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COMPARISON OF ALPHA-AMYLASE ACTIVITY OF WHEAT FLOUR ESTIMATED BY TRADITIONAL AND MODERN TECHNIQUES

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A b s t r a c t. Falling number method and amylograph test are methods widely used to determine the alpha-amylase activity of wheat flour. By comparison, mixolab might be used to measure dough characteristics such as protein quality, starch gelatinization, enzymatic activity and starch retrogradation in a single test. The objective of this study was to determine the variability of, and relationship among falling number, amylograph properties and mixolab parameters which characterised starch complex. Test was performed on 76 samples of wheat flour type 550 and type 750 produced in Poland. Mixolab parameters which characterise starch gelatinisation (C3), amylolytic activity (C4) and starch retrogradation (C5) allowed to better differentiate types of flour than falling number method or amylograph test. Falling number, maximum viscosity and final temperature of gelatinisation were positively correlated with starch gelatinisation (C3), amylolytic activity (C4, difference of the points C3C4) and starch retrogradation (C5, difference of the points C5C4).

K e y w o r d s : alpha-amylase activity, wheat flour, amylograph, falling number, mixolab

INTRODUCTION

Wheat flour, annual production of which in Poland is approx. 2.2 million tons (GUS 2013), is classified into eight types based on ash content, according to the Polish Standard PN-A-74022:2003. Two types of flour are most important in the baking and pastry industries. Wheat flour type 550 is used for the production of bread and pastry products. Wheat flour type 750 is used for the production of mixed bread, wafers and sticks.

The technological properties of flour and the quality of bread depend on both protein and starch characteristics. Starch quality is related to the amount of starch, starch damage and the activity of amylolytic enzymes of flour (Đurić *et al.* 2008, Koksel *et al.* 2009). Starch damage affects the ability of flour to absorb water during dough formation, and the ability to produce carbon dioxide in the fermentation process. Higher starch damage is required for bread production, lower for pastry production (Dubat 2004). Amylolytic activity of flour influences the quality of bread. The falling number method and the amylograph test are methods commonly used to estimate alpha-amylase activity of flour by millers and bakers (Rothkaehl 2003, Papouškova *et al.* 2011). Bread baked from wheat flour with too low alpha-amylase activity (falling number over 300 s, maximum viscosity over 800 AU) has diminished loaf volume, pale crust and dry crumb. Bread baked from wheat flour with too high alpha-amylase activity (falling number below 150 s, maximum viscosity below 100 AU) is characterised by low volume, dark crust and crumb, sticky crumb and large holes inside.

The rheological properties of a dough determined by mixolab are recorded on a graph. Measuring the consistency of a dough over time with gradual increase in the applied temperature enables the user to determine the quality of wheat flour and provides, in a single test, information on the protein and starch characteristics (dough development time, protein breakdown, starch gelatinisation, starch retrogradation, enzymatic activity) and interaction between these features (Dubat 2010).

The use of results obtained by mixolab requires much research and comparison with the results of traditionally used quality parameters (Codina *et al.* 2010, Banu *et al.* 2011, Szafrańska 2011). In recent years, a growing interest in the possibilities of using mixolab in research has been seen. Most of the research has been done in scientific units outside of Poland. The growing interest in mixolab by milling and baking industries means a need to adapt the interpretation of its results for wheat flours produced in Poland. For this purpose, two types of wheat flour produced in Poland were analysed using the starch damage, falling number and amylograph properties. The data were compared to those obtained from mixolab in order to establish some predictive models for evaluating the falling number and amylograph parameters as a function of mixolab values.

MATERIALS AND METHODS

Materials

Thirty eight samples of commercial wheat flour type 550 and thirty eight samples of wheat flour type 750 (harvest 2009 and 2010) were collected from nineteen milling companies located in Poland. The ash content varied between 0.45 and 0.63 for tested wheat flour type 550 and between 0.58 and 0.85 for wheat flour type 750 (Tab. 1).

