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STARCHES FROM WHEAT OF VARIOUS TECHNOLOGICAL VALUE

Summary

The research was carried out on the grain of wheat classified to different quality classes (A, B or C) grown in 1998-1999. Protein content, wet gluten were measured, and bread was baked from flour. When starch was extracted from the flour, the following analyses were performed: amylose and phosphorus content, and its swelling and pasting characteristics.

It was stated that investigated starches from the varieties of wheat belonging to different classes greatly vary in their properties.

It was stated with full confidence that a high pasting temperature and medium water binding capacity and solubility are favourable for baked bread volume.

Introduction

It was commonly believed that properties of proteins, mainly gluten, were responsible only for dough properties and a large volume of the obtained bread from wheat flour. But, for many years much attention has been devoted to the role of the main component of flour, that is starch. Sanstedt [16] and Hoseney et al. [8] defined the role of this component in dough and obtained in the process of baking bread. Starch is a substrate for amylases. It provides them with fermentable sugars. It is also a water system regulator, which brings gluten dilution to proper consistency. It has been scientifically proven that wheat starch has the best baking characteristics [1, 7, 8].

Many scientists were investigating the influence of the physico-chemical properties of the starch on dough and bread quality. Dennet et al. [2] claimed that a greater volume of bread was connected with the decrease in the amount of amylose. The stud-

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ies of Werli and Pomeranz [14], followed by Gambuś [5] proved the important role of fatty substances in flour, especially glicolipids, but also phospholipids in the formation of dough structures.

The integrity of starch granules plays an important role in obtaining the optimal properties of dough. It depends on its swelling and pasting properties. Although Gambuś et al. [17] showed a negative correlation between baked model breads and starch solubility in water, the recent studies by Gambuś [4, 5] proved, that limited swelling and solubility positively influenced bread quality.

Apart from the starches of low viscosity, which have a negative impact on bread quality, the extent of viscosity of starch pastes plays no key role in the formation of bread structure [17].

Basing on a thermal analysis of wheat flour Eliasson et al. [3] claim that a high pasting temperature and a small paste enthalpy improves baking properties.

From the work of D'Appolonia and Gilles [1] one can conclude that baking properties of starch depends not only on a type of plant from which the starch was extracted, but also its variety. There is a lack of full information about the physicochemical properties of the starch extracted from wheat varieties belonging to different quality classes. Therefore, this problem is the subject of this article.

Materials and methods

Winter and spring wheat came from the two cultivation seasons of 1998 and 1999 [table1].

The above mentioned varieties were divided into classes according to the following quality parameters [9]: a falling number of grain, protein content in grain, sedimentation test, farinnographic analysis (water absorption, softening), bread volume, flour yield.

The starches were separated by the laboratory method [15], next they were analyzed to determine their total phosphorus content by Marsch [11], pasting characteristics of 8.5% water suspensions in a rotating viscometer Rheotest II, using spikes as a measuring device [6], water binding capacity (WBC) and solubility in water at 60^0 and 90^0C by modified the Leach's method [15] and apparent amylose content by Morrison and Laignalet [13].

Results and discussion

The starch was extracted from eight varieties of wheat (grown in the season of 1998–1999 (Table 1)), which were classified according to their quality [9] into A, B and C classes.

Table 1

Characteristics of the used for research material.

Kind of variety	Harvesting season	Variety of wheat	Quality class
Jara	1998	Torka	A
		Jasna	A
		Eta	A
Ozima	1998	Begra	A
		Almari	C
		Elena	C
Jara	1999	Torka	A
		Jasna	A
		Eta	B
		Helia	C
Ozima	1999	Begra	A
		Kobra	C
		Elena	C

The extent of changes of the physicochemical properties of the starches from the varieties of wheat of the same quality class is presented in table 2. From this table one can conclude that the value of the individual physicochemical properties do not considerably vary for the starches of different quality classes. On the contrary, the starches from the wheat of different quality classes were characterized by a similar range of changes of the individual properties.

Table 2

Properties of starch isolated from wheat of different quality classes.

Quality class	Starch properties							
	Amylose content	Total phosphorus	WBC [g/1g d.m.]		Starch solubilty in water [%]		Pasting characteristics	
	[%]	[mg%]	60°C	90°C	60°C	90°C	Pasting temp. [°C]	Maximum viscosity [B.u.]
A	17.9 - 22.1	47 - 60	5.1 - 6.9	9.1 - 10.5	0.5 - 5.0	7.7 - 10.7	63.5 - 79.5	46 - 101
B*	18.2	57	6.2	9.9	3.1	7.1	73	84
C	19.6 - 21.1	48 - 55	5.7 - 6.5	9.3 - 11.0	1.4 - 3.2	4.8 - 14.1	64.5 - 78.5	38 -58

*only one variety was analysed in this class.

