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KARTUPEĻU MERISTĒMU KLONU MAINĪBA - JAUNI FAKTI ZINĀTNEI UN PRAKSEI

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Vīrusu samazināšanas procedūras gaitā atveseļotie augi *in vitro* tika uzturēti kā meristēmu kloni *in vitro*. Katras izdalītās meristēmas pēcnācēji bija izejas materiāls meristēmu klonam. Katra klona agronomiski nozīmīgās pazīmes tika novērtētas lauka izmēģinājumos. Meristēmu klonu izturība pret lakstu puvi tika noteikta *in vitro* līmenī, augus mākslīgi inficējot ar *Phytophthora infestans*, kā arī lauka apstākļos. Vairāk kā 600 meristēmu klonu, kas iegūti no 40 šķirnēm, tika pētīti ilgu laiku. Rezultāti parāda, ka meristēmu kloni atšķiras ražas, cietes saturā, kā arī slimību izturības ziņā. Piemēram, šķirnes 'Agrie Dzeltēnie' 16 meristēmu klonu trīs gadu vidējā raža variēja no 32.4 līdz 51.4 t ha⁻¹. Šķirnes 'Bintje' viens meristēmu klons pārspēja citus ar augstu izturību pret lakstu puvi, lielāku ražu un cietes saturu. Šķirnei 'Ants' netika konstatēta sakarība starp jutīgumu pret lakstu puvi un ražu. Izturīgākā meristēmu klona raža bija 38.1 t ha⁻¹, bet vidēji izturīga klona raža bija 51.8 t ha⁻¹. Mēs varam secināt, ka ir iespējams uzlabot šķirnes agronomiskās īpašības atlasot meristēmu klonus, šis fenomens ir izmantojams sēklaudzēšanā un selekcijā.

BREEDING OF WINTER WHEAT FOR END-USE QUALITY

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Abstract

The winter wheat varieties 'Ada', 'Alma', 'Milda', 'Taurus' and 'Seda', corresponding to different groups of end-use quality, have been developed at the Lithuanian Institute of Agriculture during the last decade and included in the Lithuanian National Plant Variety List. The new varieties are of

different earliness. The earliest-ripening variety is 'Alma'. It can be harvested one week earlier than the well known variety 'Širvinta' and 2-3 weeks earlier than 'Zentos'. The variety 'Ada' is the second in earliness and has the same length of growing period as 'Širvinta'. The varieties 'Milda' and 'Taurus' ripen one week later compared to 'Širvinta', 'Seda' ripens 10 days later. The best composition of HMW subunits predicting high quality as Glu-A1 1; Glu-B1 7+8 and 7+9; Glu D1 5+10 has been determined for the varieties 'Alma', 'Milda' 'Taurus' and 'Ada'. The mean sedimentation value of the varieties tested was as follows: 'Alma'- 64 ml, 'Milda'- 62, 'Ada'- 53, 'Taurus'- 53, 'Širvinta'- 52, and 'Seda'- 22 ml. The strongest flour was produced from the variety 'Alma', excellent from 'Ada', 'Milda' and 'Taurus'. The variety 'Seda' is intended for alcohol production and confectionary. All the varieties are characterized by a high Falling Number index. The yield penalty - grain loss, associated with high quality declined for the varieties 'Ada', 'Milda' and 'Taurus'. The varieties are high yielding and are characterized by strong and elastic gluten.

Key words: winter wheat, breeding, bread- making quality

Introduction

The winter wheat breeding programs of the Lithuanian Institute of Agriculture (LIA) are divided into the following groups according to their ultimate targets: early- ripening varieties with a high protein content and very strong gluten; early- medium ripening varieties with high bread-making quality; medium-ripening, high yielding varieties, with satisfactory bread- making quality; late ripening high yielding varieties not meant for bread- making purposes. For the milling industry it is necessary to have a large range of wheat varieties to produce flour mixtures because the baking industry requires raw material with specific processing characteristics. Increasing yield potential while maintaining desirable industrial quality is not an easy task because increases in grain yield usually result in decreases in protein, which is one of the major factors defining the industrial quality of wheat (Pena, 1996; Mašauskienė *et al.*, 2001).

