Predicting Bread Volume of the Rapid Mix Test (RMT) procedure with the Mixolab

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PRESENTATION

Technological tests such as bread making tests are the most accepted quality control methods for determining wheat flour quality. However, the duration of the tests and the need for expert operators (test bakers) limit the productivity of this type of analysis. Therefore the development of quick and reliable methods for predicting flour quality offer a great benefit. Moreover, for breeders, knowing wheat properties as early as possible during the breeding process is very important. Using existing laboratory instruments to develop predictive models of the real bread making results is a very interesting strategy to meet this goal. In this project, the Mixolab, a comprehensive device which measures the rheological properties of dough subjected to the dual stresses of mixing and temperature change, has been used. The goal of this study is to use all the information given by the instrument (protein behavior, starch behavior, enzymes actions and interactions) to develop mathematical models that predict bread volume from the Rapid Mix Test (RMT) procedure which is used as a reference in Germany.

MATERIAL AND METHODS

387 German wheats from four different crops (2013 to 2016) have been used during this study. Every sample was referenced for bread volume following the RMT procedure. Two qualified laboratories participated in order to increase the variability of the results. Each sample was ground using a CHOPIN Grinder and was tested with the Mixolab using the "RapidWheat+" protocol (**Figure 1** and **Table 1**).

This protocol works with ground wheat, at constant hydration, in order to limit the amount of sample to analyze. Data statistical analysis was made using Minitab® 1.15. The model predictors are the characteristic points of the curves (C1 to C5), the smoothed torques per minute (CL1 to CL20) and the absorbed energy per minute (PA1 to PA20) (**Figure 1**).

Two sets of data were used (**Figure 2**):

- Development set: 369 samples with volumes from 430 to 809 ml
- Validation set: 18 samples selected to be as representative as possible of the volume range (450 to 742 ml)

The performance of the models are evaluated using 4 indicators:

- The % of well predicted results according to the fidelity of the reference method data (3 uncertainties to take into account: 3 indicators) (**Table 2**)
- The absolute average difference with the reference values.

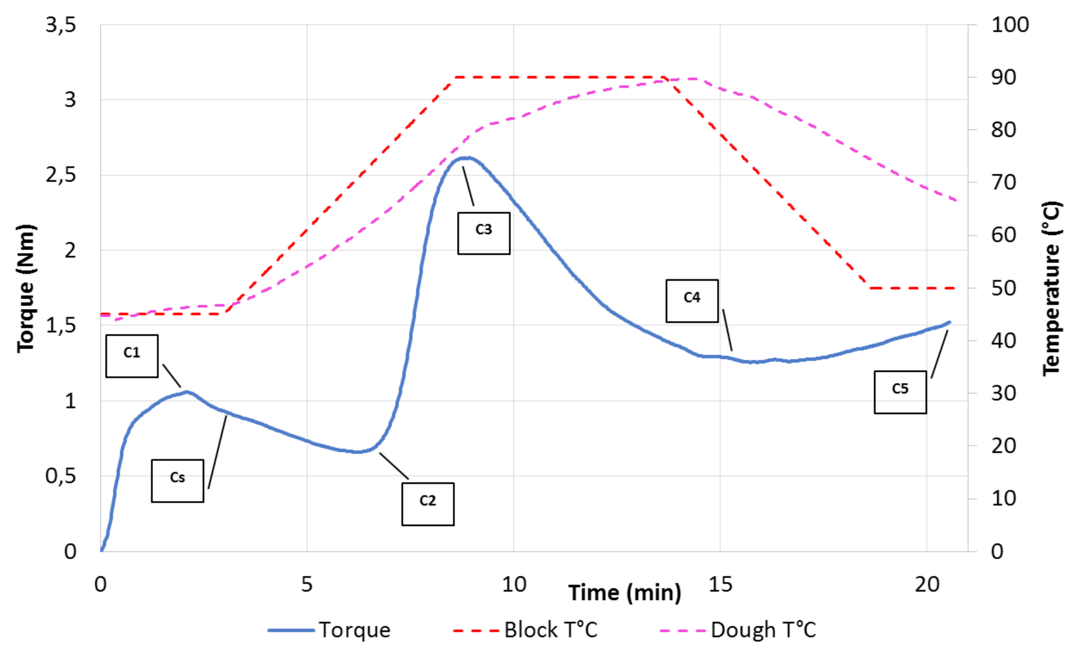

Figure 1: Example of a Mixolab Curve

Table 1: "RapidWheat+" protocol

Mixing Speed	180 rpm
Constant Hydration	60%, b14%
Dough Weight	75g
Water tand t°C	45 °C
T°C 1st step	45 °C
Duration 1st step	3 min
1st t°C gradient	8 °C/min
T°C 2nd step	90 °C
Duration 2nd step	5 min
2nd t°C gradient	8 °C/min
T°C 3rd step	50°C
Duration 3rd step	2 min
Total analysis time	20,6 min

