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# INFLUENCE OF NITROGEN FERTILIZATION OF WINTER WHEAT ON ITS GLUTEN QUALITY*

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A b s t r a c t. Five winter wheat varieties grown in 1992-95 at two levels of the nitrogen fertilization: 50 and 150 kgN/ha, were tested. Protein content, wet gluten content and gluten index value were examined. Gluten index values, which according to Perten's method determine baking quality, were negatively correlated with protein and wet gluten contents. Within the tested varieties significant differences were found for the values of gluten index. The results obtained suggest that irrespective of the effect of N-fertilization, gluten indices for the varieties tested are also genetically determined.

K e y w o r d s: winter wheat, N-fertilization, protein, wet gluten, gluten index

## INTRODUCTION

Because of its characteristics wheat gluten has been used over 250 years for breadmaking and up to now is the object of interest for researchers. It should be stressed that diversified conditions of winter and spring wheat cultivation in various regions of the world additionally affect its technological quality. It is commonly known that the quality of wheat depends on many factors involved in the processes of grain production. However, in the part of the chain related to crop production in some environmental conditions and for some chosen varieties, the level of N-fertilization can play a special role in wheat quality.

Application of the increased level of N-fertilization during wheat cultivation, usually leads to increased levels of protein content [2]. It also shows significant influence on the quality characteristics of dough [4,5]. In the previous work by the present authors [1] it was stated that an increased level of N-fertilization leads to the increased level of protein content and wet gluten content in the grain of a few varieties of spring wheat. Those characteristics did not show positive correlation with the gluten index that characterises the baking value of flour.

A confirmed relations between the above indices for the grain of spring wheat encouraged the present authors to undertake similar research work on at least a few varieties of winter wheat.

## MATERIAL AND METHODS

Five varieties of common red winter wheat were grown in the same location at the Experimental Station near Lublin in 1992-1995. The following varieties: Alba, Lama, Begra, Nike and Rosa were chosen. These varieties represented a wide range of baking values of wheat from weak to strong.

Two levels of mineral N-fertilization in four replications were applied, 50 kg and 150 kg of N/ha, respectively. Wheat grain was mechanically harvested at full ripeness.

Quality tests were carried out on the three months old harvested grain. In the beginning, samples of grain from four field replications

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**Table 1.** Mean values of the protein content PC, gluten content (WGC) and gluten index (GI) for tested varieties of winter wheat, seasons and levels of N-fertilization

| Varieties | Levels of N-fertilization (kg/ha) | Mean values | | | Total means |
|---|---|---|---|---|---|
| | | 1993 | 1994 | 1995 | |
| | | PC (%) | | | |
| Alba | 50 | 10.4 | 13.9 | 13.2 | 12.5 |
| | 150 | 11.5 | 14.7 | 14.7 | 13.6 |
| | Mean | 11.0 | 14.3 | 14.0 | 13.1 |
| Begra | 50 | 12.3 | 16.0 | 14.2 | 14.2 |
| | 150 | 13.8 | 16.2 | 15.2 | 15.1 |
| | Mean | 13.1 | 16.1 | 14.7 | 14.6 |
| Lama | 50 | 11.1 | 14.8 | 13.6 | 13.2 |
| | 150 | 12.2 | 15.5 | 14.9 | 14.2 |
| | Mean | 11.7 | 15.2 | 14.3 | 13.7 |
| Nike | 50 | 12.8 | 15.4 | 13.4 | 13.9 |
| | 150 | 13.4 | 16.5 | 15.3 | 15.1 |
| | Mean | 13.1 | 16.0 | 14.4 | 14.5 |
| Rosa | 50 | 11.8 | 14.8 | 13.3 | 13.3 |
| | 150 | 12.8 | 16.0 | 14.6 | 14.5 |
| | Mean | 12.3 | 15.4 | 14.0 | 13.9 |
| | | WGC (%) | | | |
| Alba | 50 | 19.5 | 25.0 | 21.0 | 21.8 |
| | 150 | 23.2 | 27.7 | 26.9 | 25.9 |
| | Mean | 21.4 | 26.4 | 24.0 | 23.9 |
| Begra | 50 | 20.0 | 27.5 | 21.1 | 22.9 |
| | 150 | 24.3 | 29.5 | 26.4 | 26.7 |
| | Mean | 22.2 | 28.5 | 23.8 | 24.8 |
| Lama | 50 | 17.8 | 25.7 | 22.1 | 21.9 |
| | 150 | 20.7 | 30.8 | 27.0 | 26.2 |
| | Mean | 19.3 | 28.3 | 24.6 | 24.1 |
| Nike | 50 | 22.8 | 29.7 | 20.1 | 24.2 |
| | 150 | 25.7 | 33.5 | 27.8 | 29.0 |
| | Mean | 24.3 | 31.6 | 24.0 | 26.6 |
| Rosa | 50 | 18.3 | 26.5 | 19.0 | 21.3 |
| | 150 | 24.7 | 30.3 | 25.0 | 26.7 |
| | Mean | 21.5 | 28.4 | 22.0 | 24.0 |
| | | GI (%) | | | |
| Alba | 50 | 8.0 | 39.5 | 45.0 | 30.8 |
| | 150 | 7.8 | 25.0 | 32.1 | 21.6 |
| | Mean | 7.9 | 32.2 | 38.5 | 26.2 |
| Begra | 50 | 95.8 | 84.2 | 91.2 | 90.4 |
| | 150 | 73.2 | 75.2 | 74.9 | 74.4 |
| | Mean | 84.5 | 79.7 | 83.1 | 82.4 |
| Lama | 50 | 24.0 | 50.8 | 48.2 | 41.0 |
| | 150 | 17.3 | 35.2 | 34.2 | 28.9 |
| | Mean | 20.7 | 43.0 | 41.2 | 35.0 |
| Nike | 50 | 12.8 | 39.0 | 44.3 | 32.0 |
| | 150 | 10.8 | 37.7 | 36.1 | 28.2 |
| | Mean | 11.8 | 38.4 | 40.2 | 30.1 |
| Rosa | 50 | 74.0 | 67.5 | 72.4 | 62.3 |
| | 150 | 43.0 | 52.7 | 48.9 | 48.2 |
| | Mean | 58.5 | 60.1 | 60.7 | 59.8 |

