CORRECTION OF LOW VALUES OF GLUTEN POWER (W value) DUE TO THE SUNN PEST ATTACK

Crina–Liana GRĂDINARU[1], Eugen ULEA[1], Florin-Daniel LIPŞA[1], Andreea Mihaela FLOREA[1]

e-mail: crina. gradinaru@yahoo. com

Abstract

Determining the quality of wheat-derived flours is influenced by some essential parameters. These parameters are wet gluten, index gluten, Falling Number and W-power from the alveoconsistograph analysis. The quality of the wet gluten represented by the power parameter (W) is directly influenced by the sunn pest attack. The sunn pest, scientifically called *Eurygaster integriceps* is a pest that can bring not only quantitative damages, but also qualitative ones. The sunn pest stings the grain during various developing stages and, with the saliva, it introduces an enzyme named protease. The gluten's main components are gliadin and glutenin, the protease introduced at the same time with the saliva by this pest plays the role of dissolving the gluten's bonds. The glutenin contributes to the dough's resistance, firmness and extensibility, while the gliadin contributes to the dough's elasticity. These components form a three dimensional skeleton within the dough's mass prepared out of the wheat flour, conferring it all the bread making properties. As per W value, the minimum value considered suitable for bread making is 120, below this value we speak of the protease activity; the harder the attack, the lower the W value, and, implicitly, the increased protease activity. The presence of proteolytic activity leads to the change of the rheological features of the dough meaning the decrease in elasticity and the increase of extensibility. 100 tons of wheat were analysed and an average sample has been selected. This sample was analysed from the flour stage to the final bread product. The uncorrected sample was considered a witness sample. The witness sample was corrected with: ascorbic acid, glucose oxidase and lipase in order to follow the evolution of the W value. The correction was performed by the three separated components and then the synergic effect was followed. In parallel with the evolution of the quality parameters, the behaviour improvement of the bread-making process was followed as well.

Key words: Sunn pest, wheat, alveograph analysis

Wheat represents a basic food element for more than 40 % of the globe's population. Wheat species are part of the *Gramineae* family, the *Triticum* genus. According to Seares (1963), quoted by Ceapoiu et al. (1986), there are 11 species of wheat grouped in three groups: the diploid group (2x) AA genome, tetraploid group (4x) AABB genome and the hexaploid group (6x) AABBDD genome. Due to its genetic characteristics, this plant presents a high degree of adaptability, its area of cultivation extends from 60 north latitude to 45 south latitude, and as per altitude the wheat can be cultivated up to 3500 meters. The oldest form of cultivated wheat was Einkorn wheat (*Triticum monococum*) and among the hexaploid species, the *Triticum spelta*. The main component that defines the wheat's bread-making quality is the wet wheat. This reveals importance not only from the quantitative point of view, but also qualitative point of view. The gluten, given its properties, directly influences the technological preparation of the dough, thus, during the milling process, the accent is placed on a series of tests which define its bread-making qualities, such as: the wet gluten determination, the index gluten, the Falling Number and the W value from the alveoconsistograph analysis.

The main components of the gluten are gliadin and glutenin. These components contribute to the formation of a three-dimensional skeleton in the dough's mass prepared out of wheat flour. The glutenin contributes to the resistance, firmness and extensibility of the dough, while the gliadin contributes to the dough's elasticity. The bread-making characteristics of the gluten can be negatively influenced by the sunn pest's attack. The sunn pest, scientifically denominated *Eurygaster integriceps* is a pest which can produce damages not only from the quantitative point of view, but also from the qualitative point of view. The sunn pest stings the grain during the various developmental stages and, together with the saliva, introduces an enzyme named protease. The protease hydrolyses the peptide bond from the amino group of an amino-acid and the carboxyl group of the

following protein amino-acid (Enuta Iorga, Gh. Câmpeanu).

The regular flour obtained from bread-making wheat has a reduced proteolytic activity while the wheat which has been attacked by the sunn-pest reveals an increased proteolytic activity, resulting in non-conforming bakery products. The dough obtained from this flour does not show stability, it cannot retain the gases resulting from the fermentation process, thus resulting such flat bakery products lacking volume. The quality parameter that directly measures this proteolytic activity is represented by the W value from the alveograph analysis. This value can range from 10, the minimum determined with the help of alveo-consistograph, with the maximum values surpassing 300. Based upon the W value, the bread-making wheat can be classified into several sub-classes, according to the type of flour we wish to obtain from this wheat. The minimum W value considered to be bread-making is 120. Beneath this value, the proteolytic activity begins to increase and the higher the activity, the lower the W value is.

