SAT–LB-P-2-BFT(R)-03

DETERMINATION OF RHEOLOGICAL PROPERTIES WITH FARINOGRAF And EXTENSIGRAF OF BIO-FORTIFIED FLOUR

Assistant Prof. Marija Menkinoska, PhD
Assistant Prof. Tatjana Blazhevska PhD
Assistant Prof. Viktorija Stamatovska PhD
Faculty of Technology and Technical sciences-Veles
University "St. Climent Ohridski", 7000 Bitola, Republic of Macedonia
E-mail: marija_menkinoska@yahoo.co.uk
E-mail: msptatjana@yahoo.com
E-mail: vikistam2@gmail.com

Professor Vinko Stanoev PhD
Agricultural Institute
University "St. Cyril and Methodius: Skopje, Republic of Macedonia
E-mail: v.stanoev@zeminst.edu.mk

Abstract: *Rheological properties of dough are very important indices for product development in terms of product quality and process efficiency. There are several ways to evaluate the rheological behaviors of the dough, one of them is using farinographc and extensographic.The aim of this research was to examine the impact of agronomic bio-fortification on the rheological properties of flour obtained from wheat variety Radika. In this research are included 7 samples obtained by adding high quality chelate fertilizers at different stages of wheat growth: Fe soil (1), Fe soil + foliar (2), Fe foliar (3), Control (4), Zn soil (5) , Zn soil + foliar (6) and Zn foliar (7). From farinograph data for water absorption it is concluded that all variants have approximate values with minimal differences compared with variant 4. According to the data obtained for the level of softness, it is concluded that the dough for all variants are with medium quality. According to the qualitative number, all variants fall into the quality level B2, with exception of variant 5 which belongs to quality level C1. The results obtained from the extensigraf have shown that variant 1,2 and 7 has higher value of extensibility of the dough compared to variant 4, while variant 5,6 and 3 have lower values.The greatest resistance is measured in variant 2, and the lowest value for variant 5. Higher values were found in variants 1, 6 and 7, but variant 3 has a lower energy value compared to variant 4. Highest value the ratio (esistance / exstensibility) was measured in variant 1 and 3, and the lowest in variant 5. Higher values were found in variants 6 and 7 compared to variant 4. From the farinographc analysis it can be concluded that the application of iron and zinc chelating fertilizers did not have a significant effect on the technological quality of the flour. From extensographic analysis is ascertained influence from application of iron soil, iron soil + foliar and zinc foliar wherein for variants 1,2 and 7 are obtained flour with higher extensibility, resistance and energy.*

Keywords: *bio-fortification, rheological, farinograph and extensigraf*

INTRODUCTION

In recent years there have been significant changes in terms of the desire of food consumers to buy and consume healthier foods, higher quality foods, with lower prices and more exotic foods. Individual food producers must respond quickly to consumer demands in order to remain competitive in the food industry. The plant food provides a range of nutrients essential for human consumption, yet, in most parts of the world, the main raw materials derived from agricultural crops are often deficient in terms of some nutrients such as zinc and iron.

Biofortification is the process by which the concentration of micronutrients as zinc, iron, manganese, etc increases, in agricultural products, especially the cereals. The genetic biofortification uses specially grown cultures that will be able to accumulate (absorb) more zinc and other micronutrient elements from the soil in the nutrient parts of the grains (Ryan, E., 2010). Agronomic biofortification involves the use of fertilizers with higher concentrations of zinc and other micronutrients. It also provides a short-term and efficient approach that will provide an

increase in the concentration of Zn / Fe in the soil and wheat grains, using Zn / Fe fertilizer or NPK fertilizer enriched with Zn or Fe (Cakmak, I ., 2008).

However, accepting biofortificated crops on one hand from the consumers and on the other hand the producers in the milling and bakery industry is another issue that needs to be paid special attention. Taking into account that in the Republic of Macedonia no research was conducted in the field of biofortification, the purpose of this research is to investigate the influence of zinc and iron chelating fertilizers on the rheological properties of flour obtained from the wheat variety Radika.

