

SOME METHODOLOGICAL ASPECTS OF DETERMINING WET GLUTEN QUALITY BY THE GLUTOMATIC METHOD (a laboratory note)

A. Miś

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, P.O. Box 201, 20-290 Lublin 27, Poland

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Abstract. One of the weak sides of the glutomatic method for testing wet gluten quality (ICC Standard No. 155) is a variable amount of wet gluten subjected to the action of the centrifugal force as various amounts of gluten are washed out from various wheats. The present study on the influence of such conditions as: storage (from 0 to 50 min), fragmentation (from 1 to 6 equal parts) and a weighed amount of wet gluten (from 0.5 to 3.5 g) on the gluten index (GI) value were conducted.

The results showed that the physical properties of wet gluten formed at the end of its washing out and expressed by the gluten index are liable to considerable changes in the course of its storage at invariable moisture. The fragmentation degree of a wet gluten piece during centrifuging had not significant influence on value of the determined gluten index. An increasing quantity of gluten from 0.5 to 2.5 g during centrifugation causes a proportional decrease of the GI value. However, a further rise of the weighed amount of wet gluten above 2.5 g results in slow-down and then slow-lift of the gluten index value. The range of decrease in the GI depends, first of all, on the wheat cultivar and, most frequently, it is inversely proportional to the gluten quality.

The results obtained indicate the necessity to consider the constant weighed amount of the wet gluten piece when it is subjected to centrifugal force test by the Glutomatic method.

Keywords: wheat wet gluten, gluten index determination, glutomatic system

INTRODUCTION

Wet gluten is a visco-elastic proteinaceous substance obtained after washing out the starch granules from wheat flour dough. Quality of the resulting gluten is a considerable index of the wheat baking potential [2]. So, objective and reliable methods for determining physical properties of the wet gluten are required.

Recently a method and a laboratory set a Glutomatic System, developed by the Perten Instruments AB is available for testing wet gluten quality [8]. The glutomatic method according to the ICC Standard No 155 [5] consists in subjecting a sample of wet gluten placed on a special sieve to a centrifugal force (Fig. 1). During centrifugation the gluten ball passes through the sieve holes and the gluten index (GI) is determined. The GI value expresses a weight percentage of the wet gluten remaining on the sieve after centrifugation. The higher GI values, the better quality of the tested gluten.

However, one of the weak sides of the glutomatic method is a variable amount of gluten tested during centrifugation as the wet gluten content for most wheat cultivars ranges from

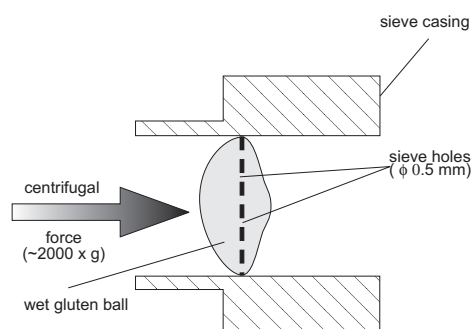


Fig. 1. Lay-out of a special sieve cassette developed by the Perten Instruments AB and used for centrifuging of the wet gluten ball.

17 to 35 % at 14 % grain moisture [1,3,6]. In the case when the rotational speed and the radius of rotation are constant, the centrifugal force is proportional to the weight of the wet gluten ball. Unfortunately, GI values depend to a certain degree on the quantity of the washed-out gluten. Therefore there is a need to improve this method in order to make determination of wet gluten quality by the Glutomatic System more objective.

There are two possible simple ways to ensure always the same and invariable weighed amount of wet gluten in the course of its centrifugation. One of them would consist in the collection of wet gluten balls from two succeeding cycles of washing-out, and a short-time storage for them (up to 10 min). Then the gluten balls are joined, and the required weighed amount is obtained. The other method includes cutting out the excess of gluten or, in case of its deficit of gluten, adding a part of the gluten ball, taken from the second parallel cycle of washing-out, as it is possible to use the Glutomatic 2200. However, the above ways could only be used both the storage and the used fragmentation of the gluten ball do not change physical properties of wet gluten.