Typical to the 2016 harvest year was the sunn pest's attack and the low values of the W. In order to counter-attack the negative effects of this attack and to further strengthen the gluten, several correction versions were tested. The best results obtained were with the oxidising substances such as ascorbic acid or enzymes such as glucose-oxidise and lipase.

The ascorbic acid is an organic acid with antioxidant properties which presents itself as a powder or some whitish-pale yellowish crystals. It is soluble in water and is a good dough hardener. The ascorbic acid oxidase, catalyses the oxidation with the help of the molecular oxygen of the ascorbic acid (Enuţa I., Câmpeanu Gh.). The glucose-oxidase is a good oxidant with the effect of hardening and drying the dough (Enuţa I., Câmpeanu Gh.).

The lipases are enzymes spread in nature, not only in animal organisms, but also in the vegetal and microbial ones. For bread-making, the micro-organisms constitute the main source of the lipase. The effects of the lipase in bread-making are: the increased stability of the dough, the increased volume of the bread, the improved structure and elasticity of the bread's core, the lighter colour of the core and the prolonged freshness (Bordei et al., 2000).

MATERIAL AND METHODS

The study has as aim the monitoring of the improvement of the W parameter determined by alveoconsisograph analysis, following the sunn pest's attack.

100 tons of wheat attacked by the sunn pest were taken into consideration, from which an average sample was made.

These samples were subjected to laboratory testing and the following parameters were determined: wet gluten, index gluten, the alpha-amylase activity and the characteristics of the alveoconsystograph analysis.

In order to determine the wet gluten, the mechanical washing method has been used with the help of the glutamate. The principle of the method: the wheat is milled using the laboratory's mill capable of obtaining the granulometric distribution specific to the working method. From this grinding precisely 0.01g is measured, 10 g from the testing sample, and is transferred to the two washing containers of the glutamate. Sodium chloride is used for washing, with a concentration of 2 %. When the washing process is finished, the wet gluten is removed with the help of tweezers and introduced in the centrifuge chambers in order to eliminate the excess solution. With the help of the tweezers, the gluten is removed and precisely 0.01 g is weighted and it is calculated using the following formula:

$G_{wet} = m_1 \times 10\%$

The result is given by the arithmetical average calculating the average of two determinations and it is expressed with only one decimal.

In order to determine the index gluten, the two fractions of the gluten are weighed separately by the centrifuge separator. Its value is calculated using the following formula:

$$\text{gluten index (\%)} = \frac{\text{wet gluten from the separator (g)}}{\text{total wet gluten (g)}} \times 100$$

The determination of the rheological properties of the dough is done with the help of the alveograph.

The principle of the method: the wheat sample is conditioned upon the analysis and it is milled with the help of an experimental mill. The humidity of the flour is determined, following which it is subjected to the mixing stage. For this step, a sodium chloride solution with a 2 % concentration is used. The humidity is determined in order to establish the solution quantity needed to be used in order to form the dough. The mixing time of the dough is usually 8 minutes, after which the dough is laminated in 5 different pieces which are laid to rest for another 20 minutes within the temperature-controlled environment at 25° C. Thus, the final duration of the analysis is of 28 minutes. After rest, the dough pieces are subjected to pressure in order to determine the alveograph analysis parameters.

The alveograph analysis parameters are:
- P is the maximum pressure index correlated with the deformity resistance, tenacity;
- L parameter represents the dough's elasticity;
- G is the raising index and represents the dough's extensibility;

- P/L is the ratio between the pressure parameter and the dough's elasticity;
- W value represents the flour's power and the deformation energy.

Determination of the fall index is done with the device called Falling Number. This fall index represents the activity of the alpha-amylase enzyme of the flour.

RESULTS AND DISCUSSIONS

The analysed wheat was milled using the experimental mill and the flour subjected to testing was derived.