Table 2: Fidelity data*

Parameter	Type	Uncertainty
Volume (ml)	Minimum	28
	Mean	70
	Maximum	126

**Fidelity data done with:*
- *17 participating laboratories*
- *48 samples of flour*

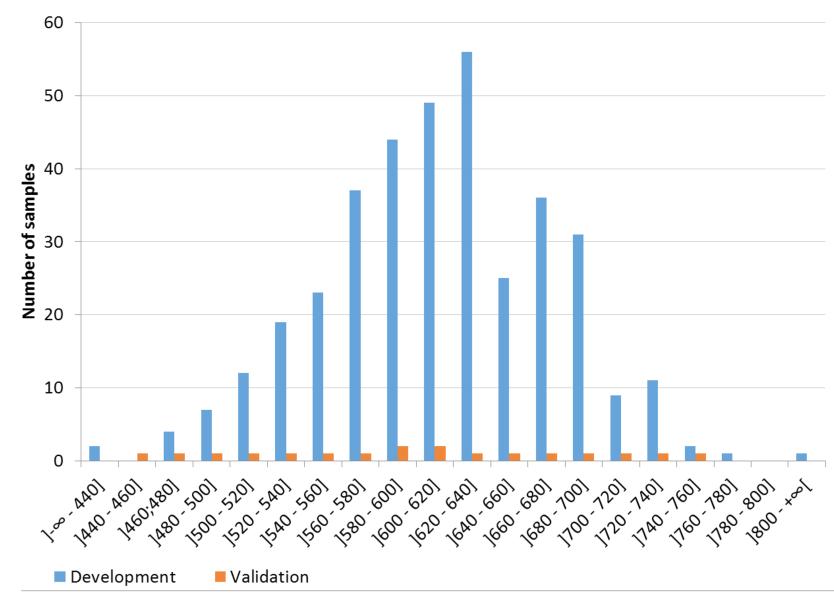

Figure 2: Samples distribution

RESULTS & DISCUSSION

The results are represented using 3 graphics:

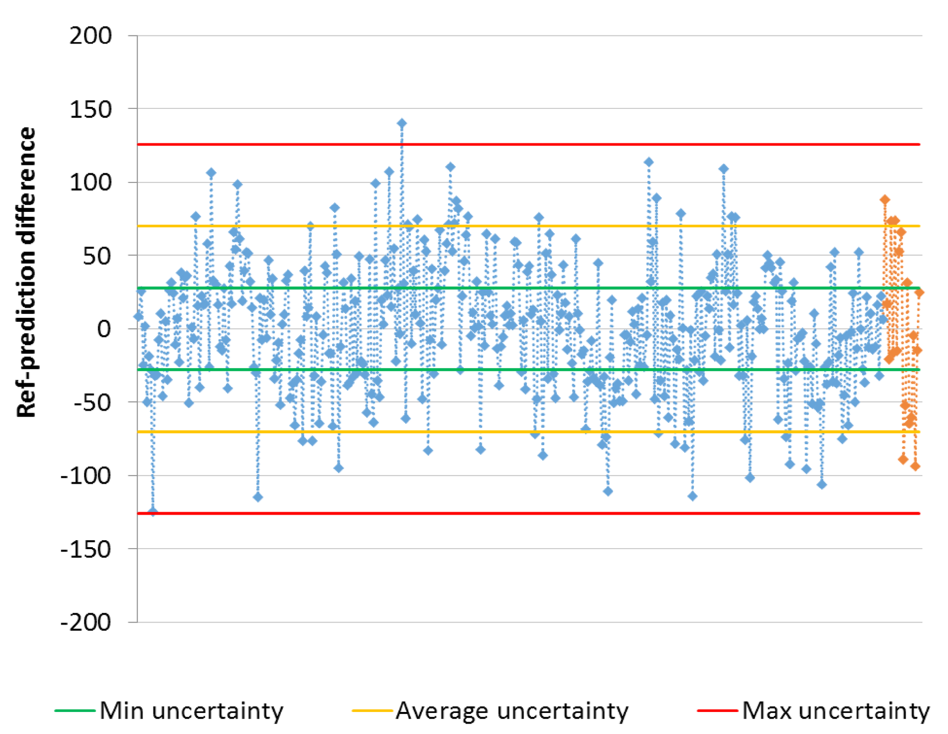

Figure 3: Difference, for each sample, between the reference value and the value predicted by the model

