully to develop mutants in many species. In *Brassica* species, mutants for fatty acids and glucosinolates have been obtained (Khalatkar and Indurkar, 1991, Auld et al., 1992). Mutagenesis involves the analysis of many samples in a short time, between harvesting and sown (3-4 months in Southern Spain). As mutagenesis can affect several characters, it is very important to analyze as many components as possible. Near Infrared Reflectance Spectroscopy is a fast, non destructive technique, developed in the 1950's, that allows to analyze several components simultaneously with a low cost. These characteristics make NIRS an optimal technique for screening of plants derived from mutagenesis.

For Rapeseed, Near-Infrared Reflectance Spectroscopy has been used to estimate oil and protein, glucosinolates, oleic and erucic acids (Reinhardt, 1991).

The present study describes the accuracy of NIRS in the estimation of a wide range of seed quality components in *Brassica carinata*: protein, oil, specific weight, thousand seed weight, seed colour, glucosinolates, palmitic, oleic, linoleic, linolenic, gadoleic and erucic acids.

EXPERIMENTAL

1182 M2 and 10353 M3 individual plants derived from EMS mutagenesis were analyzed from 400 to 2500 nm in a Near Infrared Reflectance Spectroscopy instrument (NIR Systems 6500, Servicio Centralizado NIRS, Universidad de Córdoba). Center samples and Select samples algorithms (Infrasoft International) were applied for outlier detection and sample selection in M2 population. 110 samples were selected and analyzed for oil (Nuclear Magnetic Resonance), protein (Dumas), glucosinolates (Pd-glucosinolate complex method), fatty acids (Gas Chromatography). Specific weight and thousand seeds weight were also calculated. For colour estimation, a factorial analysis including wavelengths from 400 to 700 nm was carried out, and the values of factor 1 were used as an indirect measure of seed colour. Calibrations were obtained for all these characters.

M3 samples were estimated with previous calibrations. With the values obtained, sets of calibration and validation were selected for each component, covering all the range of variability. For glucosinolates calibration, several samples of *B. napus* with low glucosinolates content were also included. These sets were analyzed in laboratory and calibrations and validations were performed. For calibration, the best results were obtained with Modified Partial Least Squares and second derivative of spectra. Cross validation was used for selecting the optimal number of terms. Tables 1 and 2 show the ranges in the calibration sets and the parameters of calibration and validation respectively.

Table 1. Mean, standard deviation and ranges in the calibration sets

Component	n	Min. value	Max. value	Mean	S.D.
Oil (%)	60	21.29	49.07	37.49	6.32
Protein (%)	47	16.20	35.01	26.08	3.91
Specific weight (g/l)	60	261.94	675.75	595.31	110.35
1000 seeds weight (g)	60	1.09	6.08	2.931	0.836
Colour (factor 1)	78	-1.78	2.58	0.33	1.01
Glucosinolates (μmol/g)	56	38.29	275.84	171.99	59.57
Palmitic acid (% oil)	60	4.07	10.30	6.18	1.34
Oleic acid (% oil)	61	4.59	20.94	10.44	4.12
Linoleic acid (% oil)	62	8.54	29.66	21.01	4.18
Linolenic acid (% oil)	62	4.9	21.49	15.05	3.31
Gadoleic acid (% oil)	60	2.78	13.70	6.84	2.96
Erucic acid (% oil)	62	14.67	42.65	30.63	7.78

Table 2. Parameters of calibration and validation

	CALIBRATION				VALIDATION	
Component	SEC	R2	SECV	n	SEP	r2
Oil	0.328	0.997	0.736	50	0.68	0.99
Protein	1.062	0.934	1.626	16	1.70	0.89
Specific weight	12.579	0.987	44.703	50	37.61	0.92
1000 seeds weight	0.196	0.946	0.434	50	0.530	0.72
Colour	0.160	0.98	0.210			
Glucosinolates	11.320	0.965	20.607	56	16.24	0.93
Palmitic acid	0.550	0.832	0.770	61	0.91	0.58
Oleic acid	1.336	0.895	1.848	62	2.84	0.55
Linoleic acid	0.992	0.944	2.551	62	2.46	0.67
Linolenic acid	0.473	0.980	1.340	62	1.75	0.71
Gadoleic acid	0.928	0.901	1.152	62	1.41	0.77
Erucic acid	1.426	0.966	3.153	62	3.20	0.83

SEC= Standard error of calibration; R2, r2= Coefficient of determination; SECV= Standard error of cross validation; SEP= Standard error of performance.

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