MATERIAL AND METHODS

Material

Plant material

The variant of the type "Radika" soft wheat (*Triticum aestivum*), was used as a plant material in this research.

Location and setting experiment

On the lands belonging to the Agricultural Institute in Skopje (Macedonia), in the testing economy "Dolno Lisiche", during the production year 2012/2013, a test was placed according to the method of accidental bloc system, with 7 variants, three time repeated, while the testing parcel being of 30 m² size. The distance between the variants and the repeating procedures was 50 cm. The procession of the parcel was a standard one by bringing the plowed layer in condition of normal sowing. The sowing was conducted manually with 600-650 life-able grain/m².

Application of fertilizer

The following variants are included in the test of this research:

- Fe application in soil (variant 1)
- Fe application in soil and foliar (variant 2)
- Fe foliar application (variant 3)
- Control – without fertilizing (variant 4)
- Zn application in soil (variant 5)
- Zn application in soil and foliar (variant 6)
- Zn foliar application (variant 7)

Basic characteristics of the fertilizers

Yara Vera™ Amidas is a highly qualitative granular fertilizer which contains nitrogen and sulfur. The nitrogen is mostly available in the form of urea. The sulfur is available in the form of sulfate and is totally water-soluble. The ratio between the nitrogen and sulfur is from 7 towards 1.Nutrichem folifer-Fe EDTA chelate product, which is used for a foliar nutrition of the plants.Yara Vita Rexolin is a product for prevention of a shortage of zinc formulated in the form of EDTA chelate. Containing 15% and 148 grams of zinc per kilogram a product can be used for soil or foliar application.

Period of application of fertilizer

The nutrition of the wheat is conducted in the following stages of development:

1. Germination stage-fertilizing with NPK(9:15:15) 200 (kg/h) soil at the variants 1,2,3,4,5,6 and 7. Fe EDTA 10 (kg/h) soil apllication with the variants 1 and 2. Zn EDTA 20 (kg/h) soil apllication with the variants 5 and 6.

2.Tillering stage- applied Yara Vera Amidas 160 (kg/h) soil at the variants 1,2,3,4,5,6 and7.

3. Booting stage- Yara Vera Amidas 100 (kg/h) soil at the variants 1,2,3,4,5,6 and 7.

4. Booting stage- Fe EDTA 1 (kg/h) foliar at the variants 2 and 3. Zn EDTA 1kg/h(0.1%) foliar at the variants 6 and 7

5. Heading and flowering- Fe EDTA 1(kg/h) foliar at the variants 2 and 3.Zn EDTA 1kg/h(0.1%) foliar at the variants 6 and 7

6. Flowering Fe EDTA 1 (kg/h) foliar at the variants 2 and 3. Zn EDTA 1kg/h(0.1%) foliar at the variants 6 and 7

The foliar fertilizing was conducted by a dorsal sprinkler, with 3 liters of solution (mixture) with the variants 2 and 3 at the early morning hours.

Methods

The grinding of wheat from each variant is performed with a laboratory mill from the BRABENDER company.

Determination of the rheological properties of the biofortificated dough is carried out with the pharynograph and extensograph from the company BRABENDER.

-pharographic analysis with the method AACC 54-21 (American Association for Cereal Chemistry - AACC 1995) the following parameters were examined:

- water absorption%, degree of softening (Fj), quality number and quality group.

- Extensographic analysis with the method AACC 54-10 (American Association for of Cereal Chemistry - AACC 1995) and the measured parameters were:

extensibility (mm), resistance (Ej), relative number and energy (cm^2)

All parameters are measured after 45, 90 and 135 min of the rest time. Grinding and testing of the flour is carried out in the farinological laboratory of "Zito Luks AD" - Skopje.