Methods

For each wheat flour sample, the following qualities were determined: ash content (PN-EN ISO 2171), particle size distribution (PN-A-74015), falling number (PN-EN ISO 3093), starch damage (Górniak 2006). Wheat flour colour was evaluated using Minolta Chroma Meter Cr-310. The flour colour results were reported in terms of 3-dimensional colour values based on *L**, *a**, *b**. The amylolytic properties of flours (maximum viscosity, initial temperature of gelatinisation, final temperature of gelatinisation) were determined by Brabender amylograph (PN-ISO 7973). Rheological properties of a dough were studied using Chopin mixolab (Dubat 2010). The protocol has the following settings: mixing speed 80 rpm, total analysis time 45 min, dough weight 75.0 g, tank temperature 30°C, hydratation water temperature 30°C. Flour and water were added accordingly to obtain 75 g of dough with a maximum consistency of 1.10 Nm (±0.05) during the first test phase. Mixolab test was performed using standard protocol: 8 min at 30°C, heating at a rate 4°C min^{-1} for 15 min, holding at 90°C for 7 min, cooling to 50°C at a rate 4°C min^{-1} for 10 min and holding at 50°C for 5 min. A typical mixolab curve (Fig. 1) is divided into five different phases: phase 1, initial kneading; phase 2, protein weakening; phase 3, starch gelatinisation; phase 4, cooking stability; phase 5, starch retrogradation (Rosell *et al.* 2007).

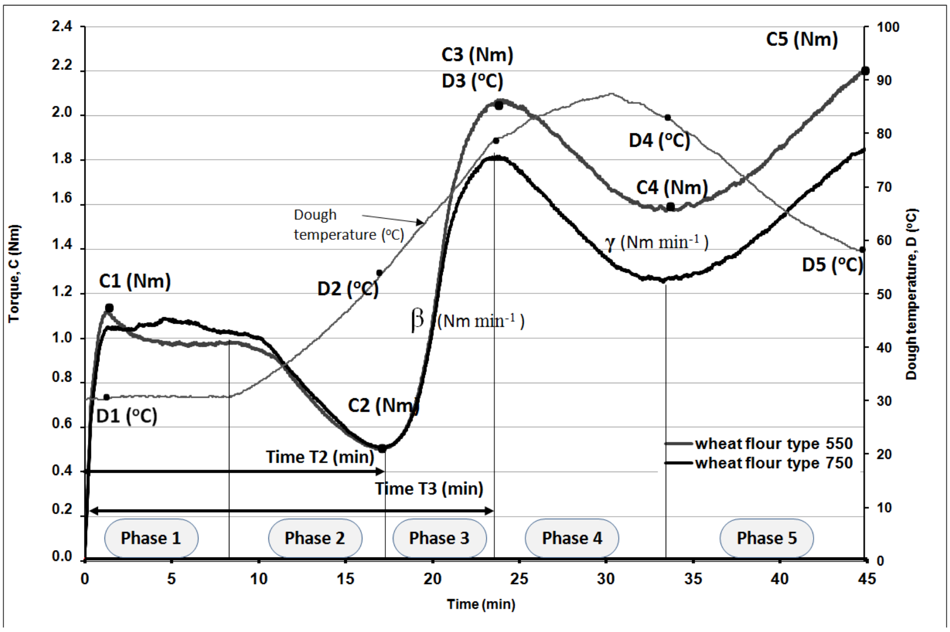

Fig. 1. Typical mixolab curves of wheat flour type 550 and type 750

The parameters that are obtained from the curve are water absorption (%), dough development time (time T1, min), dough stability (min), protein weakening (C2, N m), starch gelatinisation (C3 and the difference between points C3 and C2, abbreviated C3C2, N m), amylolytic activity (C4 and the difference between points C3 and C4, abbreviated C3C4, N m), starch retrogradation (C5 and the difference between points C5 and C4, abbreviated C5C4, N m). Time and dough temperature for C2 (time T2, min; D2, ^{o}C) and for C3 (time T3, min; D3, ^{o}C) as well as curve slopes between C2 and C3 (slope β, Nm min^{-1}) and between C3 and C4 (slope γ, Nm min^{-1}) were also recorded.

