Method of flour evaluation news of laboratory technics

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Abstract

Wheat flour is a major commodity produced from domestic raw materials with wide use in the food industry. The quality of food wheat predetermines the characteristics of all mill products and varies depending on external conditions, especially the harvest year. Monitoring of quality characteristics according to final use is conditioned by accuracy of determination and technical solution, especially by speed of operational tests. The development of new methods and equivalent laboratory techniques is directed towards the non-destructive principle and the ability to multiple detection of quality features from one determination. The above assumptions are fulfilled by the use of instruments based on NIR spectra analysis. A new method for describing the individual components of wheat flour is the SRC profile, which allows the evaluation of both protein and carbohydrate components.

Wheat flour, SRC profile, NIR principle

Introduction

Wheat flour represents an important commodity for the food industry. It is used for direct consumption in households and for other industrial processes in production of various cereal goods.

For direct consumption, which is about 10 kg of mill products per capita and year, the traditional division of market types into semolina, flour coarse, semi-coarse and smooth is complied.

For production consumption, almost 90% of wheat and all produced rye flours, mostly smooth, are used. They can be classified according to use for types:

– smooth light, semi-light, wholemeal, bread one: for bread and pastry production
– coarse pasta one (semolina) for pasta production
– smooth pastry one (biscuit, wafer, cracker, gingerbread ones): for production of long shelf-life pastries
– special types as a recipe ingredient in different food products.

According to the Food Act, mandatory criteria for assessing the quality of wheat flours for direct and production consumption are two: a granulation and mineral compounds content. All types of mill products should have a characteristic smell, taste and colour and be free from pests. Health safety is declared by the Decree of the Ministry of Health of the Czech Republic 294/97 and 297/97 (as amended), where permissible contamination by microorganisms (fungi, coliforms) and chemical contaminants (e.g. residues of heavy metals, pesticides, etc.) is determined. The manufacturer guarantees the hygienic safety of its products.

The beginning of the evaluation of the quality of mill products is dated back to the last century. Among the oldest are methods for determining the water content by drying and wet gluten by hand washing. Currently, there are more than 20 methods based on chemical or physical principles that describe in particular the protein and saccharide-amylase complexes. The procedures are also focused on the monitoring of technological characteristics (rheological tests), which simulate the behaviour in individual food productions.

The principle of modern methods predominantly on non-destructive and non-chemical basis allows new testing – be quicker and achieve acceptable assay accuracy. Despite the relatively high acquisition costs in the mill firms, the devices enabling simultaneous

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determination of several characteristics for different cereal products on the NIR principle are irreplaceable. However, the latest test from the year 2000 (determination of retention capacity – SRC profile) describing the behaviour of individual components of mill products means a return to the analytical principle.

Retention capacity (SRC profile)

Retention capacity is the result of an analytical test to describe the behaviour of the gluten complex, the damaged starch and the pentosans present on the principle of flour hydration and sedimentation in different environments and subsequent gravimetric determination. Indicates the weight of the solvent bound by the test sample after the standard rotational shaking and centrifugation. It is expressed in wt. % of samples, based on standard 14% moisture. Four solvents (demineralized water, 50% sucrose solution, 5% sodium carbonate solution and 5% lactic acid solution) are used independently for the determination. In one sample analysis, water SRC, sucrose SRC, sodium carbonate SRC and lactic acid SRC are obtained (usually abbreviated as WASRC, SUSRC, SCSRC and LASRC, respectively). Water SRC covers absorption ability of all components of wheat products, while SUSRC pentosans, SCSRC damaged starch and LASRC protein quality. The combination of four SRC values provides the quality profile of products suitable for predicting bakery and special use. Grinder Perten 3000, analytical balances, centrifuge tubes (50 ml, conical-bottomed polypropylene with screw cap) and the Centrifuge 5702 Eppendorf are required for the assay. According to the method AACC 56-11 (2000), practical use of SRC method for flour in standardized and shortened variant was developed by breeders (Sedláček, 2009). It also lists the relationships of the retention capacity of wheat flour to the usual quality characteristics. Within the Czech wheat breeding program, expected significant correlation of WASRC to the flour farinograph absorption was determined. Other scientific papers (Ram et al., 2005 Xiao et al., 2006, Colombo et al., 2009) confirmed that finding. Lactic acid SRC correlates with parameters describing protein quality (alveograph ratio P / L, Gluten Index and SDS test; Gaines, 2006). Significant dependence of all SRC foursome was found on protein content and specific bread volume. The method AACC 56-11.02, the Solvent Retention Capacity Profile, is designed for smooth flour of 14% moisture, where the sample composition plays a role. (Plate XII, Fig. 1), shows the difference in SRC values for wheat flour used for pastry and bread production.