The determined values for the flour witness sample are shown in table 1.

Table 1
Quality parameter values of the witness sample

Parameter	Wet Gluten	Index Gluten	W	FN
Value	27.8	72.6	89	412

The low value of W indicates an increased proteolytic activity. Figure 1 shows the alveograph's chart obtained after the laboratory analysis.
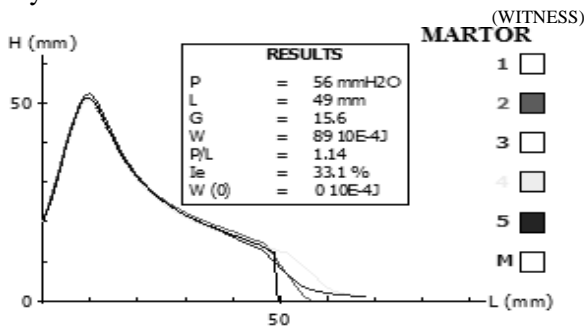

Figure 1 **Rheological analysis witness sample**

As per the wet gluten's quantity and the value of the index gluten obtained, the wheat can be classified as wheat for bread-making.

As per the W value's standpoint, a very low value indicates a low bread-making quality. After the analyses performed, the derived flour was subjected to the further analysis, the baking test was applied to it as well.

The recipe used for the baking test was the following: 1 kg flour; 1.5 grams of salt and 52 % hydration capacity in order to obtain a dough with normal consistency. The increased proteolytic activity manifests itself starting from the dough state, conferring its sticky trait. The modelled products were subjected to the raising process for 40 minutes at a temperature of 35 degrees C and 60 % humidity.

The baking temperature was set to 220 degrees C for 15 minutes.

The resulting bread produced using the sunn pest attacked wheat is flat, without shine, with a dense core and dark coloured (Figure 2).

Figure 2 **Bread obtained using sunn pest attacked flour**

The bread's quality is shown using the measurements made on the bread slice.

The slice's height (h) was measured as well the width of the slice (l) and the total length (L) (Table 2).

Table 2
Quality parameters of the bread slice

Parameter	h-mm	l-mm	L-mm
Value	4	11.6	27.5

The selected witness sample was corrected using ascorbic acid, glucose-oxidase and lipase, initially each corrector being added separately, and later on mixed with all three gluten hardeners.

The effects of the three correctors were closely analysed initially using the alveograph analysis and then during the baking stage.

The last performed testing serves to document what is the synergic effect resulting from the three correctors when they are added together as well as further improvement of the dough and finally the bread product.

The first sample is the flour corrected with ascorbic acid.

The dosage used is 10g per 100 kg of flour.

The values resulting from the alveograph analysis for this sample are documented in table 3 and in figure 3 the chart from the alveograph analysis obtained after the laboratory analysis.

Table 3
Quality parameter values of ascorbic acid correction

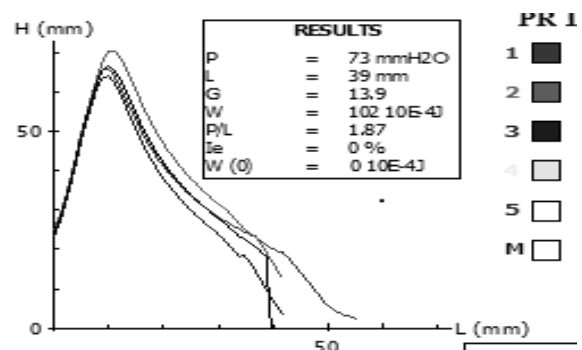| Parameters	Wet Gluten	Gluten index	W	FN
Value	27.8	72.6	102	412

Figure 3 **Rheological analysis of the sample corrected by ascorbic acid**

From the alveograph analysis we can deduce the increase relating to the dough's tenacity as well as the W value.

For the baking test the same recipe was used together with the same technological parameters just as in the witness sample.

The products obtained show volume and stability during the fermentation stage.

The measured quality parameters of the bread slice are presented in table 4.