Statistical analysis

The results were statistically evaluated by the one-way analysis of variance (ANOVA) with subsequent Tukey's HSD test with Statgraphics Centurion XVI.I. Correlations between the mixolab parameters and wheat flour quality characteristics (ash content, falling number, amylographic parameters) were determined with the statistical significance expression on the level p = 0.05 and p = 0.01.

The multiple regression analysis was used to determine whether the falling number and amylograph characteristics were functionally related to mixolab parameters values, particle size distribution and starch damage. By this method the best subgroup of tested variables with the highest multiple correlation coefficients $R^2_{adjusted}$ of the 95% confidence interval was determined. The dependent variables are: falling number, maximum viscosity and final temperature of gelatinisation. The regression model between the dependent variables (Y) and independent variable (x_n) is:

$$Y = b_0 + b_1 \cdot x_1 + b_2 \cdot x_2 + \ldots + b_n \cdot x_n \qquad (1)$$

where b_0 is a constant value and b_i, $i = 1,\ldots,n$, are the regression coefficients of the predictive model (Tab. 7). The predictive models were well correlated with the measured data and were significant at p = 0.05. Student's t-test was used to determine the significance of each coefficient in the regression model.

RESULTS AND DISCUSSION

Flour samples were obtained from wheat from 2009 and 2010 crops in which grain was characterised by low alpha-amylase activity. Therefore the data was not characterised according to the year of production of flour. Tested flours were characterised in terms of particle size distribution, flour colour and parameters informing about alpha-amylase activity of flour (falling number, amylograph properties and chosen mixolab properties).

Particle size distribution (granularity) affects the ability to absorb water by flour, the physical properties of gluten and dough, as well as the quality of the bread (Jankowski 1981). Tested flours were characterised by fine granulation. Flour type 550 was characterised by higher share of fractions with particle size less than 95 μm than flour type 750 (Tab. 1). This fraction is said to be the most aligned in terms of size and has the best baking quality (Jurga 2003). There was no significant correlations between Mixolab parameters and particle size distribution.

Table 1. Ash content, particle size distribution and flour colour of tested wheat flours

Parameters	Wheat flour type 550			Wheat flour type 750		
	Mean	Range		Mean	Range	
		min	max		min	max
Ash content (%)	0.54^{a**}	0.45	0.63	0.75^{b**}	0.58	0.85
Particle size distribution (%)						
>132μm	22.1^{a**}	6.9	32.2	30.1^{b**}	13.9	48.5
95-132μm	29.0^{a**}	21.5	35.0	40.2^{b**}	22.3	60.3
<95μm	48.2^{b**}	27.7	62.7	29.6^{a**}	14.5	48.6
Flour colour						
Brightness, $L*$	91^{b**}	90	92	89^{a**}	88	91
$a*$	-1.80^{a**}	–2.26	–1.46	-1.42^{b**}	–1.80	–1.11
$b*$	9.51^{a*}	8.54	10.96	9.76^{b*}	8.80	10.82

ab – Mean values marked by different letters differ significantly at $p < 0.05$ (*) and $p < 0.01$ (**), respectively.

Flour colour often affects the colour of the final product and therefore is one of many wheat flour quality parameters included in specifications required by end-users. Flour colour is related to the type of wheat, bran layer content, bran colour, moisture content and particle size distribution (Jankowski 1981). Tested wheat flours were characterised by high brightness, $L*$, in the range of 88-92, which is required for production of pastry and many assortments of bread. Wheat flour type 550 had a significantly higher brightness than wheat flour type 750 (Tab. 1), due to lower content of bran particles. The $a*$ values, with all measurements below zero, confirm that the green tone was dominating over the red in tested wheat flours. Significantly more expressed green tone was detected for wheat flour type 750. The $b*$ values, with all measurements above zero, confirm that yellow tone was dominating over the blue in tested wheat flours.

