*Agronomy Research* **15**(S2), 1369–1374, 2017

# Development of a rapid method for determination of gluten content in wheat flour

V. Nazarova[1,*] and O. Zhdanova[1]

[1]ITMO University, Faculty of Food Biotechnologies and Engineering, Lomonosov St. 9, 191002, Saint-Petersburg, Russia
*Correspondence: vvnazarova@yandex.ru

**Abstract**. Gluten content is one of the most important factors of the quality of wheat flour. Bread price depends on the quality and quantity of gluten. For the professionals of baking industry it is important to quickly and efficiently determine gluten content in wheat flour. Gluten content is commonly defined by manual or automated washout. The present study aimed to develop a rapid method for determination of gluten content in wheat flour by electrophysical method and compare it with the other standard methods (ISO 21415–1:2006, ISO 21415–2:2015). The method is based on determination of permittivity of flour, which varies depending on the amount of free water produced by heating and correlated with the content of gluten. The methodology of research included the use of wheat flour samples (gluten content in the range of 23.0% and 32.0% and flour humidity to 15.0%). The heating temperature of the analysed flour samples was in the range of 30 ºC and 70 ºC. Mathematical processing of the results of the experiment allows to establish the relationship between gluten content and capacitance of flour. The proposed method makes it possible to reduce the time of analysis by reducing the number of operations within the analysis and the influence of subjective factors comparing to manual and automatic washing method a gluten flour (ISO 21415–1:2006, ISO 21415–2:2015).

**Keywords:** gluten content, rapid determination, permittivity.

## INTRODUCTION

Gluten is an indicator of quality not only of flour but also of a grain. Flour can be used in various fields of food industry depending on the gluten content of wheat (Kazakov, 2001). Control of gluten content and its quality is carried out in the production of wheat flour and bakery products. It is important to collect this information as soon as possible (Zannini et al., 2012).

Therefore, many countries are developing rapid methods for determining content of gluten based on the various approaches (Puchkov et al., 2005). Wet gluten content is determined by washing dough with water or other solution under certain conditions in order to remove starch and other soluble components of the sample (Mis, 2000). Elastic mass that remains after washing is wet gluten. Operating condition and type of solution bears heavy influence on the results. It is recommended to use a solution of NaCl (2%) to neutralize the effect of different minerals normally found in drinking water. Also, washing time should not exceed 30 minutes.

There is a device called Glutomatic 2200 included in the International Standards

AACC–38–12, ICC–155, ICC–158, but the device is expensive and is not always possible to implement. The standard method for determining the quantity and quality of gluten (ISO 21415–1:2006**,** ISO 21415–2:2015) is time consuming and requires a significant amount of drinking water.

The aims of following research were the development of a rapid method for determination of gluten content in wheat flour using capacitive method and comparison of the proposed method and standard method **(**ISO 21415–1: 2006, ISO 21415–2: 2015).

## MATERIALS AND METHODS

This study used 5 samples of high grade bakery wheat flour with different gluten content. Wet gluten content was found according to the method ISO 21415–1:2006 (Table 1). Moisture content was determined according to the method ISO 712:2009. All tests were carried out three times and the mean values were noted with the standard deviation.

To obtain the results using the following method it is required to: prepare the flour samples with different gluten content and different humidity; provide a constant density of the sample; and provide a temperature control system for measuring gluten content in heated flour sample.

**Table 1.** Gluten content of wheat flour (ISO 21415–1:2006)

| Flour sample | Gluten content, % |
|---|---|
| 1 | 23.0 |
| 2 | 27.6 |
| 3 | 29.3 |
| 4 | 30.5 |
| 5 | 32.0 |

The flour samples with a specific gluten content were put in the capacitive transducer. Flour was heated to 70 ± 5 °C. The values of capacitance were measured every 10 seconds in the range of 30–70 °C. Considering a possible gluten protein denaturation heating temperature was considered as 70 ± 5 °C (Sherwy & Tatham, 1997; Moick & Rogova, 1988). The values of electrical capacitance of flour were determined on the experimental setup shown in Fig. 1.

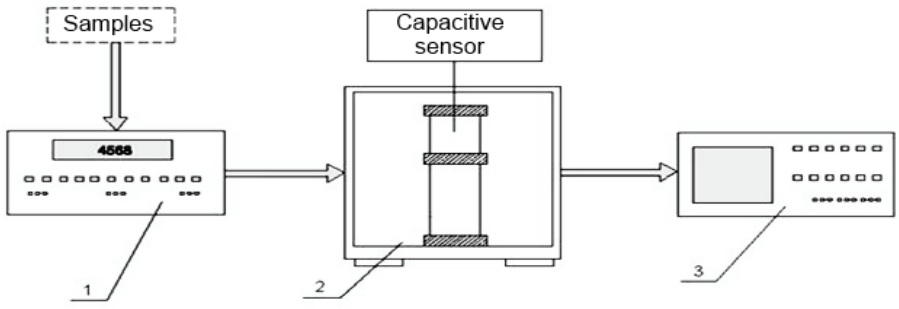


**Figure 1.** The experimental setup. 1 – moisture meter ELVIZ–2, 2 – oven SNOL58/350 with a capacitive sensor, 3 – capacitance meter ET–20.