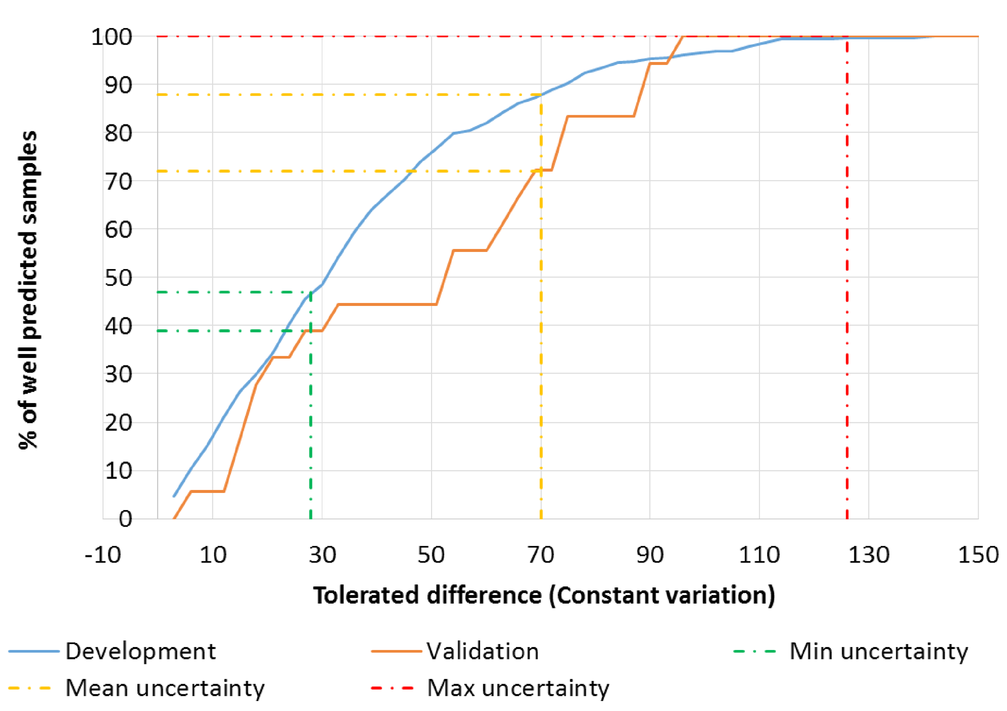

Figure 4: Percentage of samples properly predicted according to the acceptable difference between RMT and predicted results

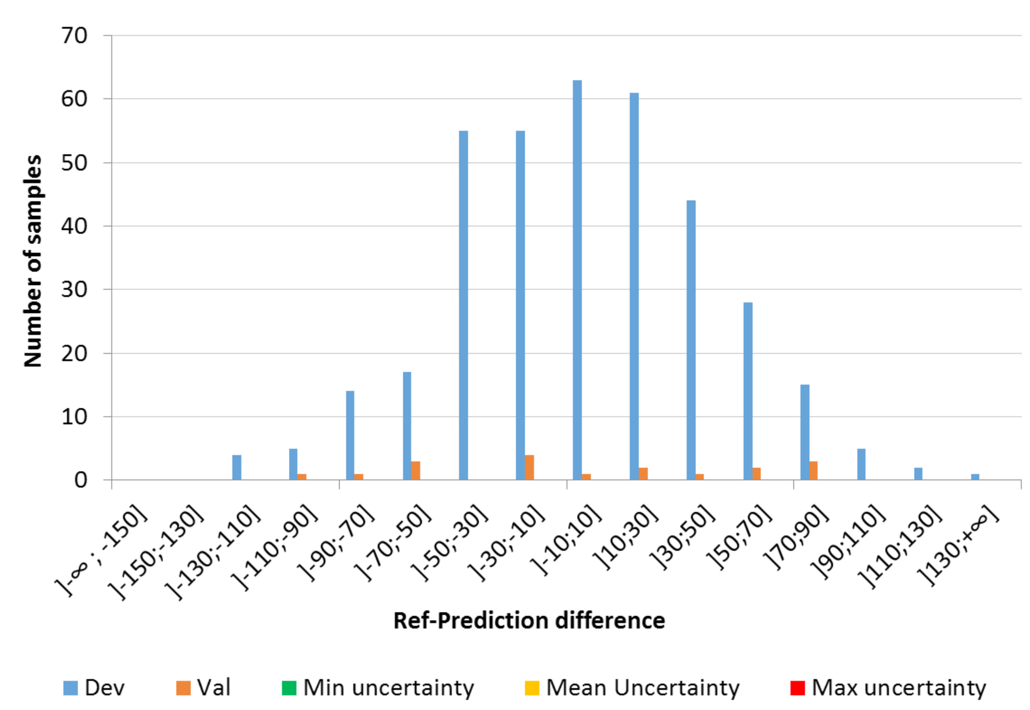

Figure 5: Distribution of the difference between the reference value and the prediction value

In **table 3**, a synthesis of all the results is presented.

Almost 100% of the samples have a difference with the reference method lower than the maximum uncertainty for the development set (only one sample out) as well as for the validation set. Moreover, the average difference with the reference method is in both sets is lower than the average uncertainty.

Indicator		Development set	Validation set
% of well predicted samples	Min uncertainty	47%	39%
	Average uncertainty	88%	72%
	Max uncertainty	99.7%	100%
Average difference with the reference		35.49 ml	47.65 ml

Table 3: Synthesis of the results

CONCLUSION

The excellent performance of the model shows that the Mixolab is fully capable of predicting bread volume as obtained by the Rapid Mix Test procedure. The model is precise and robust given the high number and variety of samples used for its development. The model should be validated, by application, before being used as routine. This method for developing prediction models from the Mixolab information, first developed for French bread making, can be applied to any other type of processes.

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