The falling number test is a relatively simple and rapid method of estimation of alpha-amylase activity in flours. Optimal alpha-amylase activity of wheat flours for baking purposes should be on the average level (falling number in the range of 220-280 s) (Jurga 2003). Tested wheat flours were characterised by low alpha-amylase activity (falling number in the range of 288-476 s) (Tab. 2). These results agree with the observations of Cichoń and Ptak (2005) and Achremowicz *et al.* (2010) who indicated medium and low alpha-amylase activity of wheat flours produced in Poland.

Amylograph test measures the effect of alpha-amylase on the peak viscosity of a cooked flour slurry. It requires a sample size of approx. 80 g of flour and each test has a running time of 45 min. There were no significant differences in the values of maximum viscosity of tested wheat flours. Gelatinisation temperature is an important factor determining the technological quality of starch (Shuey and Tipples, 1994). Wheat flour type 550 was characterised by lower initial temperature of gelatinisation and higher final temperature of gelatinisation than wheat flour type 750 (Tab. 2).

Table 2. Falling number, amylograph properties and starch damage of tested wheat flours

Parameters	Wheat flour type 550			Wheat flour type 750		
	Mean	Range		Mean	Range	
		min	max		min	max
Falling Number (s)	362[a]	288	442	352[a]	291	476
Maximum viscosity (AU)	654[a]	310	1290	585[a]	340	1300
Initial temperature of gelatinisation (^oC)	58.5[a**]	57.5	59.5	58.8[b**]	57.0	60.0
Final temperature of gelatinisation (^oC)	86.1[b*]	78.5	91.5	84.2[a*]	78.0	91.0
Starch damage (UCD)	14.4[b**]	4.9	16.0	12.8[a**]	6.1	15.9

ab – Mean values marked by different letters differ significantly at $p < 0.05$ (*) and $p < 0.01$ (**), respectively.

The level of starch damage directly affects the water absorption and the dough mixing properties of flour and has a strong influence on dough preparation and baking process. The optimum damage starch value varies with the use of the flour and is greatly dependent upon the flour protein content, the alpha-amylase activity and the type of bread to be made from the flour (Dubat 2004, Górniak 2006).

Starch damage in tested wheat flours was in the range of 4.9-16.0 and was significant dependent on the type of flour (Tab. 2).

Rheological properties of dough was measured using mixolab. For this study only mixolab parameters related to the characteristics of starch were shown. Wheat flour type 550 was characterised by significant higher torque in points C3 (starch gelatinisation), C4 (amylolytic activity) and C5 (starch retrogradation) than wheat flour type 750 (Tab. 3). These results agree with the observations of Codina *et al.* (2010) who indicated a higher torque in point C3 in flours with lower ash content. Ash content determined in wheat flour type 550 and type 750 was negatively correlated with the torque in point C3 ($r = -0.431$ and $r = -0.504$, respectively) (Tab. 5 and Tab. 6).

Table 3. Mixolab characteristics (torque in chosen points and slopes) of tested wheat flours

Parameters	Wheat flour type 550			Wheat flour type 750		
	Mean	Range		Mean	Range	
		min	max		min	max
C3 (N m)	2.10^{b**}	1.91	2.30	1.94^{a**}	1.81	2.20
C4 (N m)	1.79^{b**}	1.33	2.09	1.61^{a**}	1.25	2.09
C5 (N m)	2.60^{b**}	1.91	3.32	2.37^{a**}	1.85	3.38
C3C2 (N m)	1.58^{b**}	1.44	1.75	1.44^{a**}	1.29	1.66
C3C4 (N m)	0.31^{a}	0.12	0.58	0.33^{a}	0.11	0.57
C5C4 (N m)	0.81^{a}	0.58	1.26	0.76^{a}	0.53	1.29
β slope (N m min^{-1})	0.528^{a}	0.320	0.698	0.518^{a}	0.376	0.620
γ slope (N m min^{-1})	-0.053^{a}	–0.162	–0.060	-0.051^{a}	–0.162	0.010

ab – Mean values marked by different letters differ significantly at $p < 0.05$ (*) and $p < 0.01$ (**), respectively.

