SHORT COMUNICATION

STANDARD METHODS AND CRITERIA TO PREDICT BREAD CEREAL QUALITY – DO THEY STILL MEET THE DEMANDS OF MODERN RAW MATERIALS AND THEIR PROCESSING?

Meinolf G. Lindhauer

Department of Safety and Quality of Cereals, Federal Research Institute for Nutrition and Food, Max Rubner-Institute (MRI), Schuetzenberg 12, D-32756 Detmold, Germany, e-mail: meinolf.lindhauer@mri.bund.de

Abstract

Reliable prediction of the baking behaviour of bread cereals (wheat, rye) is of utmost importance in the respective production, trade and processing. Consequently, there is a great interest in easy to handle, rapid and precise methods. A broad variety of such methods has been established by international standardisation organisations like ICC, AACCI, ISO and CEN, respectively, to assess a wide range of criteria of grain raw material and products thereof. In wheat because of its gluten functionality in baking performance protein quantity and quality assessment criteria play a decisive role. In addition, starch characteristics may be of significance.
In this respect, it has become tradition in practical wheat trade and buying decision making to measure raw protein content (by the Kjeldahl or Dumas method, preferably by NIR), protein quality (as sedimentation value), and Falling number, only. Data received are then put into relation to the bread volume tentatively to be expected. In rye starch and pentosan quantity and quality play the crucial role in baking performance. Thus, the amylogram data gelatinisation maximum and gelatinisation temperature serve as criteria of quality prediction. The presentation will show that progress in wheat and rye breeding on the one hand and the increased diversity in baked goods on the market have made the prediction reliability of traditional methods questionable, at least in specific cases. Furthermore, the technical procedure of performing individual methods will have to be evaluated to avoid misleading results.

Keywords: Wheat, rye, baking quality, standard methods.

Introduction

On different levels of the bread cereal (wheat, rye) production and utilization chain it is of utmost interest to sufficiently predict the tentative processing, i.e. baking quality of the raw material. In early stages of their selection process breeders would like to know if the wheat or rye material they work with will finally fulfil the demands of the processing industry after a ten to 14 years breeding and variety releasing process. Cereal traders and/or millers are permanently facing the challenge to select the right quality material they are aiming at for their specific interest and bakers, finally, need to know the specific processing quality of the milling products they ordered. Therefore, since many decades cereal scientists in close cooperation with practice have elaborated and established a system of methods suitable for mostly rapidly predicting the processing, especially baking performance of a raw material lot of interest and/or a milling product prepared thereof. Basically a baking test would mirror best and most comprehensively the real processing (baking) quality. However, baking tests afford specific and expensive equipment and infrastructure and they are rather time consuming and thus not suitable to be practised under time constriction during harvest and/or primary cereal uptake in mills or trading points.
As a consequence a broad range of so-called indirect methods has been established the results of which are put into relation to a specific dough making and subsequent baking performance thus enabling prediction of the baking result. To facilitate international cereal trade a wide range of methods has been standardised by international standardisation organisations such as the International Association of Cereal Science and Technology (ICC), the American Association of Cereal Chemists International (AACCI), the International Standardisation Organisation (ISO) and the Comité Européen de Normalisation (CEN).
As in wheat baking performance is to a high extent caused by its protein, specifically by its gluten fraction and by the starch fraction, specific (rapid)methods are designed to measure protein (or gluten) quantity and quality, respectively, and starch quality. In rye, the baking quality of which is characterized predominantly by the carbohydrate fraction, i.e. starch and pentosans. Consequently, methods aim at describing this fraction in its dough and gel forming capacity.
For a long period of time it had become practical use in wheat evaluation – at least in the phase of primary uptake of cereal material at harvest – to measure total protein content and sedimentation value as protein (gluten) quality criterion and in addition Hagberg-Perten Falling Number to get information about the starch. This had turned out to be sufficient as the wheat variety material so far on the market showed a good linear relationship between protein characteristics and baking performance mostly taken as volume of the baked good. In specific years with pre-harvest sprouting Falling number was of additional significance.
In rye, more susceptible to pre-harvest sprouting, Falling Number and starch gelatinisation patterns as measured by means of the Brabender amylograph equipment, i.e. starch gelatinisation maximum and temperature at gelatinisation maximum were sufficient to handle rye milling products for bread making.
In most recent years, however, there is – at least in Germany – more and more complaining among wheat and rye breeders, farmers, traders and millers that these traditional methods are no longer sufficient to predict

wheat and rye baking quality. This is specifically conferred to modern German wheat varieties and to a certain extent to rye cultivars it is the intention of the following to describe the given situation in Germany and to consider the question of still existing significance of the established quality assessment system.