RESULTS AND DISCUSSION

Farinological studies of the quality properties of flour

The physico-chemical properties of food (rheological properties, physical properties, stability, taste) determine the quality of food and are an important factor for the consumer when coosing the product. The most important factors are the production conditions and the raw materials used for production (Nakov, G., 2018).The quality of the flour is tested by physical and chemical methods. The physical characteristics of the dough have a major influence on the quality of ready-made bakery products. The determination of the quality of the flour with the farinograph is based on the registration of a change in the physical properties of the dough during a particular mixing time, which depends mainly on gluten. It is actually a dynamometer that measures the resistance of the dough that produces the dough on the mixer blades when it is absorbed in the container. From the obtained farinographic curved graphs for wheat flour, are obtained data related to the absorption capacity, the degree of softening the dough during the filling, and also the quality number and the quality group (Wheat and Flour Testing Methods, 2004).

Table 1. Determination of the physical properties of wheat flour with Farinograph

Farinograph data	1	2	3	4	5	6	7
Water absorption %	65.4	64.5	64.5	64.7	65	64.2	64.9
Level of softness (Fj)	80	100	95	110	115	90	95
Qualitative number	54.4	48.6	49.6	48.8	43.4	53.3	52
Qualitative level	B_2	B_2	B_2	B_2	C_1	B_2	B_2

An important technological feature for the baking industry is the degree of softening the dough, expressed in Farinoghraphic units (in Fj). If the degree of softening is greater, the flour, i.e. the dough is harder to tolerate fermentation and vice versa. It is considered that the 75 Fj softening grade flour is of good quality, from 75 to 125 Fj with medium and over 125 Fj of poor quality. The more value is lower, the dough has better quality.

The technological quality of the flour, based on farinograph is evaluated in three quality groups. To quality group A belong strong flours with optimal baking ability; to quality group B belong middle flours with good baking characteristics, while to quality group C belong weak flours, ie. with poorer quality and lower absorption power (Albrecht, T., 2010).

From the results obtained for water absorption it is concluded that all variant have approximate values with minimal differences with regard to variant 4. The degree of softening the dough for all varieties is within the limits of 80 to 115 Fj accordingly, and this dough belongs to the dough group with medium quality. As for the quality number variants 1, 2, 3, 4, 6 and 7, it belongs to the quality group B2, while the flour of variant 5 belongs to the quality group C1.

With the extensograph, are examined the physical properties of the dough and its reaction to resting and mechanical processing i.e. are measured the extensibility and the resistance. The obtained results complement the image of the flour quality obtained with the examination of the Farinograph (Žeželj, M., 2005; Kalugerski, G., 2006).

Table 2. Determination of the physical properties of wheat flour with an extensograph.

Extensigraf data	1	2	3	4	5	6	7
Extensibility (mm)	181	170	130	161	152	150	170
Resistance (Ej)	100	140	100	80	65	95	100
Value the ratio (esistance / exstensibility)	0.5	0.8	0.8	0.5	0.4	0.6	0.6
Energy (cm^2).	36	45	24	26	21	28	36

From the results presented in Table 2, it is noted that the varieties 1, 2 and 7 have higher spreadability of the dough compared to variant 4, while variant 5, 6 and 3 have lower values.

The highest resistance and energy were measured in variant 2, and the lowest value for variant 5. In the other variants, higher values were found in relation to variant 4, with the exception of variant 3 having a lower energy value compared to variant 4.

As for the ratio, the highest values were measured in variant 2 and 3, and the lowest in variant 5. For variants 6 and 7, higher values have been found, compared with variant 4.

CONCLUSION

Rheological methods are used to determine the technological quality of wheat and the quality of wheat flour, which is the basic raw material of the mill and bakery industry. The results of these tests have a direct relationship to the quality of the product.

On the basis of the obtained results of the research for determining the effects of agronomic bio-fortification, it can be concluded that the application of zinc and iron chelating fertilizers does not have a significant effect on the examined Farinographic parameters.

From extensographic analysis is ascertained influence from application of iron soil, iron soil + foliar and zinc foliar wherein for variants 1,2 and 7 are obtained flour with higher extensibility, resistance and energy.

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