Many experimental studies established the correlations between mixolab parameters and falling number as well as amylograph properties. According to Kahraman *et al.* (2008), there is no significant relationship between falling number and starch gelatinisation (C3), amylolytic activity (C4) and starch retrogradation (C5). Banu *et al.* (2011) obtained a positive correlation between falling number and the torque in points C4 and C5 and negative correlation with C3, whereas Dhaka *et al.* (2012) found negative correlation between falling number and C3, C4 and C5. In this work, significant correlations were observed between falling number and C3, C4 and C5 (Tab. 5 and Tab. 6). Higher correlation coefficients between falling number and mixolab characteristics points were noted for wheat flour type 750, ranging from 0.386 to 0.779 ($p<0.01$). Results obtained in this work agree with the observations of Codina *et al.* (2010) in which maximum viscosity showed a stronger connection with the torque in points C3, C4 and C5 than falling number (Tab. 5 and Tab. 6). The reasons for the differences should be seen in the methodology for determining both parameters. During amylograph and mixolab test there is a gradual heating of the sample, similar to the conditions inside bread dough during baking. The final temperature of gelatinisation of wheat flour type 550 and type 750 determined by amylograph was positively correlated with mixolab parameters C3, C4 and C5, with correlation coefficients ranging from 0.576 to 0.802 ($p<0.01$) and from 0.349 to 0.795 ($p<0.01$), respectively (Tab. 5 and 6).

The results obtained by Koksel *et al.* (2009) and Banu *et al.* (2011) indicate that the difference between the torque in points C3 and C2 (abbreviated C3C2), C3 and C4 (C3C4), C5 and C4 (C5C4) better characterised changes in the properties of a dough than analysing these parameters separately. The difference between points C3C2, which is associated with starch gelatinisation, decreased with increase in the ash content in wheat flour type 550 and type 750 ($r = -0.458$ and $r = -0.496$, respectively). The difference C3C2 of wheat flour type 550 was positively correlated with falling number and maximum viscosity (Tab. 5). The difference between the points C3C4, which is defined as an enzyme activity, was negatively correlated with falling number ($r = -0.643$ and $r = -0.835$, respectively), maximum viscosity ($r = -0.698$ and $r = -0.853$, respectively) and final temperature of gelatinisation ($r = -0.769$ and $r = -0.892$, respectively) (Tab. 5 and Tab. 6). The difference between points C5C4, which is related to staling of bread and may be a determinant of the shelf life of bread (Papouškova *et al.* 2011), was positively correlated with falling number ($r = 0.727$ and $r = 0.782$, respectively), maximum viscosity ($r = 0.861$ and $r = 0.823$, respectively) and final temperature of gelatinisation ($r = 0.706$ and $r = 0.794$, respectively).

Dough temperature, which is measured at each point of mixolab curve, allows to get information about initial temperature of gelatinisation (D2) and final temperature of gelatinisation (D3) (Szafrańska 2013). Initial and final temperature of gelatinisation measured by mixolab was lower than that measured by amylograph, by 4.5°C and 5.5°C, respectively, because of the differences in consistency of tested material (Tab. 4). The consistency of a dough tested by mixolab is approx. 500 BU while the amylograph test measures a flour-and-water slurry.

Mixolab measures the time required to obtain a torque in characteristic points of a curve. Time T2 is related to time in which starch begins to gelatinise, whereas time T3 is related to the end time of gelatinisation. Difference between these two parameters is connected to gelatinisation time (abbreviated Time T3T2) and in tested wheat flours was in the range of 6.0 to 8.7 min (Tab. 4). The gelatinisation time (Time T3T2) was significantly shorter for wheat flour type 550, with higher starch damage. Gelatinisation time determined by mixolab was shorter than obtained by amylograph by Wianecki and Kołakowski (2007) (16.4 min) because of the difference in heating rate which was 1.5°C min^{-1} for amylograph and 4°C min^{-1} for mixolab, respectively, and the difference in consistency of tested material. Gelatinisation time (Time T3T2) was positively correlated with maximum viscosity and final temperature of gelatinisation (Tab. 5 and Tab. 6). Higher correlation coefficients were obtained for wheat flour type 550 than for wheat flour type 750.