Material and Methods

Data for bread wheat *(Triticum aestivum)* and rye *(Secale cereale)* are derived from the official yearly German quality assessments of bread cereals performed by law by Max Rubner-Institute (MRI) - Department of Safety and Quality of Cereals during recent years as well as from processing quality assessments performed in the framework of the releasing process for new varieties.

Analytical methods applied are according to the ICC standardization protocol as follows (ICC 2001): Total protein (ICC Standard No. 105/2), sedimentation value (ICC Standard No. 116/1), falling number (ICC Standard No. 107/1). As baking test the RMT (Rapid Mix Test) with rolls has been chosen being the respective standard procedure in Germany (Arbeitsgemeinschaft Getreideforschung e.V., 1994).

For quality assessment of rye the Brabender Amylograph procedure (ICC Standard No. 126/1) was applied.

Results and Discussion

With respect to baking quality much progress in breeding has been made during the last decades with wheat rather than with rye. Therefore, emphasis is laid in the following on wheat. In Germany – and to a certain extent in other countries too – it has been well established in the wheat business to look at raw protein content as measure of protein quantity. And as there is sufficiently narrow relation protein content enabled anticipating the gluten content of a wheat sample. As a certain measure of protein quality sedimentation value added further information. Starch characteristics, i.e. it's gelatinization capacity and indirectly the sample's status of amylase activity could (and of course, can) be derived from falling number measurements, the significance of these data being of utmost relevance in harvest years with pre-harvest sprouting as a problem.

Taking this into account the "3 pillars" - protein content, sedimentation value, and falling number – were mostly sufficient to evaluate the baking quality of a wheat sample (Fig. 1). This was especially due if the variety or a blend of varieties in a sample were known.

It has not been earlier than 1969 that Prof. Bolling of the former German Federal Research Institute of Cereal Processing established a system of equations (see Fig. 2) enabling the prediction of the baking volume of a roll in the Rapid-Mix-Test (RMT) to be expected knowing total protein content and the sedimentation volume of a wheat sample.

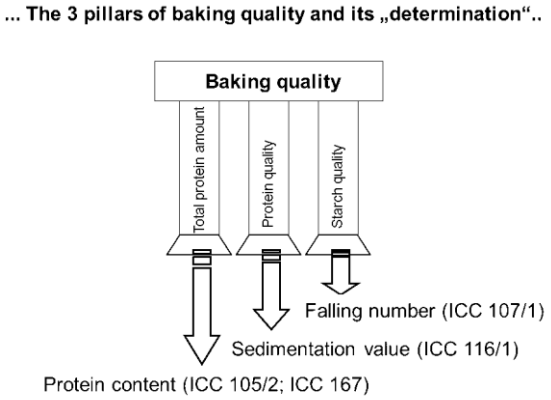

Fig. 1: The "3 pillars" of wheat baking quality measurement

As for a long time until the late nineties of the last century and the early years of the 21st century there mostly was a positive linear relationship between raw protein content and baking quality in the sense of volume forming in yeast leavened baked goods. Therefore it had become use to measure total protein content of a wheat sample, only, and to evaluate from this the baking quality to be expected. This procedure had been supported by the fact that it more and more easy to measure protein content rapidly by near-infrared spectroscopy (NIR). Consequently, it had become tradition internationally to pay wheat quality for its protein content.

RMT-volume estimation by the Bolling (1969) regression equation

Basis : Grain protein content : Sedimentation value

Volume yield = 10 protein + 3 sedimentation value + 420
(valid for E and A wheats)

Volume yield = 17 protein + 3 sedimentation value + 306
(valid for B wheat)

Fig. 2: Regression equations to estimate Rapid-Mix-Test (RMT) volume of wheat sample

More recently, however, more and more wheat cultivars have been released where obviously the narrow relationship between increasing protein content and increasing baking volume does no longer exist. This is to be demonstrated in Figure 3, showing the cultivars Pamier and Kranich representing the "old" relationships. Toras and Tarso, on the contrary, do only have a very weak relationship between protein content and baking performance. Reliable prediction of the baking quality of a wheat sample of these varieties or containing these varieties has become a challenge.