Table 4

Quality parameters of the slice of bread

Parameter	h-mm	l-mm	L-mm
Value	6.4	11	27

Figure 4 shows the large differences in the quality of the bread slice between the witness sample and the sample number 1 corrected with ascorbic acid.
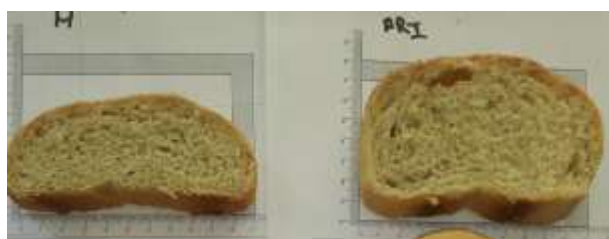
Figure 4 **Differences between slices**

The second sample is the flour corrected by lipase.

The dosage used was 1.5 grams per 100 kg of flour.

The values shown by the alveograph analysis for this particular sample are written in table 5 and in figure 5 the alveograph analysis chart resulted after the laboratory analysis is performed.

Table 5

Parameter values concerning quality of lipase correction

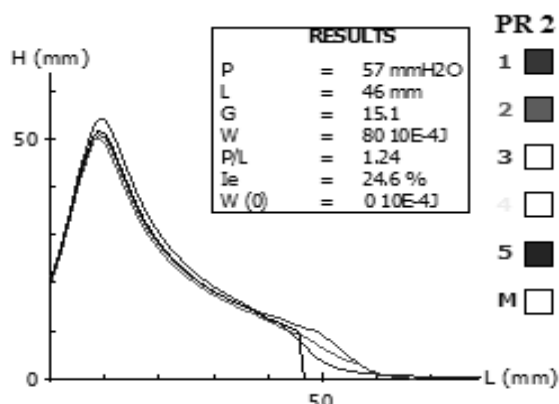| Parameter	Gluten wet	Gluten index	W	FN
Value	27.8	72.6	80	412

Figure 5 **Alveograph analysis obtained after laboratory analysis**

The power parameter (W) of the flour did not register an increase on the alveograph analysis,

but improvements have been made with regard to the malleable aspect of the bread.

The quality parameters of the measured slice of bread are presented in table 6.

Table 6

Quality parameters of the bread slices

Parameter	h-mm	l-mm	L-mm
Value	5	11.5	27.4

In Figure 6 the differences between the two slices are represented (witness probe and lipase corrected).

Figure 6 **Differences between slices**

The third test is the flour corrected by glucose-oxidase.

The dosage used was 3 grams per 100 kg of flour.

The values reported by the alveograph for this test are represented in table 7 and in figure 7 the chart of the alveograph analysis after the laboratory analysis is shown.

Table 7

Quality parameters of the glycose-oxidase corrected

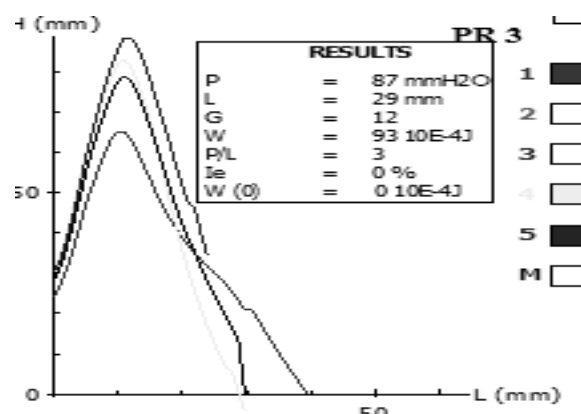| Parameter	Gluten wet	Gluten index	W	FN
Value	27.8	72.6	93	412

Figure 7 **Alveograph analysis obtained after the laboratory analysis**

The power parameter (W) of the flour recorded an increase on the alveograph analysis.

The measured quality parameters of the bread slice are shown in table 8.

Table 8

Quality parameters of the bread slice

Parameter	h-mm	l-mm	L-mm
Value	5.3	10.1	27.3

Figure 8 shows the differences of the bread slice between the witness sample and the lipase corrected sample.

Figure 8 **Differences between slices**

The fourth test was performed mixing the three correctors: ascorbic acid 10g %; lipase 1.5g % and glycose-oxidase 3g %.

The corresponding alveograph analysis values are represented in table 9 and in figure 9 the chart of the alveograph analysis of these values is represented, after the laboratory analysis.