Table 4. Mixolab characteristics (temperature and time to reach characteristic points) of tested wheat flours

Parameters	Wheat flour type 550			Wheat flour type 750		
	Mean	Range		Mean	Range	
		min	max		min	max
Temperature D2 (°C)	53.6^{a**}	52.4	54.6	54.6^{b**}	52.3	56.7
Temperature D3 (°C)	79.7^{a}	77.8	83.3	79.4^{a}	78.2	82.9
Time T2 (min)	17.1^{a**}	16.7	17.4	17.3^{b**}	16.7	18.0
Time T3 (min)	24.3^{a}	23.3	26.0	24.1^{a}	23.5	25.8
Time T3T2 (min)	7.2^{b**}	6.2	8.7	7.0^{a**}	6.0	8.7

ab – Mean values marked by different letters differ significantly at $p < 0.05$ (*) and $p < 0.01$ (**), respectively.

Table 5. Correlation coefficients between ash content, falling number, amylograph parameters and chosen mixolab characteristics[a] of tested wheat flour type 550

	Ash content	Falling Number	Maximum viscosity	Initial temperature of gelatinisation	Final temperature of gelatinisation
C3	–0.431**	0.377*	0.502**		0.576**
C4		0.582**	0.681**		0.763**
C5		0.704**	0.829**		0.802**
C3C2	–0.458**	0.338*	0.470**		0.490**
C3C4		–0.643**	–0.698**		–0.769**
C5C4		0.727**	0.861**		0.706**
γ slope					
Temperature D2					
Temperature D3					
Time T2				0.384*	
Time T3		0.380*	0.513**		0.529**
Time T3T2		0.409*	0.549**		0.595**

[a] *, ** Correlation coefficients significant at $p < 0.05$ and $p < 0.01$, respectively.

Table 6. Correlation coefficients between ash content, falling number, amylograph parameters and chosen mixolab characteristics[a] of tested wheat flour type 750

	Ash content	Falling Number	Maximum viscosity	Initial temperature of gelatinisation	Final temperature of gelatinisation
C3	–0.504**	0.386*	0.376*		0.349*
C4		0.743**	0.750**		0.763**
C5		0.779**	0.801**		0.795**
C3C2	–0.496**				
C3C4		–0.835**	–0.853**		–0.892**
C5C4		0.782**	0.823**		0.794**
γ slope		0.583**	0.650**		0.641**
Temperature D2	0.445**				
Temperature D3		0.373*	0.431**		0.515**
Time T2	0.503**				
Time T3			0.352*		0.411*
Time T3T2			0.355*		0.338*

[a] *, ** Correlation coefficients significant at $p < 0.05$ and $p < 0.01$, respectively.

In this study a multiple procedure indicated that there was more than one significant independent variable. The relationships between the studied parameters are given in Table 7. The regression equation models for falling number contain two mixolab variables: starch gelatinisation (C3) and starch retrogradation (C5) for wheat flour type 550, and four mixolab variables: C3, C5, slope β and time T3 for wheat flour type 750. The coefficients of all variables are statistically significant. The regression models obtained accounted for, respectively, 59.6 and 81.9% of the variance in the dependent variable falling number (Tab. 7). The standard errors of estimation show the standard deviation of the residuals to be 24 and 17 s, respectively.

The models for maximum viscosity explain 79.4 and 86.7%, respectively, of the variation of maximum viscosity variable of wheat flour type 550 and type 750. These models contain such mixolab parameters as starch gelatinisation (C3) and starch retrogradation (C5), slope β, slope γ and time T3 (Tab. 7). The standard errors of estimation show the standard deviation of the residuals to be 105 and 78 AU, respectively.