The sample form (groats vs smooth flour), used for the determination, also influences the SRC values. As is shown in (Plate XII, Fig. 2), the greatest difference was found for the SRC values of lactic acid. In order to confirm the significance of SRC, the correlation analysis described the relationship to the results of a complex analysis of flour quality. For example, there was a significant correlation between the WASRC and Zeleny sedimentation (-0.686; P = 99 %), or the LASRC to mineral content (-0.869; P = 99 %). The SUSRC did not correlate with any of the observed quality traits (Tab. 1; Hrušková et al., 2010).

Table 1. Correlations of single SRC to selected quality characteristics of wheat flour

	Ash (minerals) content	*Protein content*	*Zeleny sedimentation*	*Wet gluten*	*Gluten Index*	*Falling number*
WASRC	0.779**	-	-0.630**	0.528**	-	-
SUSRC	0.751**	-	-0.494*	*0.577	-	-
SCSRC	-	-	-0.570**	-	-	-
LASRC	-0.820**	-	*0.638	*-0.664	-	-

WASRC, SUSRC, SCSRC, LASRC – solvent retention capacity of water, sucrose, sodium carbohydrate and lactic acid, respectively

*, ** - critical values of the Pearson’s *r* are 0.561 and 0.444 for P = 95% and 99 %, respectively (*N* = 20)

Methods based on NIR spectroscopy

For the multi-determination of quality characteristics of cereals and mill products, instruments using near-infrared radiation (NIR) for analysis provide the screening measurement. The NIR technique is generally based on the building of prediction models – in praxis referred to as calibration curves. Near-infrared measurement is applied to determine the quality and quantity of samples of the same or similar chemical composition. The prediction of analytical indicators of wheat flour has been intensively investigated since the 1980's. The determination of the content of basic constituents has been introduced into the mill practice with precision, which in a large has enabled extent to replace some direct instrumental methods. The NIR technology is particularly suitable for the determination of protein, water and mineral contents in flour. Information on protein quality, starch damage, granule sizes distribution (granularity) or colour may also be obtained. Protein-related indicators (values of the SDS test or the Zeleny sedimentation test) give less accuracy to results as the causative components are reflected in the NIR spectra. When creating prediction models, emphasis is placed on the quantity and variability of data obtained from reference tests. They ensure the robustness of the models and the accuracy of the results, but only within the error of the reference method (Hrušková et al., 2006). Fig. 2 shows the relationship between reference and NIR values of starch content in wholegrain groats. Within the set of 75 samples (Table 2), the accuracy of determination of basic quality characteristics of wheat flour was compared by standard procedure and NIR technique (Hrušková et al., 2007). According to the standard error of prediction (SEP value), the NIR procedure is not suitable for determining the Falling number, which indicates the amylases activity and the starch damage degree.

Table 2. Prediction of basic characteristics of wheat flour by NIR technique

Feature, unit	**Prediction by NIR method**				
	Calibration (N = 75)			**Validation** (N = 39)	
	Factors count	**SEP**	***r***	**SEP**	***r***
Moisture, %	4	0.08	0.942**	0.20	0.863*
Falling number, s	4	46.80	0.722**	60.30	0.219
Ash content, % d.m.	4	0.05	0.827**	0.05	0.687**
N-compounds, % d.m.	4	0.30	0.960**	0.40	0.963**
Zeleny value, ml	3	3.70	0.631**	4.60	0.548*

SEP – Standard Error of Prediction (identification of the prediction accuracy, i.e. the difference between repeated measurements)
*, ** - critical values of the Pearson's ***r*** are 0.296 for P = 99 % (N = 75, i.e. for the calibration model, and 0.317 or 0.408 for P = 95 % and 99 % (N = 39, i.e. for the validation model, respectively

The use of NIR technology has operational advantages because of its quick determination with the possibility to set several quality characteristics from one measurement only. For analysis, a small amount of sample in the form of grain, groats or flour is demanded. The evaluation of samples by classical direct methods does not provide real-time results, which limits the current information on the quality of mill products.