During the last decade, 5 winter wheat varieties, corresponding to different groups of end-use quality, have been developed at the Lithuanian Institute of Agriculture. The strongest flour was produced by the variety 'Alma', excellent by 'Ada', 'Milda' and 'Taurus'. The variety 'Seda' is intended for alcohol production and confectionary (Ruzgas, 2003).

In this article we presented the results of the investigation on end use properties of the new Lithuanian winter wheat varieties, included in the National Variety List, conducted during the period 1998-2006.

Material and Methods

The field experiments were carried out in a replicated yield test in Dotnuva during 1998- 2006. The plots were 15- 20 m² in size. The soil of the experimental site is *Endocalcari-Epihypogleic Cambisol*, of neutral acidity pH 7. It contained 1.3 g kg⁻¹ organic carbon (2.2 g kg⁻¹ humus) in the plough layer and was moderate in available phosphorus and potassium. N 90 kg ha⁻¹ fertilization was applied annually. On the basis of eight years of experiments the data of 7 varieties were processed. The varieties were characterized using the following parameters: protein content by the Kjeldahl method (LST 1523:1998), wet gluten in flour, determined according to the Lithuanian standard LST 1522:2004, sedimentation value, determined by the methods of Zeleny (LST 1498:1997) The rheological properties (mixing tolerance in minute and other traits) were investigated and recorded by the Brabender's Farinograf (LST 1696:2001; ICC 115/1:1992 , alpha-amylase activity by the Hagberg Falling Number method (LST ISO 3093:1982). The grain quality index is a composite index including several of Brabender's pharinogram indexes: dough developing time, stability and softening. The composition of HMW subunits was analyzed using sodium dodecyl sulphate- polyacrylamide gel electrophoresis. For classification the system proposed by Payne *et al.*, was used (Blacman *et. al.*, 1987). The statistical data were processed using the software ANOVA and STAT_ENG (Tarakanovas and Raudonius, 2003).

Results and Discussion

The investigations of grain yield performance showed that all winter wheat varieties bred at LIA were higher yielding compared to the early ripening check variety Širvinta (Table 1). Compared to the late ripening check variety 'Zentos', 'Seda' was found to be higher yielding, which belongs to late ripening group also. The mean yield of 'Ada' was close to that of the check variety 'Zentos'. The highest gluten content was estimated in the grain of the varieties 'Alma' and 'Milda', flour output 'Milda' and 'Tauras'. All varieties were characterized by a excellent Falling Number index.

Table 1. Yield and quality characteristics of the Lithuanian winter wheat varieties, Dotnuva, 1998-2006

Variety	Grain Yield, t ha ⁻¹	Gluten content, g kg ⁻¹	Output of flour, g kg ⁻¹	Falling number, s	High molecular weight glutenins	
					Subunits	Scores
Širvinta	5.77	292	720	345	1; 7+9; 5+10	9
Zentos	7.14	254	730	375	0; 7+9; 5+10	7
Alma	6.32	312	720	366	1; 7+8; 5+10	10
Ada	7.03	278	720	371	1; 7+9; 5+10	9
Milda	6.74	306	740	361	1; 7+9; 5+10	9
Tauras	6.85	267	730	338	1; 7+9; 5+10	9
Seda	7.28	230	690	329	0; 6+8; 2+12	4
LSD _{0.5}	0.42	21.4	11.7	33.5	-	-
LSD _{0.1}	0.74	28.6	15.6	44.7	-	-

The dough quality is one of the most important features enabling one to predict the final bread-making value of the winter wheat variety. The elasticity of the dough was measured by Brabender's pharinograph, whose operations are based on physical methods. The diagram (pharinogram) showed direct indexes: water absorption, dough developing time, stability and other traits (Table 2, Figure 2).