Table 9

Quality values of the complex correction parameters

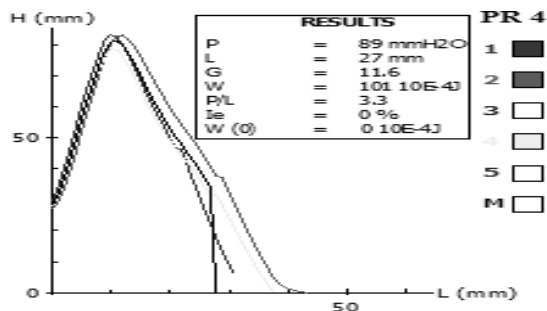| Parameter	Wet gluten	Index gluten	W	FN
Value	27.8	72.6	101	412

Figure 10 **Alveograph analysis obtained after laboratory analysis**

The power parameter (W) of the flour revealed an increase on the alveograph analysis.

The measured quality parameters of the slice are written in table 10.

Table 10

Quality parameters of the slice

Parameter	h-mm	l-mm	L-mm
Value	7	12	27.4

In Figure 10 the differences of the bread slice between the witness sample and the corrected one are presented.

Figure 10 **Differences between slices of bread**

CONCLUSION

From the results obtained we can observe that all three correctors used to improve the negative effects of the sunn pests attack have succeeded in doing so.

These results are reflected either in alveograph analysis parameters or in processability, tenacity and hardening of the dough.

The effect of the ascorbic acid correlates positively with the dough's stability, the height of the slice of bread and the obtained volume. The W value has increased from 89 on the witness sample to 102 on the corrected one.

The effects of the lipase in the dough correlate positively with the processability of the dough, the stability shows improvement together with its increase in volume as opposed to the witness sample.

On the alveograph analysis there are no signs of improvement with regard to the measured parameters.

The effects of the glucose-oxidise positively correlate with the growth of stability and processability of the dough by reducing the tendency to be sticky, and the volume of the finished product, the bread.

The best results with regard to the processability and the volume of the dough were shown in the fourth sample when all the three correctors were added.

In figure 11 all four corrected samples and the witness sample are shown for comparison.
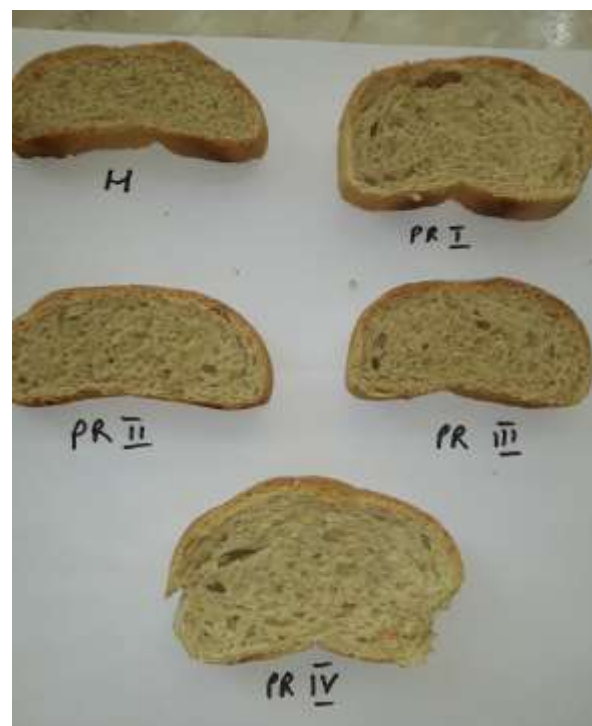

Figure 11 **Differences between slices**

In the photos 11-13 the evolution of measurements is tracked for all tests and samples

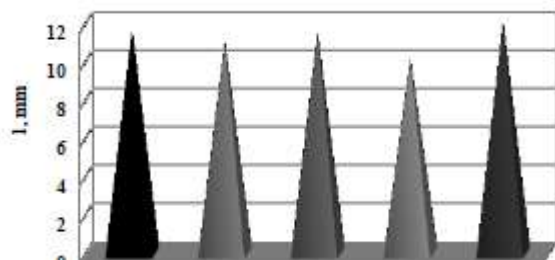**Comparative study of width variation according to different additions**