LSD at $\alpha = 0.05$ equal to 0.2, 2.8 and 4.8 for PC, WGC and GI, respectively.

were cleaned and then mixed to obtain representative test samples.

Protein Content (PC) of grain was determined by using grain tester TREBOR-90XL, made in USA. To determine the constituents within grain (e.g., protein), the following procedure is commonly used.

After assuring that the grain catch tray is beneath the grain hopper, the operator can press the START push button. After a few seconds, the instrument will display "POUR IN SAMPLE". Next, the operator should pour a clean grain sample of approximately 250 g (or more) into the grain hopper (a cupful is fine). Then the measurement of the selected constituents will be shown on the digital display. If the optional printer is attached, a full printed record is also provided.

Quality tests of gluten were carried out by Perten's instrument, called Glutomatic (2200 type), according to ICC Standard Method No. 155. For the preparation the wheat flour from whole grain a laboratory mill, model 3100, was used. A measuring set - the Glutomatic, and the Centrifuge of the 2015 type were used for evaluation Wet Gluten Content (WGC) and Gluten Index (GI) as a measure of gluten quality.

## RESULTS AND DISCUSSION

Table 1 presents the mean values of protein content, wet gluten content and gluten index for all investigated varieties under the influence of tested factors.

In the range of tested varieties, irrespective of study years and N-fertilization levels, three homologous groups of PC values existed.

Variety Alba with 13.1%. Varieties Lama and Rosa (ca. 13.8 %) and varieties Begra and Nike with 14.5 % of PC. Mean PC values in these groups differ significantly. Irrespective of the varieties and study years significant differentiation in the PC values was found between N-fertilization levels: $N_{50}$ - 13.4 %, $N_{150}$ - 14.5 %. This trend agrees with the results of the above mentioned research study [1,2].

In the case of Wet Gluten Content no significant differentiation between the varieties was found. However, we found a significant differentiation of WGC values between the two levels of N-fertilization. At the level of $N_{50}$ the value of WGC was equal to 22.4 %, but at the level of $N_{150}$, this value was equal to 26.9 %.

The present results showed that the increase of both PC and WGC values was influenced by higher N-fertilization levels.

Considering the values of Gluten Index, three homogenous groups can be created. Varieties Alba, Lama and Nike (ca. 30.4 %), Rosa with 59.8 %, and Begra with 82.4 %.

Taking into account that GI values between 60 and 95 % mean appropriate quality of gluten for breadmaking, only varieties Begra and Rosa could be considered as appropriate for breadmaking.

Influence of N-fertilization levels on the GI values are of the reverse nature. The results showed that an increase of N-fertilization level significantly influenced a decrease of GI values, irrespective of the study years and varieties. At the $N_{50}$ the mean value of GI was 51.3 % but, at $N_{150}$ it dropped down to 40.3 %.

Similar influence of intensive N-fertilization on some quality characteristics of wheat grain were confirmed by Achremowicz *et al.* [2] and Jankiewicz [3].

## CONCLUSIONS

Considering the results of our study the following conclusions can be drawn:

1. An increase in the N-fertilization level led to the increase of both, Protein Content (PC) and Wet Gluten Content (WGC) irrespective of the varieties of winter wheat.

2. Values of Gluten Index decreased with an increase in N-fertilization levels. Since, similar conclusions were found last year, in the case of five tested varieties of spring wheat, generally speaking it can be stated that with increasing of N-fertilization of wheat, higher level of PC is obtained. However, in this case, the gluten quality of grain expressed by GI values for some varieties are not satisfactory from the point of view of baking.

The present authors suggest that further investigations should be directed on the explanation of the methodological aspects of measuring of gluten index values. It could become evident, that decreasing level of gluten index is more determined by its mass than technological properties.

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