Hence, the studies on the influence of such conditions as storage, fragmentation and a weighed amount of the wet gluten on the gluten index have been conducted.

MATERIALS AND METHODS

Grain samples of wheat harvested in 1995 from the experimental plots at the Institute of Agrophysics PAS in Lublin were studied. The samples included 4 Polish cultivars of winter wheat (Almari, Begra) and one spring variety (Omega, Sigma).

The grain samples with the moisture content of 10.5 ± 0.5 % were ground by means of a Lab Mill 3100, Perten Instruments AB. The whole wheat meal obtained was placed into air-tight containers, from which specimens with the same dry weight equal to 10 g of meal at 14 % moisture content were taken for washing out gluten. The washing-out was conducted with

the Glutomatic 2200, the Perten Instruments AB, according to the ICC Standard No. 155 [5].

The effect of storage of wet gluten from the moment washing-out was finished to the start of gluten centrifugation was examined. This period ranged from 0 to 50 min. In the course of storage, the wet gluten balls were placed inside wetted Petri dishes with covers to prevent losses of gluten moisture. The minimum storage time (marked as 0 min) was equivalent to the 20 s period required to conduct manual operations after washing to prepare gluten for centrifuging according to the ICC Standard.

Different degrees of fragmentation were obtained by cutting a wet gluten ball into equal parts from 1 to 6. Directly after cutting, gluten centrifugation was conducted.

While evaluating the effect of the weighed amount, increasing quantities of wet gluten, from 0.5 to 3.5 g, were subjected to centrifugation. The range of the assumed weighed amount is equal to the wet gluten content from 5 to 35%. The required weighed amount of gluten was obtained by cutting off its excess or adding part of it from the second parallel cycle of the washing out. During centrifugation in place of the second gluten ball used to complete the weighed amount of the first one, there was a piece of rubber as a equivalent of the weight.

To study the influence of one of the above conditions, all the other factors were maintained according to ICC Standard No 155 [5]. For all studied factors, the GI measurements were executed in 6 replications.

RESULTS AND DISCUSSION

The effect of storage time of the wet gluten of the tested wheat cultivar on the GI value is shown in Fig. 2a. A longer storage time caused significant changes in the wet gluten properties. Considerable increases in the GI as a result of the gluten storage was observed for three cultivars; Almari, Begra and Omega. Contrary to that, in the case of one cultivar with the strongest gluten, Sigma, a slight decrease in the GI was observed. The highest dynamics of changes in the GI value was noticed for an

initial period of storage from 0 to 20 min. The range of these changes was inversely proportional to wet gluten quality measured by the GI directly after its washing out (0 min storage time). It means that the gluten with high index, e.g., cultivar Sigma, alters during storage less than the one with the low index, e.g., cultivar Almari.

The results in Fig. 2a indicate also that most differentiation among the studied wheat cultivars in regard to the GI took a place at 0 min storage time. This fact confirms reliability of the procedure accepted by the ICC Standard No. 155, that requires exactly a 20 s period between the end of washing and starting of centrifuging.

The influence of the degree of fragmentation of the centrifuged gluten ball on the GI value is presented in Fig. 2b. There were no significant differences in the GI value between the assumed degrees of fragmentation. For all the studied cultivars, the variation range of the GI means did not exceed the 95% confidential intervals (LSD). The results show that a division of the gluten ball had no influence on the value of the determined gluten index. Therefore one cannot agree with the rule recommended by the ICC Standard No. 155, which requires centrifuging a wet gluten ball as a one piece only. Moreover, cutting out or adding part of the gluten ball allows to centrifugate a predetermined amount of wet gluten.

The above method was used for the preparation of different weighed amounts of the wet gluten for studying their influence on the GI. As shown in Fig. 2c, an increase in the amount of the centrifuged gluten in the range from 0.5 to 2.5 g caused a proportional decrease of the GI values. The reason for the proportional decrease of the GI, is probably the increasing centrifugal force. Together with the rise of the weight of centrifuged gluten the centrifugal force rises as well. Higher centrifugal force makes the gluten ball pass faster. So that in the same centrifuging time, a larger part of the gluten ball is forced through the sieve. The effect is that the values of the GI decrease.