## RESULTS AND DISCUSSION

The diagram was plotted to determine gluten content in flour using capacitive method. It shows relationship between capacitance and temperature of 5 flour samples. Flour capacitance is greater the more the gluten content in wheat flour. Thus, electric capacitance depends on the gluten content of flour. As gluten and starch hold bound moisture then translation of moisture bounded by gluten in the free state by heating flour samples causes changes in the flour capacitance (Fig. 2) (Duckuort, 1980; Kazakov & Karpilenko, 2005).

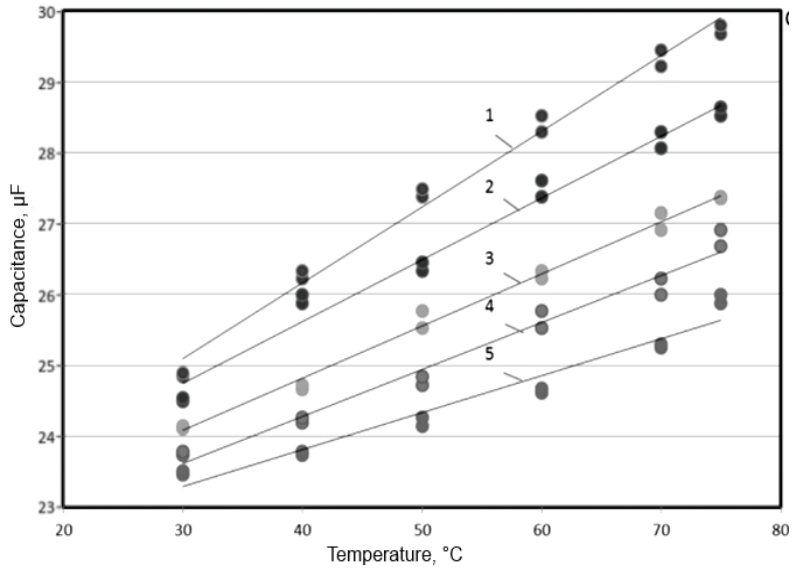


**Figure 2.** Relationship between capacitance and temperature. Gluten content of the samples: 1 – 32.0%, 2 – 30.5%, 3 – 29.3%, 4 – 27.6%, 5 – 23.0%.

To calculate gluten content in flour using capacitive method we have moved from electric capacitance to the permittivity, which value is not depending on sensor's size. Knowing the capacitance of an empty sensor and capacitance of a sensor filled with the flour sample we moved to the value of the dimensionless permittivity. Further, the relationship between permittivity and temperature was obtained, which also confirms that permittivity which grows with the temperature is greater the more gluten and starch content (Mikulovich & Dolgopolov, 1991). Gluten content can be calculated using the formula:

$$\varepsilon(70 flour\ calc.) = 1.68 + 0.018K_{gluten},$$

where: $\varepsilon$ – permittivity of wheat flour at a temperature 70 ± 5 °C; $0.018K_{gluten}$ – gluten content.

Using the experimental data we discovered the relationship between permittivity of wheat flour and gluten content, which enabled development of the regression equations.

This served as foundation for determining gluten content in wheat flour depending on permittivity of wheat flour, as shown in Fig. 3.