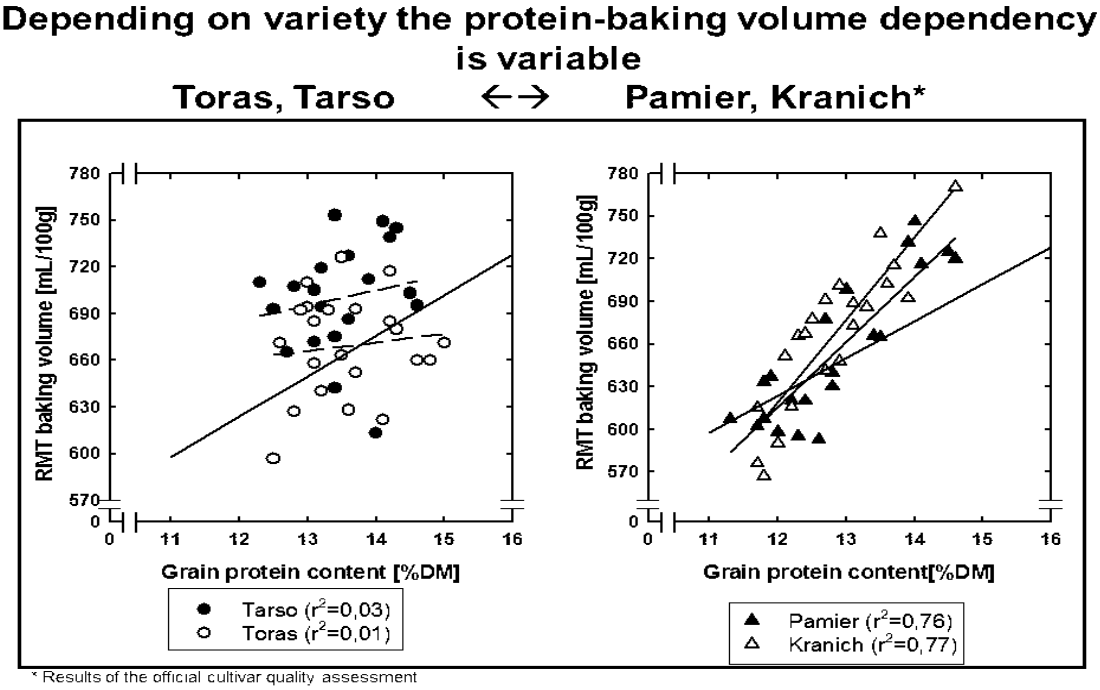

Fig. 3: Protein content/RMT baking volume interactions in selected German wheat varieties

Baking quality evaluation of wheat has become additionally more complicated as there are modern varieties on the market that sore relatively low total protein amounts (and gluten quantities, respectively) but because of the high functionality of the gluten proteins the baking performance of such wheat is much better than expected from classical measurement results.

Also it may be necessary to review the sedimentation value method as it can be shown that results alter in dependence on the milling equipment used to prepare the flours resulting into different protein content of the test sample flours (Seling, unpublished).

Low falling number values are traditionally believed to result in bad baking performance of wheat flour. Samples with low falling number values, however, have been identified during recent harvest years that showed nearly no restriction in baking performance. Own starch related studies with respective samples make assume that starch kernel integrity coinciding with strong gluten functionality are more important than falling number values acquires under conditions of a surplus of boiling water in the FN vessels (Muenzing and Lindhauer, unpublished).

Rye baking quality, finally, is also sometimes questioned as it is believed that flours from modern (German) rye varieties cause problems in baking performance. Specifically, bakers complain about so-called dry baking, i.e. reduced crumb humidity and limited shelf - life of breads. Additionally, crumb cracks are said to occur more often using modern rye varieties then it happened with older varieties.

It must remain open, so far, if the traditional criteria gelatinization and temperature at gelatinization maximum derived from the Brabender amylogram are still sufficient for describing the baking quality of modern varieties. Fact is that modern rye varieties tend to be more pre-harvest sprouting resistant and, thus, they tend to have higher falling numbers.

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