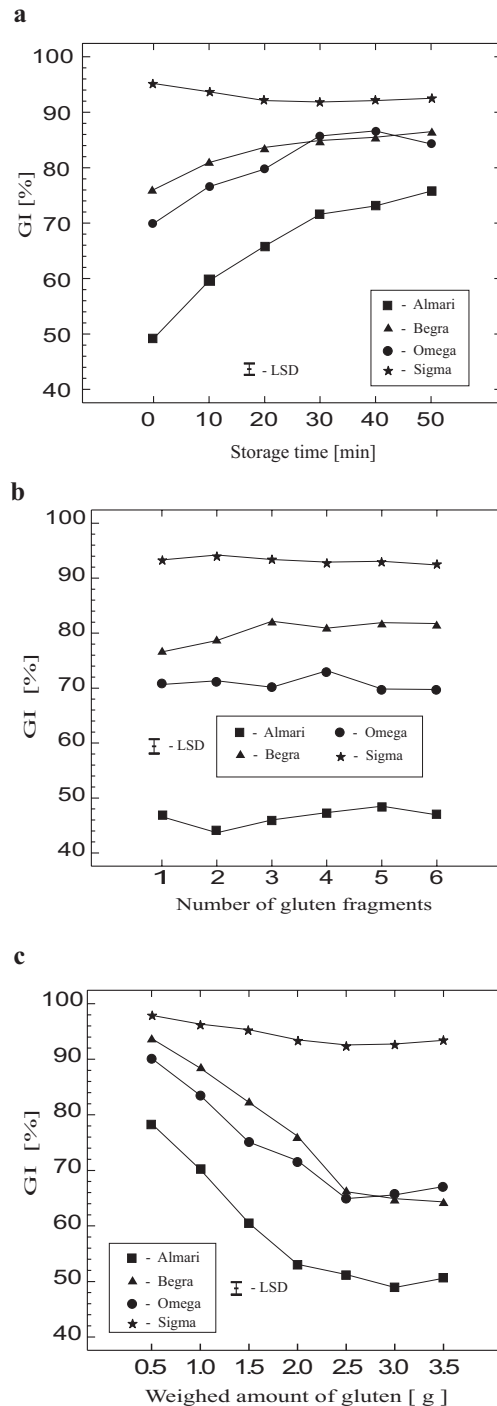


Fig. 2. Effect of storage time (a), fragmentation of the ball (b) and weighed amount (c) of wet gluten washed out from different wheat cultivars on the GI.

However, further rising of the weighed amount of the wet gluten above 2.5 g influenced inhibit the decrease and slow-down the increase of the GI value (Fig. 2c). It suggests that the increasing centrifugal force can cause a proportional increase in the velocity of gluten passing through the sieve only to a certain degree. In the higher ranges of the limit weight increase of the gluten part forced through the sieve holes, is even slower the total weight of the centrifuged gluten. The effect of that is the increase of the GI values.

The range of GI decrease as a result of increasing weighed amount of the centrifuged gluten from 0.5 to 2.5 g depended strongly on the wheat cultivar and was most frequently inversely proportional to the gluten quality (Fig. 2c). It means that the cultivars with higher GI value are characterized as having gluten more resistance to changes in the GI under the influence of its weighed amount.

The effect of the weighed amount on the GI value described above allows to explain the reason for the occurrence of an unexpected tendency reported by Perten *et al.* [9], for the gluten index to decrease with the increasing gluten content. Within the same wheat cultivar (Kosack), they observed that the gluten content ranged from 18 to 32%, whereas the gluten index values from 60 to 10%. However, they did not know that this observed relation could first of all be the result of the increasing centrifugal force as a consequence of the increasing weighed amount (the gluten content).