Figure 12 **Variation in the slice's width**

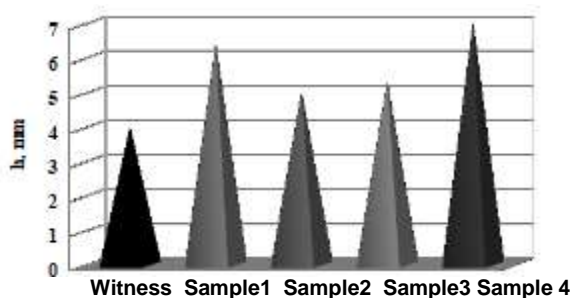**Comparative study of height variation according to different additions**

Figure 13 **Variation in height of the slices**

Comparative study of length variation according to different additions
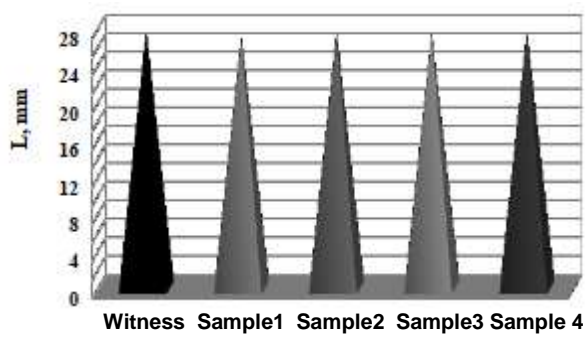

Figure 14 **Variation in total length of the bread**

In Figure 15, the bread samples using sunn pest attacked flour and the samples corrected using oxidant substances (ascorbic acid) and enzymes (glucose-oxidase and lipase) either separately or together are presented for comparison.
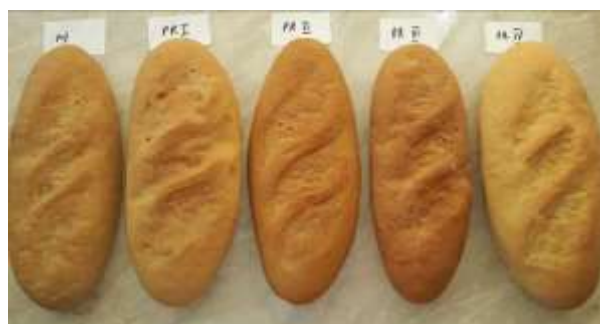

Figure 15 **Differences between final products**

REFERENCES

Batea V., **1998** – *Fermentarea aluatului de panificaţie*, Anuarul Asociaţiei Specialistilor din Morărit si Panificaţie din Romania *(Fermentation of bakery dough*, Yearbook of the Association of Milling and Bakery Specialists from Romania), Galaţi, pages 267-290;

Bordei D., **2007** – *Controlul calităţii în industria panificaţiei - Metode de analiza* (*Quality control in the bakery industry - Methods of analysis*,) Academica Publishing House, pages 246-250;

Collar C., Santosm E., Roselli C. M., 2007 – *Assessment of the rheological profile of fiber-enriched bread dough by response surface methodology.* Journal of Food Engineering 78(3): pages 820-826.

Hruskova M., Smejda P., 2003 – *Wheat flour dough alveograph characteristics predicted by NIR systems 6500.* Czech Journal of Food Science 21(1): pages 28-33.

Indrani D. R., Manohar S., Rajiv J., Venkateswara Rao G., 2007 – *Alveograph as a tool to assess the quality characteristics of wheat flour for parotta making.* Journal of Food Engineering 78(4): pages 1202- 1206.

Moradi, V., Mousavi Khaneghah, A., Fallah A. and Akbarirad, H. 2016 – *Rheological properties of wheat flour with different extraction rate, International,* Food Research Journal 23(3): pages 1056-1061.

Rosell, C. M., Rajan, J. A., Benedito, D. E. and Barber, C. 2001 – *Influence of hydrocolloids on dough rheology and bread quality.* Food hydrocolloids 15(1): pages 75-81.

Shelton D.R., Lee W.J., 2000 – Kulp and Ponte (eds*), Handbook of cereal science and technology*, CRC Press, New York.

http://www.perten.com/Products/Glutomatic/The-Gluten-Index-method/]