Protein content, wet gluten and the physicochemical properties of the starch extracted from the flour of the specific variety were compared with the volume of baked bread. Pearson's linear correlation coefficient was computed between protein content and wet gluten and physicochemical properties of starch and bread volume.

It was proven there was no significant correlation between protein content, wet gluten and volume of bread, despite the well known role of gluten in the formation of baking value of wheat flour.

A highly significant (at importance level 0,01) positive correlation (r = 0,70) was obtained between pasting temperature of starch and bread volume. This correlation was presented in fig. 1 and was confirmed in Eliason's work [3]. The authors think that completing of starch pasting causes to finish the increase in bread volume in the oven, and if it occurs at a higher temperature, there is more time for bread volume to increase.

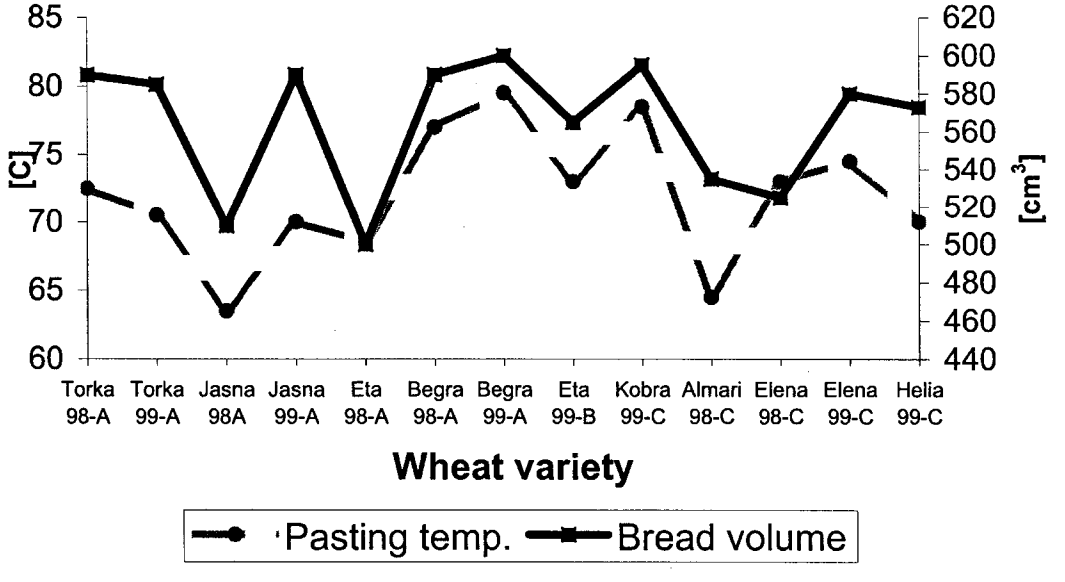

Fig. 1. Bread volume vs pasting temperature of starch.

In fig. 2 an inversely proportional correlation between bread volume and maximum starch pastes viscosity was presented. This observation is supported by a correlation coefficient between the mentioned properties which is r = -0,68 (at importance level 0,01). This correlation is contrary to the works of Gambuś et al. [17], where

model breads (40 g of dough) were made from gluten and starch of very different viscosity (27–474 mPa·s). These results were not confirmed in the later works by the above - mentioned author [4, 5], who baked model breads and came to the conclusion that functionality of starch in bakery goods did not depend on maximum paste viscosity, but on these physicochemical properties that influenced the size of swelling and pasting of starch during dough formation and baking.

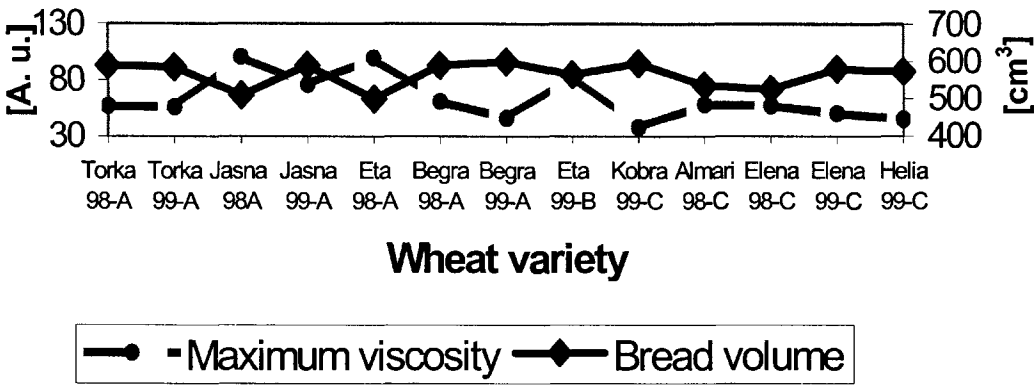

Fig. 2. Bread volume vs maximum viscosity of starch paste.