It is also interesting to discuss why wet glutes of worse quality are more liable to the effects of the increasing weighed amount and storage period. The explanation in case of the weighed amount effect is simpler and more obvious. From the physical point of view, the extent of response of the wet gluten on the increasing centrifugal force (the weighed amount) is always inversely proportional to its strength. So the weaker the glutes, i.e., with the lower GI values, the wider the ranges of change in the GI as a result of the increasing in weighed amount of wet gluten during its centrifugation.

When explaining the mechanism of the effect of storage, it should be useful to note the study [7] on the relationship between moisture content of wet gluten and its strength (GI). It showed that weaker glutes, i.e., with lower GI values, contain a distinctly higher amount of non-bound water than the stronger ones. This kind of water is in a form of pools of water placed in the reticulate material of wet gluten [4]. So, it seems likely that the absorption of non-bound water by the wet gluten, that take place during storage, is the main reason for the increase in the gluten strength (GI) during storage of the weaker glutes especially.

CONCLUSIONS

Results of the presented methodological studies on the determination of the gluten index provided significant information, which can be utilized to improve the glutomatic method for better and simpler testing methods applied for the evaluation of the wet gluten quality.

It is necessary to ensure the same weighed amount of wet gluten during centrifugation for every measurement. The present studies answered the question how to obtain the required weighed amount of the wet gluten without any changes in its physical properties. Collection of gluten balls from two succeeding washing out cycles cannot be applied due to the large variation of wet gluten properties in the course of storage. On the contrary, the process of fragmentation, consisting in dividing the division of a wet gluten ball by the cutting, does not change its physical properties.

Also it is very important to assume such a size of the weighed amount of wet gluten, which can be obtained for most wheat cultivars even if they contain small gluten quantities, and at the same time allows for carrying out reliable tests of wet gluten by the Glutomatic method. A too small weighed amount (e.g., 1.5 g and less) results in decreasing sensitivity of the GI measurements as well as narrowing differences in the GI between wheat cultivars with different quality of the gluten.

Hence the present author proposes to accept 2 g sample of the wet gluten for testing. This amount is equal to 20% wet gluten content. The proposed amount could be obtained by cutting off any excess of wet gluten above 2 g, or, in the rare cases when the deficit in the gluten content occurs, by adding part of the gluten ball taken from the second parallel cycle of the washing out.

REFERENCES

1. **Achremowicz B., Borkowska H., Styk B., Grundas S.:** The effect of nitrogen fertilization on gluten quality and spring wheat grain (in Polish). *Biuletyn Instytutu Hodowli i Aklimatyzacji Roślin*, 193, 29-34, 1995.
2. **Bloksma A.H., Bushuk W.:** Rheology and chemistry of dough. In: *Wheat: Chemistry and technology*. (Ed. Y. Pomeranz), AACC Inc., St. Paul, MN, USA, 131-217, 1988.
3. **Borkowska H., Styk B., Grundas S.:** Assessment of influence of nitrogen fertilization of winter wheat on its gluten quality. *Book of Abstracts of 6th Int. Conf. on Agrophysics*, Lublin, Poland, 11-12, 1997.
4. **Freeman T.P., Shelton D.R., Bjerke J.M., Skierkowski K.:** The ultrastructure of wheat gluten: Variation related to sample preparation. *Cereal Chemistry*, 68, 5, 492-498, 1991.
5. International Association for Cereal Science and Technology. ICC Standard No. 155. Determination of wet gluten quantity and quality (Gluten Index ac. to Perten) of whole wheat meal and wheat flour (*Triticum aestivum*), 1994.
6. **Kaczyński L.:** Wheat varieties appropriate for processing (in Polish). *Przegląd Zbożowo-Młynarski*, 7, 2-7, 1998.
7. **Miś A., Grundas S.:** Changes in physical properties of wet gluten as a result of wheat grain moistening (in Polish). *Przegląd Zbożowo-Młynarski*, 4, 29-32, 1999.
8. **Perten H.:** Rapid measurement of wet gluten quality by the gluten index. *Cereal Foods World*, 35(4), 401-405, 1990.
9. **Perten H., Bondesson K., Mjorndal A.:** Gluten index variation in commercial Swedish wheat sample. *Cereal Foods World*, 37, 8, 655-660, 1992.