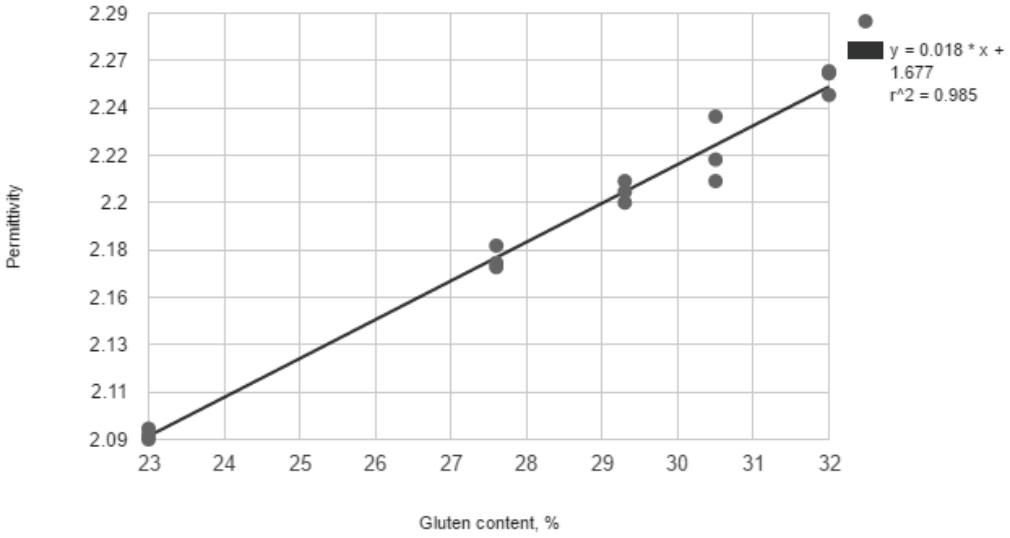


**Figure 3.** The relationship between permittivity and gluten content.

Table 2 shows comparison of gluten content values obtained using the proposed method and gluten content values obtained using the standard method ISO 21415–1:2006. The comparison shows that the proposed method gives comparable results to the standard method.

**Table 2.** Comparison of methods for determination of gluten content in wheat flour

| Flour sample | Gluten content, % (standard method) | Gluten content, % (proposed method) |
|---|---|---|
| 1 | 23.0 | 23.15 |
| 2 | 27.6 | 27.48 |
| 3 | 29.3 | 29.15 |
| 4 | 30.5 | 30.55 |
| 5 | 32.0 | 31.8 |

The closest analogue to the technical nature of the proposed method are ISO 21415–1:2006 'Wheat and wheat flour. Gluten content. Part 1: Determination of wet gluten by a manual method' and ISO 21415–2:2015 'Gluten content. Part 2: Determination of wet gluten and gluten index by mechanical means'.

As shown in Table 3, the manual method comprising nine successively stipulated operations to determine the gluten content in the flour take 70 minutes and determination of gluten content by mechanical means take 20 minutes.

The proposed method takes no more than 10–12 minutes to conduct the experiment in three operations.

**Table 3.** The comparison of methods of determination of wet gluten content of wheat flour

| ISO 21415–1:2006 | | ISO 21415–2:2015 | | Proposed Method | |
|---|---|---|---|---|---|
| Operation | Time, min | Operation | Time, min | Operation | Time, min |
| Weighing flour | 1 | Weighing Flour | 1 | Placing flour samples in the sensor | 1 |
| Dosing water | 1 | Dosing water | 1 | Heating flour samples | 10 |
| Doughing | 5 | Doughing | 3 | Determination of gluten content | 1 |
| Binning of dough | 21 | Binning of dough | 10 | | |
| Washing out | 30 | Squeezing of dough and dividing it into 5–6 pieces | | | |
| Pressing between palms (removing excess moisture from the sample) | 3 | Main washing of gluten | 3 | | |
| Weighing | 2 | Weighing | 2 | | |
| Washing and pressing | 7 | | | | |
| Weigh | 2 | | | | |
| Total time | 70 | | 20 | | 12 |

## CONCLUSIONS

The results obtained in this work indicated the prospects of the developed method of determining the gluten content in wheat flour.

The developed method of determination of gluten content can be used in flour and bakery processing industry. Implementation of this method opens up prospects for a rapid control of determining the gluten content in the flour by capacitive method.

## REFERENCES


Duckuort, R.B. 1980. *Water in food.* Food Industry, Moscow, 376 pp. (in Russian).

ISO 21415–1:2006 'Wheat and wheat flour. Gluten content. Part 1: Determination of wet gluten by a manual method'.

ISO 712:2009 'Cereals and cereal products – Determination of moisture content – Reference method'.

ISO 21415–2:2015 'Gluten content. Part 2: Determination of wet gluten and gluten index by mechanical means'.

Kazakov, E.D. 2001. Composition, structure and properties of gluten. *Bakery* **9**, 18–19. (In Russian).

Kazakov, E.D. & Karpilenko G. 2005. *Biochemistry of grain and grain products.* GIORD, Saint–Petersburg, 232 pp. (in Russian).

Mikulovich, T.P. & Dolgopolov, V.P. 1991. *Vegetable protein.* Agropromizdat, Moscow, 325 pp. (in Russian).

Mis, A. 2000. Some methodological aspects of determining wet gluten quality by the glutomatic method (a laboratory note). *International Agrophysics* **14**, 263–267.

Moick, I.B. & Rogova I.A. 1988 *Thermo and hygrometry food.* Agropromizdat, Moscow, 303 pp. (in Russian).
Puchkov, L.I., Polandova, I.D. & Matveeva, I.V. 2005. *Bread technology.* GIORD, Saint–Petersburg, 559 pp. (in Russian).
Sherwy, P.R. & Tatham, A.S. 1997. Disulphide bonds in wheat gluten proteins. *Journal of Cereal Science* **25**(3), 207–227.
Zannini, E., Julie, M., Jones, S., Renzetti, K. & Arendt, E.K. 2012. Functional replacements for gluten. *Annual Reviews of Food Science and Technology* **3**, 227–245.