Table 2. The dough rheological characteristics of the new Lithuanian winter wheat varieties

Variety	Water absorption, g kg ⁻¹	Dough developing time, min	Dough stability, min	Brabender's quality index
Ada	627	5.6	10.2	112
Alma	629	4.4	12.4	122
Milda	619	5.1	8.1	99
Tauras	597	3.7	8.2	92
Seda	565	2.1	2.9	41
Širvinta	621	3.7	6.3	77
Zentos	620	2.9	6.0	67
LSD 0.5	16	1.0	1.4	-
LSD 0.1	21	1.4	1.9	-

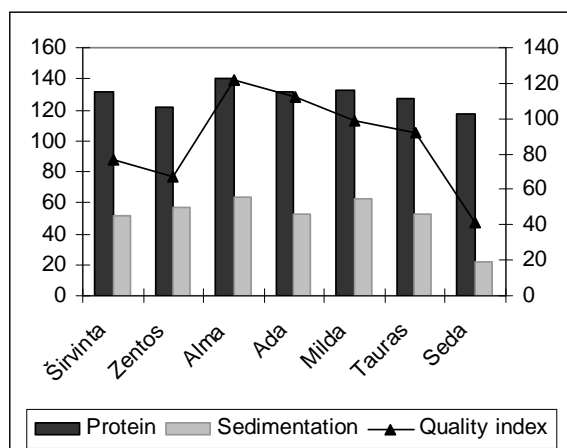


Figure 1. Protein content (g kg^{-1}), sedimentation Zeleny index (ml) and grain quality index

It is possible to consolidate all traits in the calculated Brabender's quality index. The pharinograms precisely showed the dynamics of the dough development characteristics of the individual varieties (Figure 2).

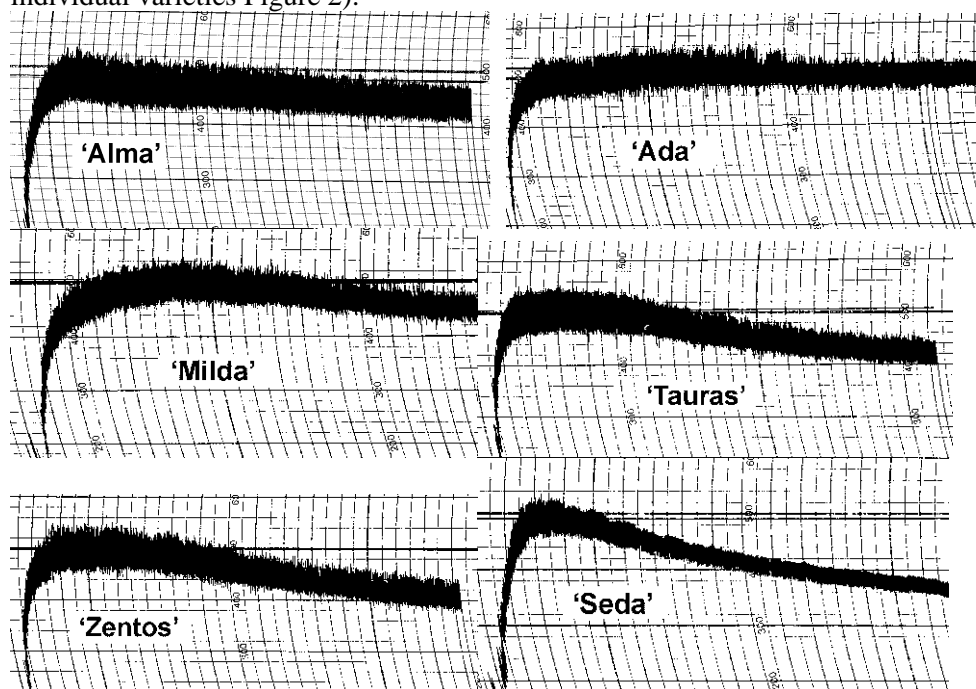


Figure 2. Dough rheology of the new Lithuanian winter wheat varieties, Brabender's pharinograms, 2006.