The content of starch lipids was measured by assessing the content of phosphorus [12]. Results obtained in the present work do not confirm the important role of starch lipids, mostly phospholipids, in the formation of dough structure, as was shown in the earlier works [5]. It is not surprising, because during the formation of dough from flour, glicolipids play the main important role. However, artificially created flour made from starch, dry vital gluten [5] was used for baking model breads and due to the lack of glicolipids a positive role of starch phospholipids was shown in stabilization of the gas pores of bread and in increasing of loaf volume.

The correlation between water binding capacity or solubility of starch and bread volume has not been confirmed. According to Sanstead's theory [16] the most suitable is such water binding capacity and solubility of starch granules, that ensures their proper contact with gluten with preservation of granule integrity. It leads to the conclusion that the most proper are medium values of these parameters.

Conclusion

The results obtained in the present work show that the properties of starch isolated from different varieties are not considerably different from various quality classes. It was only stated with full confidence that a high pasting temperature and medium water binding capacity and solubility in water of starch are favourable for obtaining optimal baking performance.

LITERATURE

[1] D'Appolonia B.L., Gilles K.A.: Effect of various starches in baking. Cereal Chem., **48**, 1971, 625.
[2] Dennett K., Sterling C.: Role of starch in bread formation. Starch/Stärke, **31**, 1979, 209.
[3] Eliasson A.C., Gudmundsson M.: Thermal behaviour of wheat starch in flour - Relation to flour quality. Lebensm. Wiss. U. Technol., **28**, 1995, 227.
[4] Gambuś H.: Przydatność testu wypiekowego do oceny zmian jakości skrobi. Mat. Na VI Letnią Szkołę Skrobiową, Poznań, 1994, 176.
[5] Gambuś H.: Wpływ fizyczno-chemicznych właściwości skrobi na jakość i starzenie się pieczywa (badania modelowe). Zesz. Nauk. AR w Krakowie, Rozprawy nr 226, 1997.
[6] Gambuś H., Nowotna A.: Physicochemical properties of deffated *Triticale* starch Pol. J. Food Nutr. Sci., **1/42**, 1992, 101.
[7] Hoseney R. C., Finney K. F., Pomeranz Y., Shogren M. D.: Functional (breadmaking) and biochemical properties of wheat components. VIII. Starch. Cereal Chem., **48**, 1971, 192.
[8] Hoseney R. C., Lineback D.R., Seib P.A.: Role of starch in baked foods. The Bakers Digest, **52**, 1978, 11.
[9] Klockiewicz-Kamińska E., Brzeziński W.: Metody oceny i klasyfikacji jakościowej odmian pszenicy. Wiadomości Odmianoznawcze, Zeszyt 67, 1997, COBORU, Słupia Wielka.
[10] Kusunose Ch., Fujii T., Matsumoto H.: Role of starch granules in controling expansion of dough during baking. Cereal Chem., 76, 1999, 920.
[11] Marsch B. B.: The estimation of inorganic phosphate in presence of adenosine triphosphate. Biochem. Biophys. Acta, **32**, 1959, 357.
[12] Morrison W. R.: Lipid in cereal starches: a review. J. Cereal Sci., 8, 1988, 1.
[13] Morrison W.R., Laignelet B.: An improved colorimetric procedure for determing apparent and total amylose in cereal and other starches. J. Cereal Science, 1, 1983, 9.
[14] Pomeranz Y.: Modern cereal science and technology. VCH Publishers, 1987.
[15] Richter M., Augustat S., Schierbaum F.: Ausgewählte Methoden der Stärke-chemie. VEB Fachbuch Verlag, Leipzig, 1969.
[16] Sandstedt R.M.: The function of starch in backing of bread. The Bakers Digest, **36**, 1961, 36.
[17] Gambuś H., Lewczuk J., Nowotna A., Fortuna T.: Effect of physicochemical properties of triticale starch on selected indices of bread quality. Acta Alim. Pol., **14**, 1988, 131.

SKROBIE Z PSZENICY O RÓŻNEJ WARTOŚCI TECHNOLOGICZNEJ

Streszczenie

Materiałem badawczym było ziarno pszenicy zaklasyfikowane do różnych klas jakości (A, B lub C), uprawiane w latach 1998-1999. Oznaczono w nim zawartość białka i glutenu mokrego, po czym z mąki wypieczono chleb. Po wyodrębnieniu skrobi z mąki, została ona przebadana pod względem: zawartości amylozy i fosforu oraz wyznaczono ich charakterystykę pęcznienia i kleikowania.

Stwierdzono, że pod względem przebadanych właściwości skrobie z odmian pszenic, należących do jednej klasy, znacznie różnią się właściwościami.

Stwierdzono z całą pewnością, że wysoka temperatura kleikowania skrobi wpływa korzystnie na objętość wypieczonego chleba.