The regression models for final temperature of gelatinisation include three mixolab variables: dough torque in points C3, C5 and slope β. The values of the determination adjusted coefficient show that the models explain 74.7 and 85.6%, respectively, of the variation of the final temperature of gelatinisation dependent variable (Tab. 7). The standard errors of estimation show the standard deviation of the residuals to be 1.7 and 1.4°C, respectively.

Table 7. Equations for the empirical relations between falling number, maximum viscosity, final temperature of gelatinisation and parameters of the mixolab curve

Dependent variable	Type of wheat flour	Regression equation	$R^2_{adjusted}$
Falling number	type 550	462.2 – 210.8C3 + 131.9C5	0.596
	type 750	1486 – 243.1C3 + 168C5 – 177.3β – 40.27T3	0.819
Maximum viscosity	type 550	758.8 – 1235C3 + 926.9C5 – 1555γ	0.794
	type 750	5159 – 1361C3 + 883.6C5 – 973.6β – 146.5T3	0.867
Final temperature of gelatinisation	type 550	71.52 + 9.077C5 – 17.06β	0.747
	type 750	105 – 28.20C3 + 14.29C5	0.856

CONCLUSIONS

1. Wheat flour types tested in this study were characterised by low alpha-amylase activity. According to the results of falling number and maximum viscosity there was no significant difference between the alpha-amylase activity of tested wheat flour types.
2. Rheological properties of dough measured by mixolab: starch gelatinization (C3), amylolytic activity (C4) and starch retrogradation (C5) were different in tested wheat flour types.
3. Wheat flour type 550 was characterised by significant lower initial temperature of gelatinisation than wheat flour type 750, determined both by amylograph and mixolab. Gelatinisation time (Time T3T2) was different between the flour types and was positively correlated with falling number, maximum viscosity and final temperature of gelatinisation.
4. Statistical analysis on wheat flour type 550 and type 750 using multiple regression method showed that mixolab values can be used to elaborate predictive models for estimating values of the falling number ($R^2_{adjusted}$ = 0.596 and 0.819, respectively), maximum viscosity ($R^2_{adjusted}$ = 0.794 and 0.867, respectively) and final temperature of gelatinisation ($R^2_{adjusted}$ = 0.747 and 0.859, respectively).

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PORÓWNANIE TRADYCYJNYCH I NOWOCZESNYCH METOD OCENY AKTYWNOŚCI ALFA-AMYLAZY MĄKI PSZENNEJ

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Streszczenie. Do określenia aktywności alfa-amylazy mąki pszennej powszechnie stosuje się oznaczenie liczby opadania i cech amylograficznych. Dla porównania, mixolab jest stosunkowo nowym urządzeniem do oceny jakości mąki, które może być wykorzystywane do badania w jednym teście cech ciasta pod kątem właściwości białka, kleikowania skrobi i aktywności enzymów amylolitycznych. Celem pracy było określenie zmienności i związków między liczbą opadania, parametrami amylograficznymi i parametrami odczytanymi z mixolabu, które charakteryzują cechy skrobi. Badania wykonano dla 76 próbek mąki pszennej typ 550 i typ 750 wyprodukowanych w Polsce. Parametry odczytywane z wykresu z mixolabu: kleikowanie skrobi (C3), aktywność enzymów amylolitycznych (C4) i retrogradacja skrobi (C5) lepiej różnicowały typ mąki niż liczba opadania i parametry amylograficzne. Liczba opadania, lepkość maksymalna zawiesiny i końcowa temperatura kleikowania skrobi były dodatnio skorelowane z kleikowaniem skrobi (C3), aktywnością enzymów amylolitycznych (C4, różnica C4C5) oraz retrogradacją skrobi (C5, różnica C5C4).

Słowa kluczowe: aktywność alfa-amylazy, amylograf, liczba opadania, mąka pszenna, mixolab