

Analysis of Wheat Varieties by Near Infrared Reflectance Spectroscopy

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Summary: Wheat is one of the most important foodstuffs. It is available in world market in different names and brands with varied quality characteristics. Different techniques are used for evaluation of quality of wheat sample; however most of these methods used in developing world like Pakistan are costly and difficult. In this study different wheat varieties were evaluated for quality characteristics in term of protein, fats and fiber, which are available as foodstuff in different ecological regions of Pakistan. These varieties are Tatar, Watan, Gandam-711, Bakhtawar-92, Fakhre-Sarhad, Bhakkar-01, Ghaznawy, Saleem-2000, Gandam-2002, Chudry-97, Inqilab-91 and Wafaq-01. The samples were evaluated for presence of total protein, fat and fiber contents by Near Infrared Spectrophotometer. Results were analyzed statistically for variance in quality parameters. Results suggest that NIR Spectroscopic tool for evaluation of quality of wheat is extremely simple and accurate and give best results for nutritional evaluation of wheat varieties.

Introduction

Near infrared reflectance (NIR) spectroscopy is a novel technology in the advance as well as in developing world. NIR spectroscopy has been used in a remarkably wide range of analytical situations. NIR methods were first developed for the rapid analysis of water, oil, and protein in grains and seeds. More recently, NIR spectroscopy has been used to identify waxy wheat [1], assess chemical pulping traits in wood [2], assess the sugar content of fruit [3], and predict the nutrients in *Eucalyptus* leaves [4]. The potentials for NIR techniques in ecology and agriculture have been reviewed by Foley, *et al.* [5].

The use of NIRS as an indirect indicator of grain yield in durum wheat grown in Mediterranean conditions was assessed. It was concluded that NIRS could be used to rank grain yield during the early generations of a breeding program, when performing yield trials is less feasible [6]. Hard red wheat was classified on using diffuse reflectance spectroscopy [7]. Delwiche [8] showed the feasibility of measuring protein content in individual wheat kernels using NIR transmittance (850-1050 nm). Abe *et al.*, [9] used the same technique but develop models using combinations of selected wavelengths. The models uses spectra averaged from four different directions yielded the least standard error of prediction, showing that

shape effects could be minimized by spectral averaging. The application of NIR spectroscopy for analysis of various agriculture and food stuff is however absent in developing countries including Pakistan. The purpose of the present study was to analyze the different wheat varieties for their quality characteristics such protein, fat and fiber on near infrared spectroscopy.

Results and Discussion

Near infrared reflectance spectroscopy (NIRS) is a diffuse reflectance technique capable of measuring the composition of different materials through spectral differences in the stretching and bending of hydrogen bonds (e.g. O-H, C-H, N-H) present in the material under study. Results regarding Near Infrared spectroscopic analysis of different Pakistani wheat varieties are given in Table- 1. All parameters like protein, fats and fiber are calculated as percentage value. Higher protein contents were observed in varieties Watan and Inqilab-91 having a value of 9.5 % (SD- 0.070; SEM-0.050; and Variance- 0.05) and 9.4 % respectively. While the lowest value was recorded for variety Ghaznawy with a value of 9.1 % protein. However there is little difference among all varieties. Higher variance level was found in Gandam-711 with value of 0.045. These results are

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Table-1: Near Infrared Spectrophotometric analysis of different wheat varieties.

S. No	Variety Name	Protein (%)				Fat (%)				Fiber (%)			
		Mean	SD	SEM	Variance	Mean	SD	SEM	Variance	Mean	SD	SEM	Variance
1	Tatara	9.25	0.070	0.050	0.005	2.2	0.000	0.000	0.000	1.65	0.070	0.0500	0.005
2	Watan	9.50	0.000	0.000	0.000	2.25	0.000	0.000	0.000	1.60	0.000	0.000	0.000
3	Gandam-711	9.25	0.212	0.150	0.045	2.2	0.000	0.000	0.000	1.70	0.000	0.000	0.000
4	Bakhtawar-92	9.2	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.75	0.070	0.050	0.005
5	Fakhrc-Sarhad	9.25	0.070	0.050	0.005	2.2	0.000	0.000	0.000	1.75	0.070	0.050	0.005
6	Bhakkar-01	9.3	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.80	0.000	0.000	0.000
7	Ghaznawy	9.1	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.75	0.070	0.050	0.005
8	Saleem-2000	9.3	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.75	0.070	0.050	0.005
9	Wafaq-01	9.2	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.70	0.000	0.000	0.000
10	Gandam-2002	9.2	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.70	0.000	0.000	0.000
11	Chudry-97	9.3	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.80	0.000	0.000	0.000
12	Inqilab-91	9.4	0.000	0.000	0.000	2.2	0.000	0.000	0.000	1.65	0.070	0.050	0.005

in similar accord with our previous study [10]. Generally grain protein content in wheat varies between 8 and 17 percent, depending on genetic make-up and on external factors associated with the crop, however the protein contents in wheat measured by NIR Spectroscopy has been shown to be in the range of 10-19 % [11]. Thus our value is little lower than reported.

Fat is important nutritional constituents of wheat grain. It is important factor for providing storage stability to food stuff [12]. With exception of Watan variety all varieties shows a similar value of fats (2.2 %). Fiber contents recorded shows a similar trend and variance level of 0.005 were recorded for Tatara, Bakhtawar-92, Fakhre-Sarhad, Ghaznawy, Saleem-2000 and Inqilab-91. The most probable reason for the low level may be the presence of lipase or lipase activity, which is responsible for the hydrolysis of lipids in dormant wheat during storage [13].

Results suggest that NIR Spectroscopic tool for evaluation of quality of wheat is exceptionally simple and accurate and can give best results in nutritional evaluation of wheat varieties for a given population particularly in the developing countries.

Experimental

Collection of Samples:

Wheat grains of different varieties were collected from different ecological regions of

Pakistan. The wheat varieties were stored in the labeled glass bottle to ensure safety, in the Department of Biotechnology, University of Malakand, for analysis.

NIRS Analysis:

Wheat samples of different varieties were placed in cuvettes 3cm diameter sealed with aluminum and plastic foil. The absorbance spectra (log 1/ R) from 400 to 2500 nm were recorded on a monochromator NIRS System model 6500 (NIR System, Inc., Silver Springs, M D, USA) equipped with computer. The spectra were obtained with the help of computer software WinISI-II version 1.02a software (Foss NIR Systems, Infracore International). The value of protein, fat and fiber were calculated directly from the system. Samples of each wheat variety were analyzed twice and results were stored in computer for statistical analysis.

Table- 2: Near Infrared wavelengths and their association with chemical structures

Wavelength (nm)	Chemical entity
1143	Aromatic compounds, lignin
1496, 1668, 1976	Amide bond
1660-1670, 1720-1730, 2100-2200	Condensed tannin
1772	Ester bonds
1930	Water
1960, 2180	Protein
2140, 2180	Peptide bond
2088, 2410-2460	Cellulose
2380	Hemicellulose
2461	Starch

Statistical Analysis:

The reflection data of statistical analysis for mean value, standard deviation, and standard error of mean were carried out for duplicate reading of NIRS using computer software SPSS, 12.0 for windows (release on 4 September 2003, Lead Technologies, Inc) on the reflectance data in order to determine the specific wavelength bands as given in Table- 2 required to quantify wheat proteins, fats and fibers. Data were tabulated in Table- 1 along with calculated statistical parameters.

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