Conclusions

Why to monitor the quality of mill products? There are several reasons for quality control of flour. It is important to note the fact of domestic origin of traditional cereals as basic row materials, whose quality fluctuations by locality and harvest year. The Czech mills of the present state of technology produce a wide range of mill goods. Wheat and rye flour cereal products represent irreplaceable satiety and nutritional functions for most of the Czech population. Their quality must be standardized by some features that need to be effectively monitored throughout the so-called grain vertical – from grain to food products.

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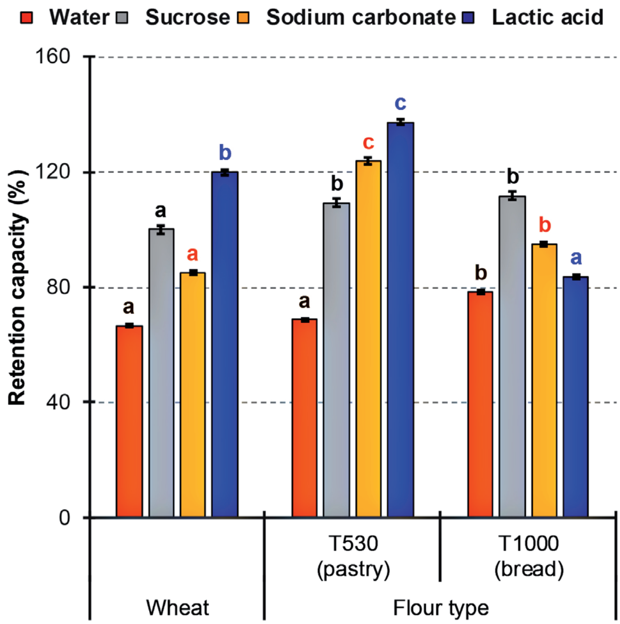

Fig. 1. SRC profiles for different wheat flour types (light T530 vs bread T1000 ones). Column triples for WASRC, SUSRC, SCSRC and LASRC signed by the same letter are not statistically different (P = 95 %)

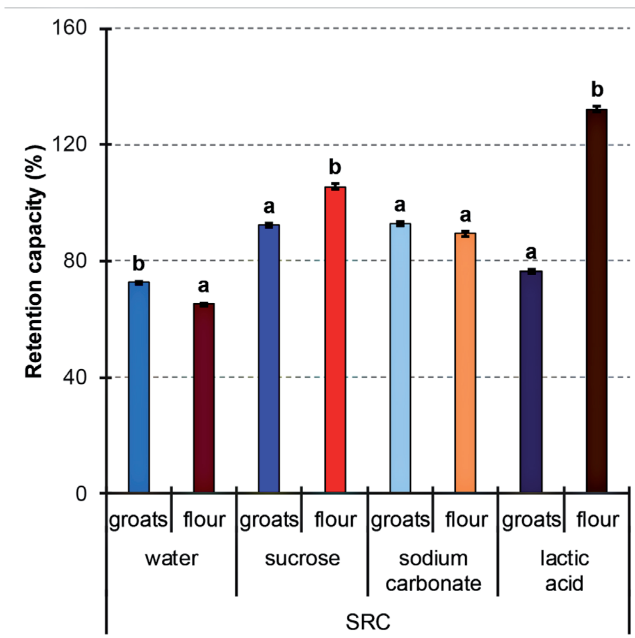

Fig. 2. SRC profiles for different mill wheat product (groats and smooth flour). Column pairs for WASRC, SUSRC, SCSRC and LASRC signed by the same letter are not statistically different (P = 95 %).