This study involved 5 new varieties bred at LIA and two checks, the local early ripening variety 'Širvinta' and the late ripening 'Zentos'. The new varieties are of different earliness. The earliest ripening variety is 'Alma'. It can be harvested one week earlier than the well known variety 'Širvinta' and 2-3 weeks earlier than 'Zentos'. The variety 'Ada' is the second in earliness, and has the same length of growing period as Širvinta'. The varieties 'Milda' and 'Tauras' ripen one week later compared to 'Širvinta'. 'Seda' ripens 10 days later. The ripening time is very important for the actual arvesting time, because the amylases of completely ripe varieties are more active compared with those of the varieties with late developing phases.

The prediction of a bread-making quality of winter wheat varieties by the analysis of HMW glutenin subunits is an important point in the conduct of breeding programs. On the another hand, the electrophoretic HMW glutenin tests are a proper method to test the genetic makeup of the new varieties, to verify if the variety is homosyous or not. The best composition of HMW subunits

predicting high quality as Glu-A1 1; Glu-B1 7+8 and 7+9; Glu D1 5+10 has been determined for the varieties 'Alma', 'Milda', 'Taurus' and 'Ada' (Paplauskienė and Ruzgas, 2002), (Table 1).

The sedimentation value indicates the protein quality. The mean sedimentation value of the varieties tested was as follows: 'Alma'- 64 ml, 'Milda'- 62, 'Ada'- 53, 'Taurus'- 53, 'Širvinta'- 52, and 'Seda'- 22 ml (Figure 1).

Varieties with sedimentation value exceeding 40 ml are considered as good, those exceeding 50 as exhibiting excellent bread-making quality. Sedimentation value below 30 ml is characteristic of wheat varieties with weak dough quality. Such varieties are intended for confectionery, alcohol production or starch separation.

Protein content is one of the more important indicators of grain quality for the bread making industry and one of the desirable traits of wheat in countries with cool climates. The Lithuanian wheat breeding programmes are focused on protein improvement and the mean protein content of the new winter wheat varieties is relatively high. It was found, that during the experimental period the mean protein value was as follows: Alma'- 140, 'Milda'- 133, 'Ada'- 131, 'Taurus'- 127, 'Širvinta'- 131, 'Seda'- 117 g kg⁻¹. The mean protein content in the grain of the check variety 'Zentos' was 122 g kg⁻¹.

The grain yield of the variety 'Alma' was the lowest compared with the other varieties (Table 1). It confirmed the conclusions of other authors that grain protein content is negatively correlated with grain yield (Bhatia, 1975). The equation of regression of the investigated varieties was $y = 21.96 - 1.20x$ (x- protein content, y- grain yield); $F = 22.56^{**}$; coefficient of determination $R^2 = 0.74$; $t = 3.10$. However, this statement is true when varieties with extremely high protein content or very strong dough properties are included in the experiment. The correlation between protein content and yield, except for the variety 'Alma', was negative but not significant: $y = 16.55 - 0.76x$; $F = 5.28$; $R^2 = 0.40$; $t = 1.23$ because the varieties 'Ada', 'Milda' and 'Taurus' were high yielding and had strong gluten.

Investigations by Brabender's pharinograf provide information about dough properties. It is important to predict the technological features of the varieties: the water absorption of the flour, dough development time, stability and mixing tolerance, to decide the quality group of a particular winter wheat variety. The highest mean water absorption was indicated for the varieties 'Alma' and 'Ada', the lowest for 'Seda'. The highest mean dough development time was indicated for the varieties 'Ada', 'Milda' and 'Alma'. The longest dough stability time was found for the varieties 'Alma', 'Ada', 'Taurus' and 'Milda'. According to Brabender's quality index the varieties ranked in the following order: 'Alma', 'Ada', 'Milda', 'Taurus', 'Širvinta', 'Zentos', 'Seda'.

The mixing tolerance showed dough elasticity. "Strong" and "weak" flours produce dough with very different mixing properties. The difference mainly results from the quantity and quality of protein. Different food stuffs prepared from wheat require very different flour strength for their manufacture. The new Lithuanian winter wheat varieties have different elasticities of dough. The strongest flour is determined for the varieties 'Alma' and 'Ada', moderately strong for 'Milda' and 'Taurus', (Figure 2), weak for 'Seda'. The grain quality index of those varieties was 122; 112; 99; 92; 41 and dough stability time 12.4, 10.2, 8.1, 8.2 and 2.9 min., respectively.

The correlation between protein content and mixing tolerance was high, the coefficient of determination was $R^2 = 0.58^*$, equation $y = -53.61 + 4.76x$ (x- protein content, y- mixing tolerance, min.), $F = 10.84^*$. The correlation between the sedimentation index and the mixing tolerance was lower, $R^2 = 0.42$, equation $y = -0.96 + 0.15x$ (y- sedimentation index, x- mixing tolerance). $F = 5.73^*$. The variety 'Seda' was characterized by weak gluten. Actually, this variety was bred for alcohol, confectionery and other purposes.

One of the most important traits of winter wheat is flour output, which is the percent of flour type 550 obtained from whole grain in the milling process. The highest output was estimated for the varieties 'Milda', 'Taurus', and 'Zentos'. All the varieties were characterized by high resistance to pre-harvest sprouting. This was shown by the Hagberg Falling Number index, highly correlating with pre-harvest sprouting and alpha amylase activities (Blacman *et al.*, 1987). The highest Falling Number index was characteristic of the varieties 'Zentos', 'Ada', 'Alma' and 'Milda'. In general, all the varieties had a Falling Number index exceeding the 250 levels required for bread-making wheat and are suitable for high quality production. This trait is very important for Lithuania and other countries with high air humidity at harvesting. Varieties for confectionery

should exhibit low protein content, sedimentation value, but a high Falling Number index. The variety 'Seda' possesses the mentioned features.

Conclusions

The winter wheat varieties 'Ada', 'Alma', 'Milda', 'Taurus' and 'Seda', corresponding to different groups of end-use quality, have been developed at the Lithuanian Institute of Agriculture during the last decade and included in the Lithuanian National Plant Variety List. The strongest flour was produced by the variety 'Alma', excellent by 'Ada', 'Milda' and 'Taurus'. The variety 'Seda' is intended for alcohol production and confectionary. All the varieties are characterized by high Falling Number index. The highest output of flour Type 550 was estimated for the varieties Milda and Taurus. The yield penalty- grain losses associated with high quality was reduced in the varieties 'Ada', 'Milda' and 'Taurus'. Those varieties are high yielding and are characterized by strong elastic gluten.

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ZIEMAS KVIEŠŲ SELEKCIJA DAŽADIEM IZMANTOŠANAS VIRZIENIEM

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Pēdējā desmitgadē Lietuvas Zemkopības institūtā izveidotas piecas ziemas kviešu šķirnes – Ada, Alma, Milda, Taurus, un Seda, kas paredzētas atšķirīgiem izmantošanas virzieniem un iekļautas Lietuvas nacionālajā augu šķirņu katalogā. Jaunās šķirnes atšķiras pēc to agrinuma. Visagrīnākā ir šķirne Alma, kas nogatavojas nedēļu ātrāk, nekā labi zināmā šķirne Širvinta un divas – trīs nedēļas agrāk par šķirni Zentos. Šķirne Ada ir otra agrīnākā un nogatavojas vienlaicīgi ar šķirni Širvinta, bet šķirnes Milda un Taurus pilngatavības fāzi sasniedz nedēļu vēlāk. Visvēlīnākā ir šķirne Seda, kas nogatavojas 10 dienas vēlāk nekā šķirne Širvinta. Šķirnēm Alma, Mild, Taurus un Ada konstatēts labākais lipekļa sastāvs - Glu-A1 1; Glu-B1 7+8 un 7+9; Glu D1 5+10, kas nodrošina labu maizes kvalitāti. Šķirne Seda ir piemērota spirta ražošanai un konditorejas izstrādājumu gatavošanai. Visām šķirnēm ir augsts krišanas skaitlis. Šķirnēm Ada, Milda un Taurus nav konstatēta būtiska negatīva korelācija starp graudu ražu un kvalitāti - tām ir augsts ražas potenciāls un vienlaicīgi arī stiprs un elastīgs lipekļlis.